Editor's Message

Dear Readers

We are pleased to present this supplementary issue of the Indian Economic Journal, which features 35 selected papers from the ICSSR Sponsored Two-Day National Seminar on "Vision 2047: Aligning SDGs with India's Development Aspirations," held on August 29-30, 2024, at Kurukshetra University, Kurukshetra.

This seminar brought together scholars, practitioners, and policymakers to discuss and share insights on the critical alignment of the Sustainable Development Goals (SDGs) with India's development aspirations. The papers included in this issue reflect a diverse range of perspectives and innovative ideas that contribute to our understanding of sustainable development in the Indian context.

We extend our heartfelt gratitude to the Indian Council of Social Science Research (ICSSR) for their financial assistance, which made this seminar possible. Their support has been invaluable in fostering academic dialogue and promoting research on important issues related to India's future.

We also appreciate the contributions of all authors who submitted papers, and the rigorous review process undertaken by our reviewers.

We hope that this collection of papers will inspire further research and dialogue on aligning India's development goals with sustainable practices, ultimately contributing to the vision of a prosperous and equitable future for all.

Thank you for your continued support.

Warm regards,

Hemlata Sharma
Sanjeev Bansal
Ravindra K Brahme

CONTENTS

Healthcare Occupations and the Structure of Gender Wage Inequality in Haryana: A Theil Analysis

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Abstract

The aggregation and integration of sectors which provides healthcare facilities to treat the patients is called healthcare industry or medical economy. The present study is an attempt to estimate the within-group and between-group wage inequality among various healthcare related occupational groups, across four selected districts in Haryana. The study has selected four districts of Haryana namely Gurugram, Panchkula, Rewari and Jhajjar on the basis of their HDI ranking. To achieve the maintained objectives, Theil index, one of the most important measures in generalised entropy family, has been utilised on the primary data of 600 workers employed across healthcare based occupational groups. The level of wage inequality has found to be highest among workers related to professional healthcare occupations and the wage inequality has witnessed lowest among other support workers. Despite, the female domination the study has found huge difference between the wages of male and female workers in healthcare related occupations. Herein, discrimination towards females, over-presented female in low paid categories, motherhood, demanding working conditions on field etc. are some of the cited reasons behind increasing wage inequality in healthcare related occupations.

Key Words: Wage Inequality, Healthcare, Occupation, Gender Discrimination, Theil Index.
JEL Code: I14, J01, J31, J71

1 INTRODUCTION:

Healthcare facilities are fundamental to every economy and society. Any job which provides healthcare facilities to others is called healthcare occupation. Wages are the payments, which labour receive for the exchange of their work contribution in the process of production. All the compensation made to the employees for their both physical and mantle work are called wages when wages are distributed unequally among working population that is called wage inequality. Further, unequal wage patterns among workers engaged in healthcare occupation is called healthcare occupational wage inequality (Jonsson et al., 2009). Herein, the study analysed within-group and between-groups wage inequalities across different occupations related to healthcare sector. Within-group and between-group wage inequality are very different form each other. Between-groups wage inequality means comparison of wages between two groups, while within-group wage inequality means comparing the wages of workers with in the same group.

According to World Health Organisation (2022), wage inequalities are increasing among healthcare occupations. The wage inequality has decreased in some of the specific occupations but the overall inequality is increasing in healthcare sector. Further, healthcare sector is female dominated industry. In spite of the dominance, female workers are facing wage inequalities in healthcare occupations (WHO, 2022). Occupational diversity has been one of the important reasons for wage inequality, since the 1980s, and employment status has been changing among healthcare occupations (Matekaasa, 2011; Williams, 2013). Such changes are characterized as a U-shape pattern of employment which is termed as job-polarization, which often coincides with wage-polarization. As per the consequences of wage-polarization, wages have increased across occupations such as; for professionals and technical

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professional of healthcare sector, because of the consequent rise in the demand of professionals doctors after wage-polarization (Helland, 2017; Sarkar, 2018; Madan and Mor, 2020).

The study has five important sections. Section 1 gives a brief introduction of the existence of wage inequality. Section 2 presents a detailed literature review to explore relevant studies to formulate a test hypothesis to fill the research gap. Detailed methodology for testing of the hypothesis is discussed in section 3 and section 4 provides the results and make a discussion of various important findings of the study. Section 5 concludes the study.

2 LITERATURE REVIEW:

2.1 Persistence of Wage Inequality across Healthcare Occupations:

Wage inequality started increasing among healthcare professional workers and technical healthcare workers after 1999. At the same time, wage inequality was the lowest among support healthcare workers and non-healthcare workers (Ahmad, 2001, Madan and Mor, 2022). Physician and advanced practitioners has highest wage inequality. During 1993-94 to 2011-12, wage inequality was highest among managers, professionals, technicians & associate professionals and senior officials including healthcare professionals (India Wage Report, 2011-12). During the phase of high economic growth i.e.1993-94 to 2005-09, wage earnings increased for healthcare professional and other administrative category workers in urban areas leading to the highest level of wage inequality among those categories of workers (Mehrotra et al., 2014). At the same time, professional and technical non-health workers also face wage discrimination. Despite a consistent rise in the overall wage level, overall wage inequality has increased by 9 percent. However, due to increasing participation of females in professional healthcare occupations, wage inequality has started declining (Moore, 2018). During 2004-11, wage earnings of technical professionals was increasing which further affected the employment growth (Chiswick, 1971; Ahuja, 2020; Khurana & Mahajan, 2020).

Different type of occupational structure leads different levels of wages among workers. As workers with risky and technical jobs are being paid comparatively higher wages than those who are engaged in less risky occupations. Because, workers in highly risky occupations requires specific skills (Madan & Goel, 2019; Madan & Mor, 2020). Further, the performance labour productivity of high and low skilled labour is also different, which leads wage differentials among different occupations (Mukherjee & Majumder, 2011). Social and legal barriers are also associated with wage inequality, which restricts the demand and supply of labour. If an occupation is providing services of quality, it shows the strength of occupations and further, it affects the wage level of related occupations (Bol & Weeden, 2015).

H_{01}: Wage inequality does not exist across different healthcare occupational groups

2.2 Gender-based Wage Inequality Among Healthcare Occupations:

Gender wage inequality is phenomenon problem in Indian labour market. Despite, the dominance of female workers in healthcare sector females are getting low wages as compare to their male counterparts. According to the World Inequality Report (2022), male workers are getting wages which is 82 percent of total labour income whereas females are earning just 18 percent. Herein, fifty years has passed of the Equal Pay Act, but the gender wage inequality remains the major issue in developing countries including India. Female spend their twenty hours in doing unpaid work which is comparatively higher than male (Human Development Report, 1995). Healthcare sector is emerging globally and this sector is dominated by female workers around the world. There is most of the work done by female is officially unpaid. A high proportion of male workers is engaged as main workers. Main workers are considered as whole time workers. In 2011, 75.4 percent of male workers were

working as main workers whereas, female workers were only 24.4 percent of total workers, which was far less than males (Census of India, 2011). Even at present, female workers are working as supportive workers. Female workers do not want to hold main workers position by their own. They prefer to do household work and the job of supportive workers.

Further, Women Labour Participation (WLP) is an important aspect in gender wage inequality (WHO, 2022). WLP in India is very low because of their domestic responsibilities. Female labour force participation rate also varies from state to state or region to region. In northern region of India, there is more patriarchal society whereas, in southern region the labour participation rate is comparatively higher (Esteve-volart, 2004; Mcdill, 2024). Healthcare occupations are sharply divided on the basis gender across north Indian states. Male worker's participation has always been higher in Indian labour market. It is two- third of total labour force. During 1971, 79.9 percent of total workforce were male workers. There was a slight decline in male workers working proportion in 2011, it was 68.9 percent of total workforce. During this time period, the number of female workers was increasing. In 1971, total working female was constituted 20.1 percent which has increased to 31.1 percent in 2011. On the other hand, the growth rate of female workers, during this time period was not uniform. Cohen et al. (2009) explained that during 1980's, entry of female workers in to scientific & technical specific occupations and business occupations benefitted the female workers' progress in labour market (Hultin & Szulkin, 2003; Ara, 2021).

H_{02}: Gender segregation does not affect wage inequality across different healthcare occupational groups.

3 RESEARCH METHODOLOGY:

3.1 Objectives of the Study:

- To analyse the wage inequality across different healthcare occupational groups.

- To identify the impact of gender segregation on wage inequality across healthcare occupational groups.

3.2 Selection of Research Area:

The study pertains towards analysis of wage inequality across five broad occupational groups in Haryana. Haryana is highly prosperous state and located in northern part of India. Haryana has 22 districts. All the districts are classified in to four categories according to their Human Development Index (HDI) on the bases of the report 'Vision 2030'published by government of Haryana in 2017. The districts with HDI above 0.800 are classified as very highly developed, districts with 0.700 to 0.799 HDI value are highly developed, those districts which have HDI value 0.550 to 0.699 are medium developed, and below 0.550 are less developed districts (UNDP, Human Development Classification, 2019-20). In this regard one district Gurugram (0.889) comes under very highly developed category, one district Panchkula (0.777) comes under highly developed category, 7 districts namely Faridabad (0.696), Panipat (0.677), Ambala (0.660), Sonipat (0.615), Kurukshetra (0.576), Yamunanagar (0.573) and Rewari (0.563) comes under medium developed category and 12 districts namely Sirsa (0.508), Mahendragarh (0.497), Rohtak (0.483), Hisar (0.480), Kaithal (0.466), Karnal (0.438), Jhajjar (0.419), Fatehabad (0.379), Jind (0.358), Bhiwani (0.339), Mewat (0.276) and Palwal (0.271) comes under less developed category. Herein 4 districts have chosen in all, selecting one from each category. Following the criteria Gurugram is selected from very highly developed category, Panchkula is selected from highly developed, Rewari is selected from medium developed category and Jhajjar is selected from less developed category.

3.3 Selection of Occupational Groups:

The study has utilized International Standard Classification of Occupations-08 (ISCO) to classify the healthcare occupations. Herein, the study has decomposed all the healthcare related occupations in to six major occupational groups (Table 2) on the basis of Gender Wage Gap Report on Healthcare Sector by World Health Organization (2022). Herein, the major groups 21 and 22, mentioned in ISCO-08, have included in Professional Healthcare workers. Workers comes under these groups are engaged in occupations such as; medical doctors, advanced nurses, professional laboratory workers. Further, the major groups 31 and 32 have been categorized as Technical Healthcare Workers. These occupational groups include workers e.g. nurses and workers who are working in technical laboratory and paramedics. Further, the major groups 51, 53 and 91 of ISCO-08, has categorized as support health care workers. Herein, the occupational groups which are mentioned in major groups 1 & 2 are called Professional Non-Healthcare Workers. Further, the occupations mentioned in major groups 31 and 32 are categorised as Technical Non-Healthcare Workers, and occupations comes under two-digit code i.e. 40 are called as Other Support Workers.

3.4 Database and Sampling:

Primary data information is collected from 600 respondents who are engaged in six selected occupational groups in healthcare sector. 100 respondents have taken from each occupation. The desired information covering various facts of study is collected by well-designed questionnaire. The selection of respondents has done as per systematic random sampling.

3.5 Data Analysis:

To estimate the complex measures related to wage inequality, Theil Index, which is a special case of generalized entropy index, has been utilized. Most of the research works related to inequality are based on household surveys and provide comprehensive details on inequality related to distribution of income & other social strata by utilising Gini coefficients index (Conceicao & Galbraith, 1988). Gini index, Atkinson index and Theil index, all are sensitive measure of economic inequality and can be used to measure wage inequality. At the same time, Gini Index has limited ability to analyse complex data & patterns related to inequality within and across different groups/countries under consideration (Conceicao & Ferreira, 2000). An Italian statistician name Corrado Gini had developed Gini Index. Gini Index also called as Gini Coefficient or Gini Ratio. It is a measure of statistical dispersion expected to calculated wage, income and wealth inequality within a nation or an occupational and social group. Gini index ranges between 0 to 1. Where the Gini index value '0' reflects perfect equality among group or nation. And when the Gini index stands on the value'1' it reflects perfect inequality. If everyone is getting same wages, it means Gini index is '0'. But when, for large number of population only one person or individual is earning all the wages and all other have nothing, the Gini index will be '1'. Whereas Atkinson index is useful in determining which end of the distribution most to the observed inequality. At the same time Atkinson index becomes sensitive at lower end and upper end of income distribution (Cowell, 1985; Fields, 2003). Hereby, the study utilised Theil index to facilitate comparing levels of inequality in interest. Theil index is a decomposable measure of inequality and an efficient measure to compares in-between and within group inequality (Braun, 1988).

The values of Theil index lie between '0' to '1'. When the value of Theil index is '0', it indicates a situation of perfect equality, whereas the value '1' shows the situation of perfect inequality in distribution. Theil index has properties which makes it more powerful measure as compared to other measures as it can calculate complex pattern of inequality (Conceicao & Ferreia, 2000).

The Theil T index is defined as (Henri Theil, 1967):

$$T(1) = \frac{1}{N} \sum_{i=1}^{N} \frac{xi}{\mu} in \left(\frac{xi}{\mu}\right)$$

Where N for size of population, x_i is individual income. μ is the mean income of population. To measure within group wage inequality, the ratio of wages for each group and average level of wages is computed using i.e. Theil index, to derive logarithm of wages for each occupational group in the first step. In the second step, mean log deviation is computed by taking summation of logarithm of wages and further dividing it by total number of 'N' and taking its negative to obtain mean log deviation. In the final step, the logarithm of wage is multiplied with the ratio of wage groups and average wages and thereafter dividing the resultant figure by summation of total number of 'N'. The Theil index thus obtained can never be negative. As a rule of thumb, equality between share of wage and working population indicates the absence of inequality and diversion from the equality leads towards wage inequality.

3.5.1 Measurement of Within-Group Wage Inequalities:

Herein, the following formula has been utilized to measure the within-group inequalities across different healthcare based occupational groups.

The Theil T index is defined as (Henri Theil, 1967):

$$T(1) = \frac{1}{N} \sum_{i=1}^{N} \frac{xi}{\mu} in \left(\frac{xi}{\mu}\right)$$

3.5.2 Measurement of Between-Group Wage Inequalities:

When wages are distributed unequally between two and more groups is called between-groups wage inequality. Present study has selected six occupational groups of healthcare sector to calculate wage inequality across them. Herein, T' formula has applied to compute between-group wage inequalities across healthcare occupations.

T' is defined as (Conceição & Ferreira, 2000):

$$T' = WOcc.1\left[log\left(\frac{WOcc.1}{NOcc.1}\right)\right] + WOcc.2\left[log\left(\frac{WOcc.2}{NOcc.2}\right)\right] + WOcc.3\left[log\left(\frac{WOcc.3}{NOcc.3}\right)\right] + WOcc.4\left[log\left(\frac{WOcc.4}{NOcc.4}\right)\right] + WOcc.5\left[log\left(\frac{WOcc.5}{NOcc.5}\right)\right] + WOcc.6\left[log\left(\frac{WOcc.6}{NOcc.6}\right)\right]$$

The above formula defines the between-group wage inequalities among healthcare occupational groups. T' formula is the weighted summation of wage share and logarithm of the ratio between wage and population of each occupational group. Where 'WOcc.' are presenting wage share of workers and

'NOcc.' are presenting population share of workers in related occupation. 'Population shares' and 'Income shares' are compared with each other. If both the shares are equal to each other, it shows perfect wage equality and if the shares are different from each other it shows different levels of wage inequality.[1]

4 RESULTS AND FINDINGS:

Wage distribution among the population is an important indication of wage inequality. When each worker gets a similar share in overall wages, wages can be perceived to be equally distributed. The more the deviation from equal distribution, the larger wage inequality will be. Table 1 is presenting the shares of working population and share total wages among six healthcare based occupations.

Table:1 Wage and population shares of different occupational groups in healthcare sector.

Occupations	Wage Share (in Percentage)	Population Share (in percentage)
Professional Healthcare Workers	21.52	16.66
Technical Healthcare Workers	19.45	16.66
Support Healthcare Workers	18.72	16.67
Professional Non-healthcare Workers	14.91	16.67
Technical Non-healthcare Workers	13.35	16.67
All Other Support Workers	12.05	16.67

Source: Author's calculation based on data gathered from survey.

Workers associated with different occupational groups has different wage shares, but the population shares are same i.e. 16.66 percent for each occupation. According to the table 1, professional healthcare workers hold 21.52 percent share of total allocated wages, which is highest among all followed by technical healthcare workers with 19.45 percent. Further, other support workers are standing on the lowest position with 12.05 percent wage share. Whereas, the wage share of support healthcare workers, professional non-healthcare workers, and technical non-healthcare workers are (18.72, 14.91 & 13.35) percentages respectively. This is common practice in an economy that equal distribution of wage and population shows equality in an economy (Madan & Yadav, 2022). But larger the difference between wage and population share shows larger the inequality. Herein, table 1 is presenting large gap between the wage shares of workers who are working as professional healthcare workers and other support workers. Further, the study utilized Theil index for computing the within-group wage inequality across selected healthcare occupations among four selected districts of Haryana (table 2).

[1]Note: Professional Healthcare Workers is defined as (Occupation 1), Technical Healthcare Workers as (Occupation 2), Support Healthcare Workers as (Occupation 3), Professional Non-Healthcare Workers (Occupation 4), Technical Non-Healthcare workers (Occupation 5), All other support workers as (Occupation 6).

Table: 2 Within-group wage inequality across six healthcare occupational groups among four selected districts.

Occupations	Gurugram	Panchkula	Rewari	Jhajjar
Professional Healthcare Workers	0.467	0.502	0.623	0.645
Technical Healthcare Workers	0.452	0.479	0.551	0.592
Support Healthcare Workers	0.406	0.471	0.502	0.570
Professional Non-healthcare Workers	0.377	0.460	0.480	0.531
Technical Non-healthcare Workers	0.350	0.421	0.444	0.464
All Other Support Workers	0.331	0.372	0.419	0.457
Within-group Wage Inequality	0.307	0.394	0.415	0.558

Source: Author's calculation based on data gathered from survey.

Herein, table 2 makes it clear that the highest wage inequality is found among professional healthcare workers and technical healthcare workers as indicated by the respective values of their Theil Index in each district. Herein, professional healthcare workers of Jhajjar district has highest wage inequality among all with the value of Theil index (0.645), which indicates 64 percent wage variation among professional healthcare workers and 59 percent wage variation among technical healthcare workers is estimated. Herein, specialization of doctors, work experience and type of organization etc. are some of the cited reasons behind the higher level of wage inequality among professional healthcare workers (Levanon et al., 2009). Further, Doctors with specialization of cardiologist, neurosurgeon, orthopedic and oncologists etc. typically earns more wage as compare to endocrinology specialists, pediatricians, public health & preventive specialists, rheumatologists (Warner & Lehmann, 2019; Dill & Frogner, 2024). On the other hand, all these groups of doctors with different area of specializations are classified under same category (professional healthcare workers). Further, workers with different work profile requiring different cognitive skills and type of organization also affects the wage level of workers. Because workers engaged in non-profit organization are earning lower wages as compare to workers in for-profit organisations. Because non-profit organisations have charitable tendencies (Levanon et al., 2009; Dill & Frogner, 2024). Herein, because of the homogeneous working pattern of workers, the within-group wage inequality is found to be the least among other support workers in each district. Theil index for other support workers in Gurugram district is found to be lowest (0.331), which indicates 33 percent wage inequality, at the same time the Theil index for the same is found to be 0.457 among workers who are associated with this occupational group in Jhajjar district, it indicates 45 percent wage variations among workers. These results correspond with the difference between wage share and population share presented in table 1. Further, the overall within-group wage inequality is found to be highest among workers in Jhajjar district with the respective value of Theil index 0.558, which indicates 55 percent wage variation among workers working in six healthcare occupational groups. Different working situations at workplace, lack of working facilities, different level of economic development, diverse labour market conditions and different socio-economic factors are the main reasons behind the different level of wage inequality among each districts (Ballou & Weisprod, 2003; Marchand et.al, 2020). Herein, the study also analysed between-group wage inequality among workers engaged in different healthcare occupational groups. Table 3 is presenting between-groups wage inequality across different healthcare based occupational groups.

Table:3 Between-Group Theil Index across different healthcare occupational Groups.

Occupations	Wage Ratio	Population Ratio	Log Wage	Contribution to Theil Index
Professional Healthcare Workers	0.22	0.16	0.318	0.069
Technical Healthcare Workers	0.19	0.16	0.171	0.032
Support Healthcare Workers	0.18	0.16	0.117	0.021
Professional Non-healthcare Workers	0.15	0.16	-0.065	-0.009
Technical Non-healthcare Workers	0.14	0.16	-0.133	-0.018
All Other Support Workers	0.12	0.16	-0.287	-0.034
Between-group Theil Index				0.061
Within-group Theil Index				0.55
Between-group+within-group= Total Theil				0.61

Source: Author's calculation based on data gathered from survey.

Herein, table 3 presents the between-groups Theil index among healthcare occupations is found to be 0.061, which is much smaller than within-groups (0.55). Further, the overall Theil index i.e. 0.61, signaling around 61 percent variation in the wages of workers associated with different healthcare occupations (table 3). The Theil index for between groups is the summation of contribution of different occupational groups. It indicates that within-groups wage inequality is the main contributor in overall wage inequality. This provides a sufficient reason to prove wrong our 1st maintained hypothesis of no-existence of wage inequality across various healthcare occupational groups in the Indian labour market. Herein, the study formulated hypothesis that is there is no wage inequality among healthcare occupations, but as the study analysed the wage inequality with the help of Theil index, it has been found 61 percent overall wage inequality within occupational groups which are exclusively based on healthcare sector. So, the study rejected its first maintained hypothesis.

The reason behind the wage inequality is the diverse work profile of workers in accordance with their position and possessed skill level to handle tasks of routine and non-routine, cognitive (learning new things, making decisions, processing language, solving problems etc.) and non-cognitive task (self-discipline, motivation, leadership, creativity and emotional intelligence of workers etc.) contents (Ahmad, 2001). Diverged skills of workers, i.e. cognitive skills and technical skills, make them different from other workers to handle specific tasks more efficiently than others. Furthermore, some socio-economic factors such as; work experience of workers, family status, stress bearing & handling abilities, risk seeking capabilities, critical thinking abilities, region, etc. also affect interpersonal capabilities of workers making them to work & respond differently at their workplaces. In case of female workers, household responsibilities usually imply dual burden, which is a challenge to them for work-life balance as revealed out in research in similar line (Jafee 1989; Chakraborty & Chakraborty 2010; Das 2012). Hereby, appropriate measures such as; advocate the biased wage policies, increase the wage transparency, stop treating the part-time doctors differently etc. are need to be adopted to

reduce the level of wage inequality. Similar studies (Wood, 1997; Ahmad, 2001; Madan, 2002; Ballu & Weidproad, 2003; Cohen et.al, 2009; Madan, 2019; Madan & Yadav, 2022) in this line have suggested that diversifying duties, policies and programmes which further remove gender occupational segregation, government policies such as; vocational training and labour awareness programs, different public employment policies for healthcare sector and education may be helpful in reducing the level of wage inequality. The strong legal regulatory framework by government medical associations for the labour market may be helpful in improving the dynamic of wage inequality and protect the rights of workers to make them less vulnerable to exploitation.

4.1 Gender Based Wage Inequality across Healthcare Workers:

Female workers are in disadvantageous position in Indian healthcare occupations. They are facing higher wage inequality as compare to their male counterparts. Table 4 is presenting the Theil index among male and female workers across six occupational groups related to healthcare sector.

Table:4 Theil index across different occupational groups in healthcare sector on the basis of gender of workers.

Occupations	Theil Index (Male)	Theil Index (Female)
Professional Healthcare Workers	0.43	0.74
Technical Healthcare Workers	0.38	0.63
Support Healthcare Workers	0.40	0.58
Professional Non-healthcare Workers	0.31	0.52
Technical Non-healthcare Workers	0.25	0.46
All Other Support Workers	0.22	0.41

Source: Author's calculation based on data gathered from survey.

Herein, table 4, female workers has different value of Theil index across each occupation is found to be highest among all. Further, values of Theil index for male workers are on the lower side as compare to female workers. Herein, highest within-group gender wage inequality is found among female workers engaged with professional healthcare workers. Theil index for female professional healthcare workers is 0.74, which indicates 74 percent wage inequality within female workers. Despite the female dominance in healthcare occupations, this is questionable level of wage inequality. Herein, gender of workers differentiates their wages, because in some of the emergency cases female doctor not available because of their domestic responsibilities. Herein wages are also different, because of workers with different specialization and locations of their institute (Warner & Lehmann, 2019; Dill & Frogner, 2024). Further, technical healthcare workers and support healthcare workers have highest wage inequality among female workers followed by professional non-healthcare workers. The Theil index is found to be (0.63, 0.58 & 0.52) for technical healthcare workers, support healthcare workers and professional non-heath care workers respectively. Wage inequality among male workers is also highest among workers who are working as healthcare professionals and those who are doing technical work in healthcare sector followed by support healthcare workers with the value of Theil index (0.38, 0.40 & 0.31) respectively. Furthermore, the lowest level of wage inequality among male and female workers is analysed among other support workers. These results provide us sufficient reason to prove wrong our 2nd maintained hypothesis of no-existence gender wage inequality across various healthcare occupational groups in the Indian labour market. Herein, the study maintained its second hypothesis that is no-existence of wage inequality on the basis of gender, but as the study analysed that wage inequality among female workers is on the higher side (table 4) as compare to male workers. So, it indicates that wages are determined on the basis of gender of workers across healthcare based occupations.

Several factors can be responsible for the gender wage inequality among healthcare workers. As male workers earn more wages and tend to supervise female workers (Hultin & Szulkin, 2003). On job working conditions are different for female workers, because of their parenting demand. Female-dominated occupations are low-paid as compare to male-dominated occupations. In healthcare sector, most of the female are working as nurses, assistant nurses, and other support workers, whereas male are associated with high-paid professional occupations. Because male workers dominate on the higher positions in working organisations (Warner & Lehmann, 2019). Male workers are being overpaid, because of the misconception that female workers can't do highly skilled work. In some cases, of emergency requirement of doctors, females are not present at workplace, because of their other domestic duties. Mother-friendly working sites and work which has least physical danger are mostly occupied by female workers. (Cohen et al, 2009; Hultin & Szulkin, 2003; Joshi & Kumara, 2018; Mohanty & Bisht, 2014). Occupational segregation is the most prominent factor for the same, because, high-paid occupation/industries hires more male workers than female workers. There are only fewer female workers are engaged on senior designations and higher paying positions. Female workers are facing a lot of social and economic barriers such as; single parenting, education, barriers to entry in labour market, motherhood, domestic work etc. Despite, the same job patterns, female workers paid lesser than male workers. Gender wage differences also affected by the difference of educational qualification of male and female workers. (Levanon et al., 2009; Dill & Frogner, 2024).

5 CONCLUSION:

The study highlights the existence of within-group and between-group wage inequality across six occupational groups of healthcare sector. After analysing various aspects of wage inequality, the study concludes that the highest wage inequality is found among healthcare professional workers. The main reason for the increasing level of wage inequality is the diverged work profiles of workers, categorized in healthcare professional group. Workers with obligation to perform varied nature of work in different occupations. Herein, Gururam district has lowest wage inequality and Jhajjar has highest wage inequality in healthcare sector. The difference in the level of urbanisation, social-economic conditions, transportation facilities etc. are some of the cited reasons behind the existence of occupational wage inequality across various districts of Haryana. Government policies to increase per-capita sates domestic product and expenditure on social and economic development may be helpful in reducing wage inequalities. Further, female workers have higher wage inequality across each occupation. The main fact behind this is the over presence of female workers in low-paid occupations (e.g. nurses, other support workers), while the male workers overrepresented in high-paid occupational categories (e.g. medical doctors). Appropriate policies to advocate the gender biased wage policies, can be helpful to remove gender wage inequality. Further, wage transparency also holds the organisations accountable by highlighting the discrimination with the female workers. Thus, ending the gender wage inequality can make females more independent and make them equitable for overall working practices. As wage inequality can severely damage the structure of the labour market which further serves as impediments for economic growth, government should adopt constitutional provisions to reduce wage inequality.

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Innovative Approaches to Sustainable Urban Planning: Technology-Driven Solutions for Drainage Management and Water Conservation

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Abstract

The investigates new technology-driven innovative approaches to sustainable urban planning with respect to drainage management and water conservation, and their alignment with SDGs 6 and 11. Available secondary literature and case studies have been reviewed in this study to assess the effectiveness, challenges, and potential of smart stormwater management systems, green infrastructure, technologies for water conservation, and decentralized water management approaches within an urban context.

According to key findings, smart stormwater systems can reduce combined sewer overflows by up to 90%, while green infrastructure can decrease peak runoff by 30-50%. Water conservation technologies, such as smart metering, have revealed their potential for reducing urban water consumption by about 10-20%. Many innovations also indicate clear alignment with several SDG targets and huge co-benefits pertaining to improved urban liveability and climate change adaptation.

Case studies from Copenhagen, Singapore, and Rotterdam illustrate best practice on long-term planning, political commitment, and engaging communities. However, the major adoption obstacles include institutional fragmentation, a lack of technical expertise, and old regulatory frameworks. Future research directions include long-term performance evaluations, strategies to scale up successful pilots, their integration with other urban systems, and explorations of governance models for the overcoming of the remaining barriers to implementation. The results of the study indicate that while these innovative approaches have huge potential to create sustainable and resilient cities, much further research, policy innovation, and cross-sector collaboration are needed to realize this potential.

Key words: Sustainable Urban Planning, Drainage Management, Water Conservation, Technology-Driven Solutions, Sustainable Urban Drainage Systems (SuDS)

1. INTRODUCTION

Due to rapid urbanization, population growth, and climate change, urban areas worldwide are facing unprecedented challenges in managing water resources and drainage systems(World Cities Report 2020: The Value of Sustainable Urbanization | UN-Habitat, n.d.). Sustainable and innovative approaches to urban planning, particularly in the realms of water conservation and drainage management are necessary to culminate these challenges (Fletcher et al., 2015). A framework for addressing these urban water management issues was provided by The United Nations' Sustainable Development Goals (SDGs), specifically SDG 6 (Clean Water and Sanitation) and SDG 11 (Sustainable Cities and Communities) (United Nations, 2015). SDG 6 seeks to "ensure availability and sustainable management of water and sanitation for all," while SDG 11 aims to "make cities and human settlements inclusive, safe, resilient and sustainable" (United Nations, 2015). As climate change induces increased precipitation and overwhelming rainstorm events, urban drainage systems are essential for controlling stormwater runoff and minimizing flooding (Willems et al., 2012). Thus,

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conventional "grey" infrastructure approaches are often insufficient to eliminate these issues, leading to an increasing number of people interested in innovative, technology-driven solutions and "green" infrastructure (Eckart et al., 2017).

1.1 Significance of the Study

For a period of one month or longer, every year, an estimate of 4 billion people experiences severe water scarcity, which indicates that the water scarcity is a growing concern in many urban areas (Mekonnen & Hoekstra, 2016). This emphasis the importance for efficient and effective water conservation techniques and technologies in urban planning and development.

In order to improve water conservation and drainage management, new technologies like artificial intelligence (AI), IoT devices, and improved sensing systems could be used to gather data in real-time, forecast outcomes, and trigger automatic responses. To enhance urban water management opportunities various new technologies, such as Internet of Things (IoT) devices, artificial intelligence (AI), and advanced sensing systems are offered (Kerkez et al., 2016). These various technologies can provide real-time data, forecast outcomes, and trigger automatic responses in order to promote water conservation and drainage management efforts.

This paper will describe how such strategies are aligned to help achieve 2030 SDGs 6 and 11. This paper seeks to identify best practices, challenges, and opportunities for implementing these creative solutions in an urban context, drawing on a comprehensive literature review from various secondary sources, including scholarly articles, case studies, and policy briefs.

1.2 Research Questions

How do innovative, technology-driven approaches to drainage management and conservation of water help in driving the process of sustainable urban planning and fall within the SDGs 6 and 11?

1.2.1 Sub-questions

- Which of the technological solutions are the most promising for a sustainable urban drainage and water-saving pattern?
- How do these new innovative approaches align and contribute to the targets of SDGs 6 and 11?
- What are some key challenges and opportunities for the implementation of these solutions within an urban context?

1.3 Research Objectives

1. To identify innovative technology-driven solutions toward sustainable water conservation and urban drainage management through an in-depth review of secondary data sources.

2. To assess the innovative approaches that might align with and contribute to specific targets within the goals of SDG 6, Clean Water and Sanitation, and SDG 11, Sustainable Cities and Communities.

3. To evaluate the challenges, opportunities, and best practices connected with the implementation of innovative solutions in urban settings and recommendations provided for targeting urban planners and policy-makers.

The research questions and objectives give sharp focus to the study, which is directed to evaluate the

relevant secondary sources for the most innovative approaches and toward more sustainable urban planning, with a peculiar interest in drainage management and water conservation technologies. These would also underline the strong link of the research to the SDGs and the practical implications for urban development.

2. LITERATURE REVIEW

One of the main focal points in sustainable development in urban areas is water management, particularly in the regions that are rapidly urbanizing. Effective drainage management strategies, water conservation, and technology innovations are required to address the main challenges arising from climate change, population increase, and resource scarcity(Water Conservation Technique - Product That Reduces Water Use in Building - Econaur, n.d.). This literature review compiles available material on current urban drainage management practices, water conservation strategies in urban settings and technological innovations in urban water management.

2.1 Reviews on Current Urban Drainage Management Practices

A review of new drainage solutions for improving performance and sustainability in urban drainage is necessary. This paper presents a range of approaches, including SuDS, integral to sustainable urban drainage that involves the process of naturalization into urban environments (Harahap et al., 2024).

The paper reviews, based on 78 journals, the effectiveness of urban stormwater drainage systems in flood management within urban areas. It identifies common challenges and offers insights into best practices for improving drainage infrastructure (Teshome, 2020).

The principles of sustainable drainage highlight the need for considering the environmental and social impact of decisions made regarding drainage. This paper gives a general overview of SuDS benefits to be adopted for flood risk management and water quality improvement (Sustainable Drainage, n.d.).

2.2 Reviews on Water Conservation Strategies

In this respect, the study on surveys based on various strategies for water saving in urban areas and highlights the fact that when it comes to resolving the causes of water insufficiency, integrated approaches are essential(Lestari et al., 2024).

One of the reviews discusses how user behaviours impact urban water conservation efforts. This review shows how personal factors and economic stimuli can be key drivers to influence such conservation practices(Saurí, 2013).

2.3 Reviews on Technological Innovations in Urban Water Management

The reviews underline the IoT innovations' transformative potential in the city water management sector, from wastewater management to water quality monitoring(Aivazidou et al., 2021).

A study on technological innovations related to water has shown their high impact in improving the efficiency of water use in several urban settings but barely any researching into scaling them in developing regions and at what cost (Tan & Zou, 2023).

2.4 Gaps Existing in The Research

- While many publications do focus on innovative drainage practices, there is a lack of summary evaluations with respect to long-term effectiveness and adaptability in diverse urban contexts.

- There is a real lack of studies that assess how far integrated water conservation strategies bringing together technological, behavioural, and educational components are effective.

Such gaps, if addressed, can help future research in developing more effective and sustainable urban water management practices.

3. METHODOLOGY

3.1 Research Design

The research design of the study is qualitative in nature, with a broad review and analysis of secondary data sources. The research is exploratory-descriptive, as it tries to collate knowledge lying in the realms of innovative urban water management solutions and point out patterns and trends. The described nature of the research also allows it to borrow elements from both the systematic review and integrative review, such that the study provides an in-depth, comprehensive review of available literature.

3.2 Data Collection Methods

The data collection will be based on a systematic search and retrieval of sources relevant to answering the questions, which are secondary. The following sources are to be considered:

a) Academic databases: Scopus, Web of Science, Google Scholar, and Science Direct will provide the relevant peer-reviewed journal articles, conference proceedings, and academic books.

b) Government and international organization reports: Websites and databases of relevant organizations such as the United Nations, World Bank, OECD, and national urban planning departments will be scouted for policy documents, technical reports, and statistical data.

c) Industry white papers and technical reports: Reputable industry associations, think tanks, and technology companies will also be scouted for relevant publications on innovations in urban water management.

d) Case studies: Several documented case studies of urban centres around the world that have implemented innovative solutions to water management problems will be sourced through research in academic literature and publications from professional journals.

3.3 Data Analysis Methods

a) Systematic Review: Many studies' findings will be taken into consideration. This study shall, therefore, be guided by the principles in PRISMA to ensure that the process for this review is very transparent and reproducible.

b) Content Analysis: Qualitative content analysis for the identification of themes, patterns, and trends within the data collected. This will comprise an exercise in coding and categorization of information relating to technological solutions and their alignment to the SDGs, together with implementation challenges and opportunities.

c) Comparative Analysis: Comparison of case studies for the identification of best practices, common challenges, and successful implementation strategies across different urban contexts.

4. RESULTS

Hence, several resultant key findings arise in respect to the investigations on the current practices of urban drainage management, water conservation strategies in the urban setting, and technological innovations in the management of water in the urban areas. These results are substantiated by a base of data that has been extracted from academic journals, municipal reports, and technology assessments. We summarize hereafter the main results across such thematic areas.

Figure 1: System-level stormwater measurement and control (adapted from Kerkez et al., 2016)

Sensors are currently used for anything from stormwater facility performance studies to regulatory compliance. On the other hand, by allowing stormwater infrastructure to change from static to highly adaptive, these technological advancements have the potential to become extremely revolutionary (Fig.1) (Kerkez et al., 2016).

Research confirms that traditional urban drainage systems are more and more established as inefficient through changing climate and rapid urban growth. Innovative approaches, which include Sustainable Urban Drainage Systems, have been termed hopeful in their ability to improve the efficiency and resilience of the system (Yazdanfar & Sharma, 2015). A full review identified barriers to the adoption of sustainable drainage solutions, namely regulatory and financial constraints (Kiparsky et al., 2013). Also, the case studies from around the world show how innovative drainage solutions can improve flood management and water quality (Yazdanfar & Sharma, 2015).

In urban water conservation strategies, it is the behaviors of different users that become very relevant and are affected by variables such as age and income. While large-scale public education campaigns could be an effective way to promote water conservation, the impact of these interventions has seldom been rigorously evaluated (Saurí, 2013). Literature points out that integrated strategies coupling technological solutions with behavioral interventions should be implemented in order to realize enhanced water conservation efforts (Aivazidou et al., 2021). While smart technologies, such as IoT devices and real-time monitoring systems, have shown a promising trend in optimizing urban water management. On the other hand, nature-based solutions, in this case Green Infrastructure, is a relatively new practice for managing urban water resources; it still lacks long-term performance data (Sustainable Water Management in Urban Areas: Integrating Innovative Technologies and Practices to Address Water Scarcity and Pollution, n.d.).In spite of the potential benefits, major barriers exist in the widespread diffusion of innovative technologies, ranging from fiscal constraints to lack of technical expertise (Kiparsky et al., 2013).

In some cases, combined sewer overflows can be reduced by up to 90% through real-time control of urban drainage systems using IoT sensors and actuators. Furthermore, they observed that such systems could be built at about 1/10 of the cost of traditional infrastructure expansion (Kerkez et al., 2016). Results suggest that on a local scale, green infrastructure solutions could reduce peak runoff by 30-50%. Moreover, those types of solutions give other benefits related to improved water quality and reduction of the urban heat island (Eckart et al., 2017). Implementations of smart water metering in several cities are described, with these systems likely to achieve average water savings of 10-20% through leak detection and changes in consumer behavior (Cominola et al., 2015).

Grey-water re-use systems can save from 16% to 40% of potable water demand in buildings, depending on the type of building and system design (Ghaitidak & Yadav, 2013). Other researchers have examined rainwater harvesting systems in urban areas and reported that they can supply 30-50% of the non-potable water demand of residential buildings, significantly reducing municipal water supply pressure (Campisano et al., 2017). The nature-based solutions for urban water management contribute to SDGs. It established close links to SDG 6, especially targets 6.3, 6.4, and 6.6, and with SDG 11, targets 11.3, 11.5, and 11.7, and synergies with climate action, SDG 13 (Wendling et al., 2018). It identified institutional fragmentation, lack of political will, and limited community engagement as the major barriers to adopting Water Sensitive Urban Design. It called for approaches that are integrated and backed by supportive governance structures (Brown et al., 2016).

4.1 Case Studies: "Analysis of successful implementations in different cities; lessons learned and best practices."

This would typically be a detailed investigation into discrete urban areas that have had successful implementation of innovative approaches to sustainable urban planning with regard to drainage management and water conservation. Also, this shows an evaluation of good practices in the implementation of innovative water management solutions in cities worldwide. Drawing on case studies with different approaches and contexts that can result in a wide range of outcomes, some good practices and lessons can be learnt.

4.1.1 Copenhagen, Denmark: Climate Adaptation Plan

Copenhagen's climate adaptation plan, initiated in 2011, utilizes blue-green infrastructure for stormwater management, reducing flood risks (Copenhagen, n.d.).

Table 1: Copenhagen, Denmark: Climate Adaptation Plan

Key features	Outcomes	Lessons learned
Water management combined with urban design	Lower flood risks Improved livability in cities	The necessity of long-term planning and political commitment
Creation of multifunctional areas that can serve recreation and flood control purposes	Higher biodiversity	The importance of citizen participation in design and process planning

(Copenhagen, n.d.; Liu & Jensen, 2018)

4.1.2 Singapore's ABC (Active, Beautiful, Clean) Waters Programme

In 2006, an initiative of Singapore was launched to make the city-state's waterways and water bodies vibrant, clean, and lifestyle attractions.

Table 2: Singapore's ABC Waters Programme

Key features	Outcomes	Lessons learned
Extensive application of bioengineering techniques Incorporation of water features into urban landscapes Public education and community involvement	Improved water quality in urban waterways Enhanced flood protection Creation of new recreational spaces	Importance of holistic, multi-agency approach Value of amalgamation of engineering with ecological principles

(Lim & Lu, 2016)

4.1.3 Portland, Oregon, USA: Green Streets Programme

The Portland Green Streets program was launched in 2007 and focuses on source-controlled stormwater runoff management through vegetated facilities (Stormwater Management Manual, n.d.).

Table 3: Portland, Oregon, USA: Green Streets Program

Key features	Outcomes	Lessons learned
Extensive use of bioswales, rain gardens, and permeable pavements Green infrastructure integrated into traditional grey infrastructure	Stormwater runoffs and combined sewer overflows reduced Improved water quality Streetscape aesthetics improved	Importance of pilot projects and performance monitoring Value of flexible design standards to adapt to local conditions

(Document Display | NEPIS | US EPA, n.d.; Stormwater Management Manual, n.d.)

4.1.4 Melbourne, Australia: Water Sensitive Urban Design

Melbourne has been at the vanguard of implementation since WSUD early 2000s (Water Sensitive Urban Design Guidelines South Eastern Councils 2 Water Sensitive Urban Design Guidelines, n.d.).

Table 4: Melbourne, Australia: Water Sensitive Urban Design

Key features	Outcomes	Lessons learned
Integrated water cycle management Use of Constructed wetlands and rainwater harvesting Stormwater treatment trains	Reduced potable water consumption Improved stormwater quality Enhanced urban amenity and biodiversity	Importance of policy frameworks and design guidelines Value of capacity building and knowledge sharing

(Brown & Clarke, n.d.; Water Sensitive Urban Design Guidelines South Eastern Councils 2 Water Sensitive Urban Design Guidelines, n.d.)

4.1.5 Rotterdam, the Netherlands: Water Squares

Water squares in Rotterdam are the innovative approach to urban water management that started back in 2013. In essence, these public squares offer the provision of multi-functional urban space that, at times of heavy rainfall events, offers additional storage capacity to reduce flooding (C40 Good Practice Guides: Rotterdam - Climate Change Adaptation Strategy - C40 Cities, n.d.).

Table 5: Rotterdam, The Netherlands: Water Squares

Key features	Outcomes	Lessons learned
Multifunctional Urban Spaces Water Management Incorporated into Urban Planning Adaptive Designing for Climate Resilience	Higher flood resilience Attractive public space created Awareness creation about water management amongst the general public	Need for innovative design thinking Benefits of stakeholder engagement and co-creation

(C40 Good Practice Guides: Rotterdam - Climate Change Adaptation Strategy - C40 Cities, n.d.; Tillie & van der Heijden, 2016)

These case studies present the various innovative ways for managing urban waters in a sustainable way within different geographical and cultural contexts. These cases have in common an integrated approach to water management and urban planning, deploying nature-based solutions, and engaging the community and multi-stakeholder collaboration.

5. DISCUSSION

The findings of this study highlight the tremendous potential of new, technology-oriented approaches for sustainable urban planning in the fields of drainage management and water conservation. In alignment with sustainable goals 6 and 11, this would hold much promise for cities in finding a suitable way out from the water challenge.

Smart stormwater management systems using IoT and AI have shown remarkable effectiveness in the reduction of combined sewer overflows (Kerkez et al., 2016). Works like this align with the ballooning trend of "smart city" initiatives and unveil the promises that digital technologies hold for securing urban resilience (Bibri & Krogstie, 2017). This approach, as well as being more cost-effective than traditional infrastructure expansion, shows that one feasible path for those cities faced with budgetary constraints.

The more important reduced run-off volume delivered from the green infrastructure and nature-based solutions in stormwater management further affirms the tenets that cities must work as natural ecosystems (Eckart et al., 2017). Such an approach would not only address water management issues but would also advance broader objectives of urban sustainability such as an increase in biodiversity and a reduction in the heat island effect (Kabisch et al., 2016). It is also established that there is grossly untapped potential for greywater recycling and rainwater harvesting systems in reducing potable water demand (Ghaitidak & Yadav, 2013). Beyond water conservation, these strategies reduce the load on centralized infrastructure and eventually contribute to more resilient urban water systems (Domènech,

2011). The research thus confirms the call for holistic, systems-thinking approaches toward solving urban sustainability challenges (Webb et al., 2018).Critical barriers identified include institutional fragmentation and limited channels for community engagement, suggesting the need for governance innovations and participatory approaches to complement technological solutions if sustainability objectives are to be realized (Ferguson et al., 2013).

Case studies from Copenhagen, Singapore, and Rotterdam underline that innovative water management solutions can be delivered at the urban scale, bringing about several advantages. The cases provide critical lessons regarding long-term planning, political will, and stakeholder involvement in successful implementation (Liu & Jensen, 2018).

This research shows that novel urban water management approaches hold great potential to realize significant advances in sustainable urban development and to contribute to multiple diverse SDGs. However, more integrated planning and supportive policies, as well as enhanced community engagement, are needed to overcome implementation barriers to realize such potential. Future research should focus on developing strategies that overcome such barriers and quantify long-term impacts of such innovative approaches on urban sustainability and resilience.

6. COCLUSION

The present research has critically evaluated new approaches of sustainable urban planning with emphasis on technology-driven solutions in view of drainage management and water conservation. The results have demonstrated that these approaches indeed hold immense potential for resolving urban water challenges while contributing towards the attainment of the SDGs 6 and 11.

It is within the smart stormwater management systems, green infrastructure, water conservation technologies, and decentralized water management approaches that demonstration of promising results has occurred in differing urban contexts. They enhance water management and offer multiple benefits in terms of urban livability, biodiversity, and climate change adaptation. The alignment of these solutions with SDG targets underlines their potential to contribute to broader sustainable development goals. In addition, the high benefit-cost ratios in many green infrastructure projects indicate that, in fact, these approaches can become economically feasible substitutes or complements to traditional grey infrastructure.

The study also, however, points out important challenges to implementing such innovative approaches: institutional fragmentation, lack of technical expertise, and regulatory barriers. Tackling these types of challenges shall require dedicated efforts from the policymaker to urban planner levels, including stakeholders from communities.

6.1 Implications

1. Policy and Governance: Putting in place the enabling framework for innovative solutions by retrofitting integrated city water management policies, building codes, zoning regulations, and stormwater management standards to accommodate green infrastructure and water-sensitive urban design.

2. Urban Planning: This study, although pretty broad in itself, boils down to the question of how considerations of water management should be integrated at all phases of urban planning, which effectively means a more holistic and systems-based approach to the development of cities.

3. Integrating Technologies: The success of smart water management systems proves the case for

investment in digital infrastructure and capacities for data management that can put such technologies to work.

4. Community Engagement: The case studies demonstrate that public involvement is essential for both design and implementation of water management solutions. Therefore, the need for amplified community outreach and education is emphasized.

6.2 Future Directions

1. Long-term Performance: While most of the novel solutions show very promising results, long-term studies shall be conducted in order to assess their performance and durability across different environmental conditions and urban contexts.

2. Integration with Other Urban Systems: In this respect, future research needs to investigate how such innovative solutions for water management could be fitted into other urban systems such as energy, transport, and solid waste management to provide holistic solutions for the smart city.

3. Climate Change Adaptation: With the increasingly serious climate change, further research is required to discover the potential of such innovative approaches at the urban scale in improving resilience to extreme weather events and long-term climate shifts.

4. Artificial Intelligence and Machine Learning: Huge potentials of these technologies need to be targeted in future research, focusing on prospective applications in the optimization of urban water management systems or in predicting future water-related problems.

Innovative approaches to urban water management indeed serve good potential for sustainability and resilience in cities, but the unlocking of their full potential is work in progress. It will require further research, policy innovation, and multi-sector collaborative efforts in pursuit of such opportunities. If these challenges are addressed and these research directions followed, cities will be one step further towards accomplishing the vision of sustainable urban development enshrined in the SDGs.

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Economic and other Considerations: A Case for Marking Some Higher Fee Structure Seats (SMART Seats) in University of Delhi Admissions

Deepti Taneja

Abstract

In the recent years, the number of students going abroad for higher education is continuously on a rise. Government data as well as various private researches and studies have concluded vociferously that the expenditure on these students going abroad for higher education in on a rise and is fueling the foreign economies at the cost of Indian economy. Besides the financial burden this causes on the family, there are also ramifications for the economy as a whole, where the expenditure made by such students abroad on tuition fee, boarding, lodging and travel expenses is a dent on the Indian economy. This study also found that the fees charged by these universities abroad is commensurately much higher than what they charge from their domestic citizens, and is exorbitantly higher as compared to similar courses being run in the University of Delhi. In this backdrop, this paper therefore studied the feasibility of proposing a reservation system and separate seats to be brought in for such candidates who are willing to pay a fee higher than the existing fee for other students being admitted through the usual CUET based centralized allocation system. It is proposed to call such seats as SMART Seats—Mehangi (Quality) Shiksha Avsar ki Rooprekha aur Tatva. This can contribute to creating self-sustaining models of educational institutions and be an instrument in achieving the newly announced dream of Modiji's Viksit Bharat, by providing quality education, while simultaneously reducing the educational institutions' dependence on governmental grants.

Keywords: Foreign Education, Higher Education, Reservation, SMART Seats

Background and Introduction

According to Subhas Sarkar, the then Union Education Minister of State, in a written response to a parliament question in February 2023, more than 30 lakh Indians went abroad for higher education during 2017-2022.[2] The minister was also asked if it is a fact that the money being spent by Indian students abroad is more than the education budget of the country, the answer to which was not given. Also, Hurun India Report, (Luxury Consumer Survey, December 2023) showed that 70 percent of Indian millionaires prefer to send their children to study abroad.[3]

State-wise Breakdown of Outbound Students

According to Hurun India data, Andhra Pradesh and Punjab share the top spot, each sending 12% of their children in the eligible age group for higher education abroad, followed by Maharashtra (11%), Gujarat (8%), Tamil Nadu (7%), and Karnataka (5%)[4]. It is notable that as per Forbes India Survey, September, 2023, according to the Gross State Domestic Product (GSDP) figures 2023, 5 out of these 6 states are among the top 10 ranking states in GSDP figures in the country.[5]

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[2] https://www.newsclick.in/over-30-lakh-indians-went-abroad-during-2017-22-higher-education-govt
[3] https://hurunindia.com/blog/hurun-india-luxury-consumer-survey-2023/
(https://www.indiaherald.com/Education/Read/994478242/Survey-Children-of-Indian-millionaires-study-abroad)
[4] https://oidigitalinstitute.com/news/indian-students-abroad/
[5] https://www.forbesindia.com/article/explainers/gdp-of-indian-states-union-territories/88157/1

Financial Factors in Decision-Making

According to a study undertaken by Western Union and the Report published thereof,[6] the role of budget considerations has been emphasized as an important factor in the decision-making process for Indian students heading abroad. As per the report, a striking 47% prefer shorter duration courses, such as diplomas, due to the high international tuition fees. This highlights the importance of financial factors in the decisions made by Indian students when pursuing education abroad. "Money-related concerns, particularly budgeting and financial planning, are key barriers expressed by both students and parents, playing a key deciding factor in the entire process", the report is quoted as saying. Furthermore, the report specified that 83% of the respondents "were looking to fund their studies through a loan which includes an education loan from banks and financial institutions, soft loans from friends and family, or a loan against property."

In essence, the report underscores the impact of financial constraints on the study choices of Indian students going abroad, particularly emphasizing their tendency to opt for shorter and presumably more affordable educational programs due to the financial challenges posed by high international tuition fees.

Outbound Students: Ramifications of Financial Burden on the family

As in August 2023, the number of students pursuing education overseas witnessed a remarkable 68% increase from 2021 to 2022. However, the COVID-19 pandemic in 2020 had led to a significant decline, with only 259,655 students studying abroad, which had again picked up in the post Covid years. This number of 2020 had contrasted with the numbers from preceding years: 444,553 (2021), 586,337 (2019), 517,998 (2018), and 454,009 (2017). [7] Hence, overall, with 2020 as an exceptional year, there has been a rising trend for the number of students going abroad for higher education.

As per the Western Union Report[8], based on Reserve Bank of India Bulletins, September 2021, "India is generally viewed as the world's top remittance-receiving nation, but today citizens and residents are increasingly sending money out, across borders, as they participate in the global economy - accessing international education, medical services, travel, and other services. The market for outbound remittance is, smaller, estimated at USD 12.7 billion for FY 2020-21, but outward remittances by resident Indians have risen 39% in July 2021 compared to October 2020, with a notable uptick in outflows for education purposes."

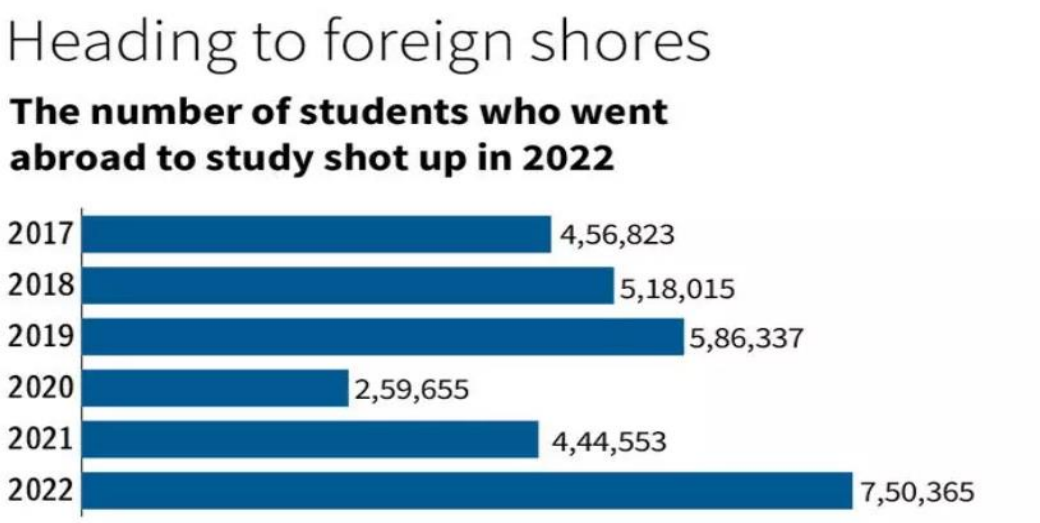
Based on various Lok Sabha answers of the Ministry of External Affairs and Ministry of Finance, The Hindu Business Line, February 2023, compiled the following statistics as given in the graphics below.[9]

[6] "Education Overseas: An Evolving Journey", A study by Western Union Group; available at https://corporate.westernunion-microsites.com/wp-content/uploads/2021/10/WU_Report_Summary_Education_Overseas_An_Evolving_Journey.pdf

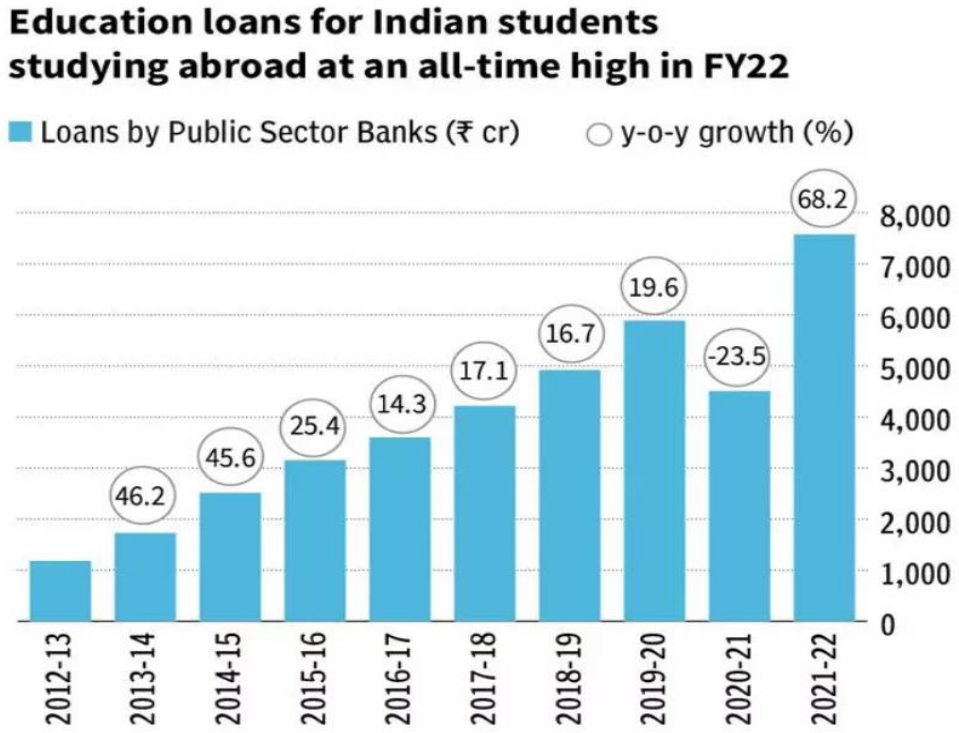
[7] https://www.mea.gov.in/lok-sabha.htm?dtl/36975/QUESTION+NO2650+STUDENTS+DATA+IN+FOREIGN+UNIVERSITIES

[8] Same as Reference 5

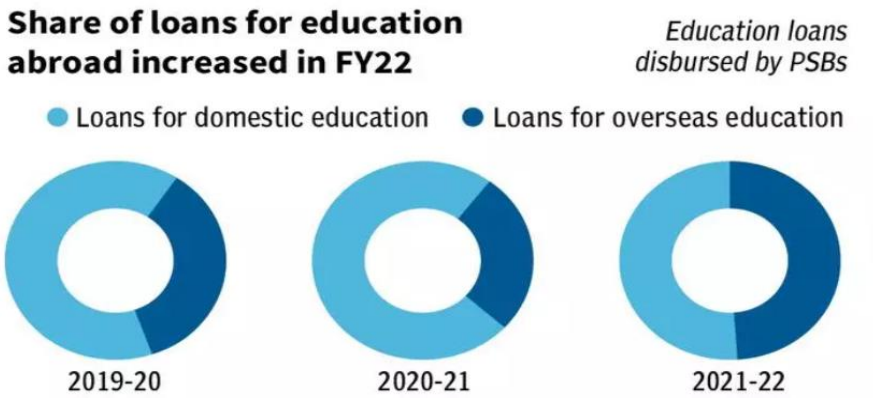
[9] https://www.thehindubusinessline.com/data-stories/data-focus/loans-to-study-abroad-students-who-went-overseas-at-an-all-time-high/article66520825.ece



Source: The Hindu Business Line



Source: The Hindu Business Line



Source: The Hindu Business Line

Furthermore, as reported by the RBI, February 2023, the outstanding portfolio under education loans experienced a remarkable 17% growth in the fiscal year 2022-23, amounting to an increase of approximately Rs 14,000 crore within a single year.[10]

Also, as reported by Public Sector Banks (PSBs), August 2023, in the last 10 years, a total of 4,61,017 number of students availed educational loans for studying abroad. Also, PSBs in the country disbursed education loans for studying abroad worth ₹7,576.02 crore in FY22, which is a 68 per cent increase compared to FY21.[11]

Furthermore, as per the banking sector data, with the rise in demand for education loans, there has also been a rise on the banking sector stress. According to the RBI data, the outstanding portfolio under education loans grew 17 per cent at ₹96,847 crore in the year 2022-23 as against ₹82,723 crore in the previous year. The Non-Performing Assets (NPAs) in education advances stood at 7.82 per cent of a total outstanding portfolio of ₹80,000 crore at the end of the first quarter of FY23.[12]

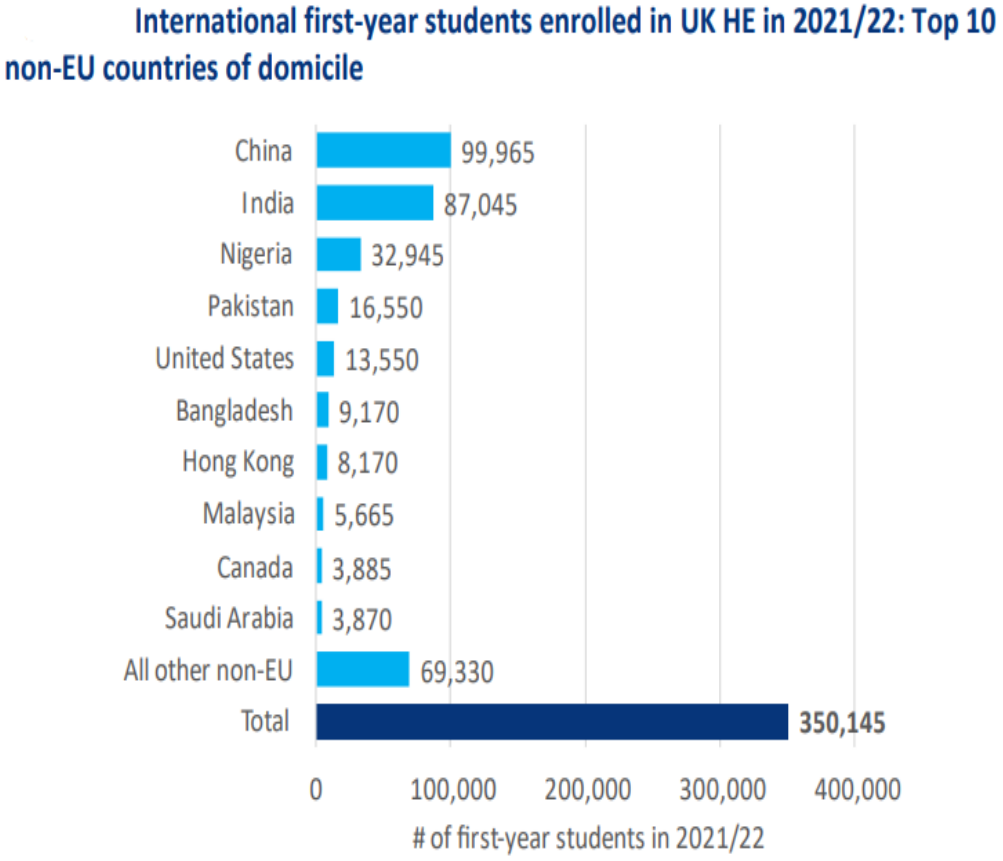
Outbound Students: Fuel for the Foreign Economy

There are substantial economic benefits that foreign countries derive from Indian students studying in their institutions. One of the most tangible benefits that foreign countries gain from Indian students is the substantial economic contribution they make in terms of direct financial contributions through tuition fees and indirect ones through the living and travelling expenses, the latter accruing if a non-domestic flight carrier is used by these students and their families for their travel to and from India. There are also indirect benefits accruing to the domestic economy when friends and family visits these students and add to the domestic tourism industry.

The countries like USA, UK, Australia, Canada, Germany, among others, where most of the Indian students migrate to for foreign education, have reported that India makes up for their first or second

[10] https://economictimes.indiatimes.com/nri/study/why-are-education-loans-growing-in-popularity-in-tier-2-and-tier-3-cities-despite-inflation/articleshow/102823681.cms
[11] https://indianexpress.com/article/education/study-abroad/over-4-lakh-education-loan-study-abroad-last-10-years-finance-ministry-8442605/
[12] https://www.thehindubusinessline.com/money-and-banking/education-loans-register-17-growth-in-fy23-turning-positive-for-first-time-in-five-years/article66959891.ece

top-most country in terms of origin of their foreign students. One such chart, as presented below, gives such a figure for UK and is a mirror of almost similar stories elsewhere.



Source: HEPI Report, May 2023[13]

The Western Union Report[14] provided a segregation of tuition fees (as for year 2020) per annum for a Bachelor's Degree in some of the popular universities of some of the popular destination countries for Indian students. This is as given below:

[13] Higher Education Policy Institute (HEPI). (2023, May). "The benefits and costs of international higher education students to the UK economy"

[14] Same as Reference 5

Country	Bachelor's degree (per year)
Canada	$22,500–50,000
United States	$26,000–50,000
Australia	$14,393–32,384
UK	$13,150–34,190
China	$1,665–3,030
Germany	$0–26,300
France	$200–3,272
Spain	$802–23,577

Source: Western Union Group. (2021, October 19). "Education Overseas: An Evolving Journey"

Furthermore, for the United States, The Institute of International Education (IIE) reported that Indian students contributed over $6.9 billion in tuition and living expenses in the 2020-2021 academic year.[15] As per the Australian Department of Education, in Australia, in 2021, Indian students contributed approximately AUD 5.2 billion to the Australian economy, making them the second-largest group of international students after Chinese students.[16] In Canada, as per the Canadian Bureau for International Education, the Indian students accounted for 34% of all international students in Canada, generating an estimated CAD 3 billion annually.[17] In addition to tuition, Indian students also spend on accommodation, food, transport, and other living expenses. This spending also stimulates the local economies. In UK for example, The Higher Education Statistics Agency (HESA) estimates that in the present times, the Indian students contribute around £1.8 billion to the UK economy in living expenses alone.[18]

To drive the point home that it is the foreign nationals, with Indians contributing a major chunk, that are a major driving force for the foreign universities and thereby those economies, this study did a case study, based on 2022 fee structures, of some of the popular courses in three universities that are among the top destinations for Indian students. It is to be noted that due to the countries' education policies, there is a cap on the maximum fee they can charge from their domestic residents, but there is no such cap on the fees charges by them from the foreign nationals, including Indians. The fees of these courses

[15] Institute of International Education (IIE). (2021). "Open Doors Report on International Educational Exchange."
[16] Australian Department of Education. (2021). International Students in Australia.
[17] Canadian Bureau for International Education. (2021). The Economic Impact of International Education in Canada.
[18] Higher Education Statistics Agency (HESA). (2021). UK Higher Education Statistics.

in local currencies have been converted in INR terms to facilitate easy comparison (at December 2022 Forex rate of 1$ ≈ Rs. 84). The study is done for the University of Oxford (UK), University of Sydney (Australia) and Cambridge University (UK).

University	Popular/ Preferred Courses	Tuition Fees: Domestic (for UK/some European nations' citizens) p.a. in INR Terms	Tuition Fees: Foreign p.a. in INR Terms
University of Oxford	BA Archeology and Anthropology	10,19,396	45,32,731
	Bachelors BioChem	10,19,396	57,17,435
	BA Computer Science	10,19,396	65,30,748
	BA Economics and Management	10,19,396	45,32,732
	BA Mathematics	10,19,396	49,46,000

University	Popular/ Preferred Courses	Tuition Fees: Domestic (for UK/some European nations' citizens) p.a. in INR Terms	Tuition Fees: Foreign p.a. in INR Terms
University of Cambridge	BA H Economics	10,19,396	29,78,180
	BA H English	10,19,396	29,78,180
	BA H History	10,19,396	29,78,180
	BA H Psychological and Behavioral sciences	10,19,396	45,32,070
	BA H Computer Science	10,19,396	45,32,070

% of International Students in all Educational Institutes across UK: 13.32%
% of Indian Students in all Educational Institutes across UK: 3.04%
Inward remittances to UK from Educational Institutions INR 4.6 Trillion
Inward remittances to UK from Indian Students INR 683.95 Million

Source: Author's own compilation using various sources of University of Oxford, University of Cambridge, Higher Education Policy Institute and Higher Education Statistics Agency [All mentioned in References]

University	Popular/ Preferred Courses	Tuition Fees: Domestic (for Australian citizens) p.a. in INR Terms	Tuition Fees: Foreign p.a. in INR Terms
University of Sydney	Bachelor of Economics	9,31,798	29,68,420
	Bachelor of Commerce	9,31,798	29,68,420
	BA Psychology	5,70,850	31,96,760

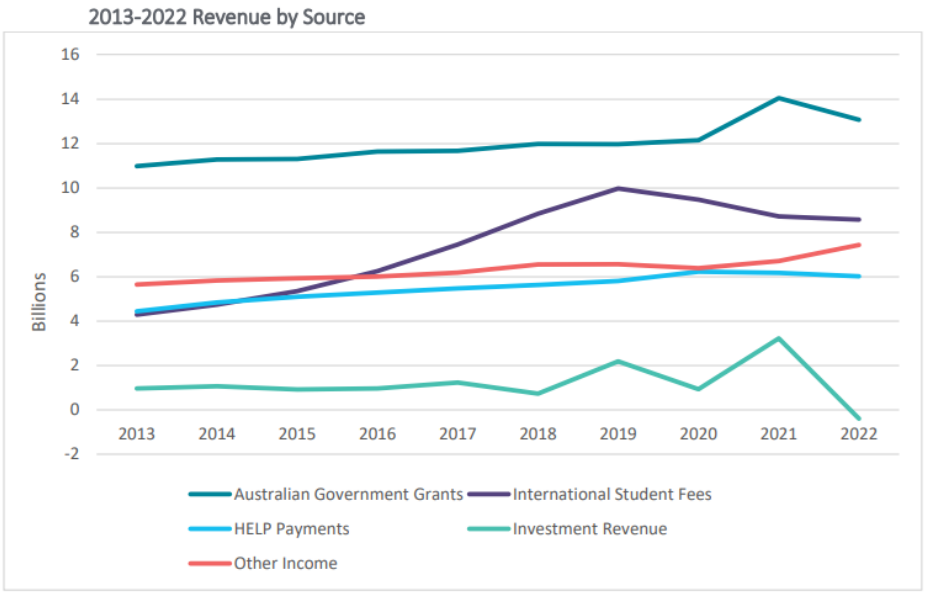
% of International Students in all Educational Institutes across Australia: 32.77%

% of Indian Students in all Educational Institutes across Australia: 8.8%

Inward remittances to Australia from Educational Institutions INR 723.07 Billion

Source: Author's own compilation using various sources of University of Sydney, Australian Government Dept. of Education and other Australian Government publications [All mentioned in References]

To highlight, how important International Students' Fees is as a source of revenue for the foreign educational institutes, given below is the figure for one such case for Australia. As can be seen, the International students fee is the second highest revenue source for the Higher Education Institutes in the Department of Education, Government of Australia.



Source: Australian Government. Department of Education. (2022). "Finance 2022: Financial Reports of Higher Education Providers"

Future Projections:

As per the Group University Living's Report, October 2023,[19] projections suggest that by 2025, Indian households will spend an estimated $70 billion on their children's foreign education, underscoring the urgency of strategic interventions. The report indicates a substantial expected rise in outbound Indian students. As per it, over 1 million students were studying abroad in 2019, which is expected to reach around 2 million by 2025. There would be a commensurate rise in their spending abroad as well. Total student spending is expected to reach as high as USD 70 billion by 2025. There have been similar reports by other institutions as well.

Thus, it is imperative to have a policy in place to prevent this huge amount of outbound remittances, which causes huge strain on the Forex Reserves and other aspects of the domestic economy.

Proposal: Marking some Reserved Seats in the University of Delhi Admissions for those having income above a given threshold limit: A Solution to Retain Capital in India

As highlighted in terms of financial burden, huge fee differentials for foreign institutions' domestic vs international students and a huge economic outflow of funds from the Indian economy, the issue of Indian students seeking higher education abroad becomes a pertinent matter to discuss among the policy makers of today. With the advent of the New Education Policy, 2020 and the adoption of Under Graduate Curriculum Framework, UGCF, 2022, by the University of Delhi, and the massive improvements in the World University Rankings (across ranking systems) that the University of Delhi is witnessing in recent years, it is a foregone conclusion that the University is providing highly quality education and that too at a hugely subsidized fee structure. Furthermore, with the adoption of Value Added Courses and Skill Enhancement Courses in the NEP structure, with a heavy focus on the Indian Knowledge System (IKS), University of Delhi is not just providing a world-class quality education, but is also connecting its students back with Indian roots, ethos and the way of living, something, like yoga, meditation, etc., which the world now is looking to.

Alongside, besides having a tuition fee and the overall fee structure as a highly subsidized one, to promote quality higher education at affordable structures for the deserving ones, the University, under the current tenure of Hon'ble Vice Chancellor Prof. Yogesh Singh, is also fulfilling its social commitment by bringing in supernumerary quotas for orphan children and for the single girl child, besides the usual supernumerary seats for persons with benchmark disabilities, Kashmiri Migrants, Armed Forces personnel wards, PMSS for J&K, Sikkimese students, etc. With some of these supernumerary seats being offered at a fee structure even lower than the usual structure (which is anyway highly subsidized), the University of Delhi has been a champion to the cause of providing quality education while fulfilling its commitment towards Institutional (Corporate) Social Responsibility.

It is therefore proposed that a reservation system and separate seats be brought in for such candidates who are willing to pay a fee higher than the existing fee for other students being admitted through the usual CUET based centralized allocation system. It is proposed to call such seats as SMART Seats—Mehangi (Quality) Shiksha Avsar ki Rooprekha aur Tatva. To begin with, we can have, as a pilot study, one such SMART seat reserved for each course running in every UG college of the University of Delhi. Eg. If Sri Ram College of Commerce has 2 courses namely, BA Hons Economics and B Com Hons, then it'll have only 2 SMART seats—one for each course. Similarly, Atma Ram Sanatan Dharma

[19] https://www.universityliving.com/blog/industry-reports/indian-student-mobility-report-2023/

College has 22 courses running (each BA Prog. Combination taken as a unique entity), then it shall have 22 SMART seats and so on.

For the purpose of rationale and forming the basis of deciding on the fee structure for such SMART seats, this paper has also drawn the following table of comparison, using fee structure of the popular courses of Universities of Oxford, Cambridge and Sydney, as shown above and comparing them with the fee structure of corresponding similar courses of the University of Delhi.

University	**Popular/ Preferred Courses**	**Tuition Fees: Foreign** p.a. in INR Terms	**Corresponding Similar Course of the University of Delhi**	**Tuition Fees of the University of Delhi** p.a. in INR Terms*
University of Oxford	BA Archeology and Anthropology	45,32,731	BSc Hons Anthropology	49,000
	Bachelors BioChem	57,17,435	BSc Hons Biochemistry	46,600
	BA Computer Science	65,30,748	BSc Hons Computer Science	51,300
	BA Economics and Management	45,32,732	BA Hons Economics	32,600
	BA Mathematics	49,46,000	BSc Hons Mathematics	32,000
University of Cambridge	BA H Economics	29,78,180	BA Hons Economics	32,600
	BA H English	29,78,180	BA Hons English	26,000
	BA H History	29,78,180	BA Hons History	26,000
	BA H Psychological and Behavioral sciences	45,32,070	BA Hons Psychology	30,600
	BA H Computer Science	45,32,070	BSc Hons Computer Science	51,300
University of Sydney	Bachelor of Economics	29,68,420	BA Hons Economics	32,600
	Bachelor of Commerce	29,68,420	B Com Hons	28,000
	BA Psychology	31,96,760	BA Hons Psychology	30,600

*There are slight variations in fee structure across various colleges of the University of Delhi. This is the average most common fee structure of the given course that exists in most of the colleges for UR (Unreserved category) for the year 2022

Source: Author's own compilation using various sources of foreign universities and of the University of Delhi Admission website

As can be seen, there is a minimum difference of 30 lakhs per annum for any course that a student pays for similar education in University of Delhi vis-à-vis any 'popular' foreign university. And this is only for the tuition fee part, that too for one year alone. For a three or four year under graduation course, this becomes commensurately higher. Coupled with the other indirect costs, earning an undergraduate degree from a foreign university becomes a highly costly affair, running into crores for the entire program duration.

Keeping this differential in mind, it is proposed that fee structure of such courses be fixed, most definitely on a self-sustaining/self-financing model, perhaps with some element of revenue generation too. Even on incorporating the latter, such fee would still be much lower than the corresponding fee a candidate would pay if (s) he chooses to pursue this course abroad. In fact, in recent times, it has even been observed that most of the Indian students who go for higher education abroad do not land up in the top ranking institutes of the host country, but have to settle for some of the lower ranked universities. This way, with such an introduction of SMART seats by the University of Delhi, the student so admitted would be confident of earning a quality education, that too in a much economical manner.

Implementing such a reservation system would enable students from affluent backgrounds to secure admission by paying additional fees. This strategic move would help retain financial resources within the country, positively impacting the economy and GDP, as also help the University's colleges to raise financial resources. Similar policies, with various nomenclatures like the 'Management Seats', 'Quota Seats', etc., are already in practice in various Private and Deemed Universities of the country, including highly reputed and technical ones too, but it isn't yet applicable to the government universities, like the University of Delhi. The private and deemed universities make use of this criteria which helps them to generate resources that are generally used in improvement of their infrastructure and facilities.

To implement such a policy of admission on the SMART Seats, we can have a separate portal for such applications, different from the usual CUET portal. Such candidates, who apply for SMART seats, like any other supernumerary seat, can also apply for the general seats, but on different portals. This way, the candidates stand a fair chance of securing a 'regular' seat too and by applying for the SMART seat, he/she will only face competition with similar applicants alone. It shall, in a nutshell, be a win-win situation for both, the students as well as the colleges, with the former saving substantially on their education expenditure while getting world-class quality education, and the latter can generate resources that can be used for infrastructural development or promoting research and providing better facilities in the institution.

Conclusion:

In conclusion, the proposal for introduction of SMART seats in the University of Delhi (and if successful, can be emulated by other central and state universities too), we aim to provides a strategic solution to encourage affluent Indian families to invest in domestic quality education. By doing so, we can curb the exodus of students seeking education abroad, fostering domestic economic growth and ensuring a well-rounded educational landscape within the country. This can contribute to creating self-sustaining models of educational institutions and be an instrument in achieving the newly announced

dream of Modiji's Viksit Bharat, by providing quality education, while simultaneously reducing the educational institutions' dependence on governmental grants.

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Spatial Analysis of Healthiness of Preschoolers in the State of Haryana, India

Sandeep Kumar[1] Lalit Sharma[2] and Priya Sharma[3*]

Abstract

Children are the future of a nation, and an excellent and proficient deal with child health infrastructure and attentiveness always glorify it in terms of its healthy, blissful, enthusiastic, and more creative generation. The healthy present will bring a happy tomorrow, while children's infirmity or nutritional deficiency restrains their physical, emotional, and intellectual maturity and seizes human development. The present research work is coupled with Haryana state and is carried out to appraise preschoolers' journey towards achieving good health. For the comparative analysis or to measure health and nutritional variation among the children, the study uses secondary statistics obtained from different sources and agencies. Simultaneously, the correlation matrix is prepared to identify the existing association between child health and its various determining factors. Though, apart from the complete vaccination, the study noticed an improvement in all selected health indicators of children, such as breastfeeding, Vitamin 'A' intake, and treatment of childhood diseases, it requires more attention to minimize the existing spatial variation. Secondly, child health is observed to be more responsive to social awareness and religious, financial, and educational features than the availability of healthcare facilities.

Keywords: Proficient, infirmity, nutritional deficiency, intellectual, preschoolers and wellbeing.

1. INTRODUCTION

"A healthy mind in a healthy body" is an English version of the Latin phrase "Mens sana in corpore Sano" that Roman poet Decimus Junius Juvenalis first narrated in the second century (**Jeyes, 1885**). It signifies how long we are concerned about good health. The children's good health is an indicator of development and an essential requirement to ensure an efficient and intellectual generation for any nation. Children are tomorrow's future, and the potential development of a country depends on today's healthy kids. Good health does not stand only for the absence of disease or illness; more broadly, it covers a state of complete physical, social, and mental wellbeing. Modern medical treatments treat diseases as maladjustments in a frail bonding of the man-environment, while health work is a dynamic equilibrium (**Park, 1994**). It is a universal admittance that any society's possible development is directly associated with its hale and hearty children, so every government should be committed to fulfilling all necessary health requirements **(WHO, 2014).** The mortality rate of infants and preschoolers is considered the most sensitive index to measure any community's social advancement (**De Hass, 1958**). Innocence, reliance, and propensity are natural features of childhood, and ignorance toward wellbeing in this progressive period will certainly be a significant loss for the nation. It later reduces work competence and intellectuality, impediments in growth, and more exposure to mortality plus infections or infirmity **(Awasthi & Kumar, 1999; Usmani & Ahmad, 2017).**

In another way, avoiding the development aspect of children is enough to make the nation's progress

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worthless. Generally, during upbringing, an infant's physical and mental growth takes place speedily. Additional care and attentiveness in early childhood ensure the child's psychological and physiological excellence and, subsequently, lower the risk of ailments **(Sen, 1985; Nurliyana et al., 2016).** Strengthening, encouraging, and shore-up the growth of initial babyhood is necessary to ensure complete health interests (**Richter et al., 2017**). The first step of embryogenesis in the womb to old age through the passing of the stages of birth, childhood, adolescence, and maturity, the proper health and nutritional care are essential to survive and grow brainpower with good quality and productivity **(WHO, 2000).** In other words, it is a fundamental right of a human being to determine his or her biological and emotional competency **(WHO, 1995).** From another perspective, growth measurement represents the health goodness of the children. It is a parameter to recognize the existing inequalities in allocation, availability, and accessibility to fundamental aspects of human development **(Onis de et al., 2000).** Good health is the outcome of proper nutrition, which is convenient and affordable for healthcare facilities. Where adequate health care develops the children's resistance power, the excellent quality dietary supplements help sustain it. On a communal and individual basis, several factors directly or indirectly impact children's health supervision **(Behrman & Deolalikar, 1987; Striessnig & Bora, 2020).** However, as the most significant investment, everyone is more concerned about their offspring's health and happiness. Yet, in the modern world, particularly in developing countries, they face various health impasses like morbidity, malnutrition, high mortality, and poor fitness. **Baye (2017) has** expressed that hunger and malnutrition caused by diverse societal, cultural, fiscal, and ecological phenomena is no less than a pandemic. Untenable food production, poverty, inequity in resource allocation, and ecological dilapidation make it more intricate and atrocious. Malnutrition arises from a bit of consumption of qualitative and quantitative food or imbalanced energy intake. It is one of the most severe health dilemmas in the world. Here, comparatively, undernutrition (which results from the long-term consumption of a poor diet) is more upsetting, mainly in poor economies, as their monthly per capita expenditure on nutritional food is significantly less **(Akthar et al., 2005).** In low-income countries, malnutrition increases child mortality and causes the persistence of major contagious diseases and respiratory infections, and preschoolers are the most susceptible to this **(Kakkar et al., 1987).** The unacceptable high prevalence of malnutrition looks like a silent emergency for the world as it causes about 45 per cent of deaths of children under five years old (**Black et al., 2013**). Global Nutrition Report reveals about 22.2 per cent (150.8 million) of stunted children, and every year, 20 million babies are born with low birth weight worldwide (**Development Initiatives, 2018**). In South Asia, malnourished children's pervasiveness is higher even than those Sub-Saharan countries considered stooge in terms of economic development. This paradox is called the 'South Asia Enigma.' It signifies that only strengthening the financial side is insufficient to explain and command the children's health and nutritional progress, and overall monitoring is necessary **(Ramalingaswami et al., 1996).**

India is the home of the second-largest population globally, and the child population (below six years) constitutes 17 per cent. Unfortunately, the country's quantity lacks in quality and stands with a ducked neck regarding the health grading of its offspring **(UNICEF, 2011).** Research related to anthropometric measures reveals that Indian children are shorter than any other developing world country (**Cofey & Spears, 2018**). Surprisingly, in India, 1.5 million children die every year because of not having proper immunizations against childhood diseases. In the age group of 1-4 years, the proportion of various anaemia sufferers is 40.5 per cent, and vitamin A deficiency exists in 17.4 per cent. Besides, 13 per cent of U-5 years children demise from diarrhoea and the associated infections **(MoHFW, 2018; Lakshminarayanan & Jayalakshmy, 2015).** In the state of Haryana, 71.7 and 29.4 per cent of children have a medical history of mild to severe anaemia and malnutrition in that order. Moreover, 37.8 per cent of children are still waiting for complete immunization of BCG, three doses of DPT & polio and measles and 38.2 per cent of children has not received even a single dose of Vitamin 'A' (**DLHS-4, 2012-13).** Though the region is well known for its agricultural plus economic development, a

significant segment of its children cannot enjoy childhood. It is a matter of apprehension and questions that even after being wealthy in resources, why are our broods unhealthy or lacking in physical and cerebral welfare?

2. STUDY AREA

Haryana is an economically developed state in North India. Having an expansion of its political boundaries on 44212 sq. km. area, the state can be traced with the geographical coordinates of 27˚40' to 29˚ 42' latitudes in the north and 74˚ 54' to 77˚ 40' longitudes in the East **(Figure: 1)**. The remarkable progress of many arenas after receiving the solo identity from Punjab on November 1st, 1966, makes the region admirable. However, ironically, a combination of some social and health statistics has also defamed its name **(Sharma & Kumar, 2020).** A significant proportion of preschoolers face multifarious health and nutritional complexities. About one-third (32 per cent) of children under five years old are stunted and wasted, and 36 per cent are observed underweight. Undeniably, the poor health of our upcoming age bracket raises a big question about the state's prosperity.

3. OBJECTIVES

The study tries to reach the following set of objectives:

1. To examine the spatial variations in selected health indices of the preschool children in the state of Haryana.

2. To analyze the role and degree of determining factors of health and nutrition of the children with possible causes and consequences.

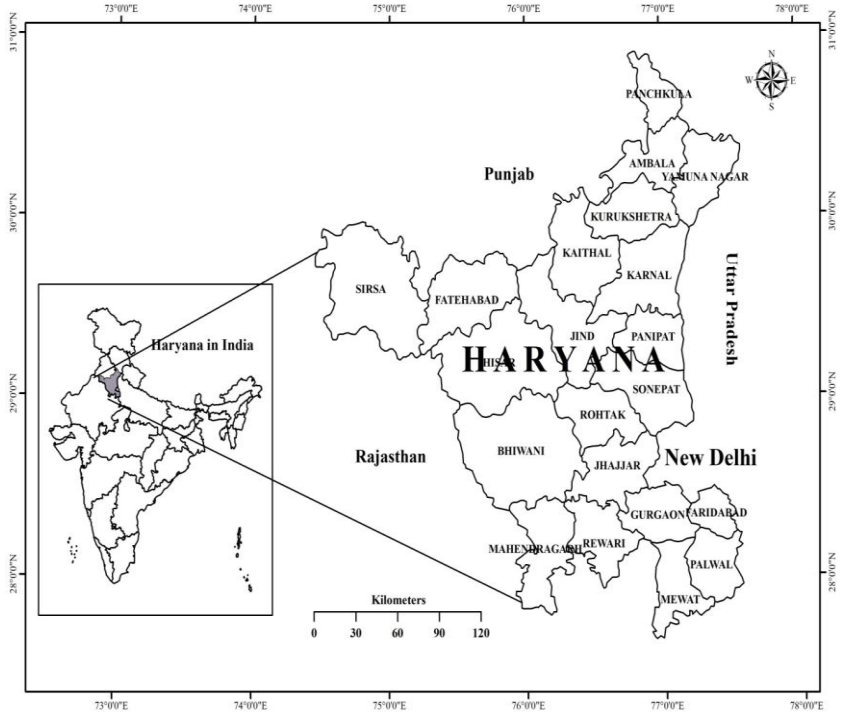

Figure 1. Location Map of Study Area

4. DATA SOURCES AND METHODOLOGY

The study uses the secondary data compiled from District Level Household and Facility Survey –III & IV (DLHS-3 and DLHS-4) containing the statics of years 2007-2008 and 2012-13 and publication in 2010 and 2014 years in that order. The rest of the records used in the correlation matrix are derived from the Census of India 2011, Statistical Abstract of Haryana 2013 (with the facts of 2011-12), and National Crime Record Bureau (NCRB) 2011. The common child health indicators like breastfeeding practices within one hour and 24 hours of birth (under 3 years), Vitamin 'A' intake at least one dose (12-23 months), full vaccination (12-23 months), treatment of acute respiratory infections (ARIs) and diarrhoea within the last two weeks (under 3 years), ORS awareness among women, and institutional deliveries, are selected to maintain the relevance of the study. The significance and necessity of the indicators in the methodology support the reasons for their selection because they shape children's health. The compiled data is presented with the help of required statistical methods, tabulation, and mapping. Karl Pearson's correlation coefficient is exercised to establish the relationship between child health and its key determinants.

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

(Where r is Coefficient of correlation (Karl Pearson's) and n = no. of observations, x and y = different variables).

4.1 Methodological Justification

Breast milk is considered a complete food that satisfies the needs of a child through its nutritional properties. Moreover, it's medicinal or antibiotic belongings, especially colostrum (a thick yellow-coloured milky substance produced after the birth of a child that raises the production of the true milk), boost the children's resistance power against major childhood diseases or gastrointestinal infections. It also enhances the bonding between mother and child **(Kramer et al., 2001; Black et al., 2008).** With the universal acceptance of breastfeeding practices, some medical studies have found that children are at higher risk of sickness and transience whose breastfeeding practice was terminated in early infancy. WHO also recommends its duration for six months, at least from the initial hour of the birth **(Pande et al., 1997; Victora et al., 2016).** Vitamin 'A' deficiency (VAD) is a major health problem among children as globally, 190 million preschool children are Vitamin' A' deficient, and it causes 2 per cent of deaths in the world, of which a considerable proportion belongs to African and south-east Asian countries **(WHO, 2011; UNICEF, 2016).** Vitamin 'A' is a multiple-functioning organic molecule or micronutrient essential for strengthening the immune system by restoring respiratory organs, gastrointestinal epithelia, and good vision **(Imdad et al., 2011).** Xerophthalmia is observed as the most specific VAD disorder that is the leading cause of night blindness or visual impairment and a high risk of childhood infections. The complete vaccination of children protects them from deadly diseases of childhood like tetanus, polio, diphtheria, etc., and minimizes the risk of mortality in illness cases.

Acute Respiratory Infections (ARIs) are related to infectivity in the body's respiratory organs from the upper respiratory tract to the lower. It starts with a common cold but becomes severe with pneumonia after finding the association with other infections like diarrhoea or malaria. It is a 'forgotten pandemic' yet in the lack of awareness about its danger (only one in five caretakers knows the symptoms); still, it is working as a 'hidden killer,' and worldwide causes the death of 802000 children annually **(UNICEF, 2020).** On the other side, diarrhoeal disorder (a condition of severe dehydration due to the passing away of water and salt from the body in the form of loose or watery stools) is also a major childhood disease that takes away the lives of 525000 children under five every year **(WHO, 2017).** Some studies have

found a close association between diarrhoeal infections and climate change, particularly in developing countries like India. The abnormal warming pattern and variation in rainfall affect the region's water supplies. Further, the inadequate quantity and quality of drinking water led to diarrhoea among the children **(Mcmichael et al., 2007; Martin et al., 2011**). Oral Rehydration Salt (ORS) is a simple, verified, cost-effective intervention that reduces the infant's diarrhoea-specific mortality by up to 93 per cent. It is a simple water solution with a specific ratio of sugar and salt (Zinc can also be added). It is used to minimize severe fluid loss and dehydration among children **(Munos et al., 2010).** A child's birth in a medical institution with the skilled medical staff and the essential surgical care to handle any emergency is called institutional delivery. It is a direct indicator to measure the health of a mother. Still, in a roundabout way, it has a significant impact on child health because it enhances the survival chances of a newborn and raises the ratio of initiation of breastfeeding and vaccination **(UNICEF, 2009).** The children who take birth under trained health workers' supervision have significantly less risk of infections than those whose birth is associated with an unhygienic place or unskilled assistants. In the correlation matrix, various variables like female literacy, percentage of below poverty line (BPL) population, percentage of female marriage below 18 years, urbanization, percentage of Hindu and Muslim population, sex ratio, crime against women, and a number of primary health care centers and sub-centers are taken into consideration. Here, all these indicators are used as independent variables to see their significance with the dependent variable of child health and nutrition.

5. RESULTS AND DISCUSSION

5.1 Breast Feeding Practices

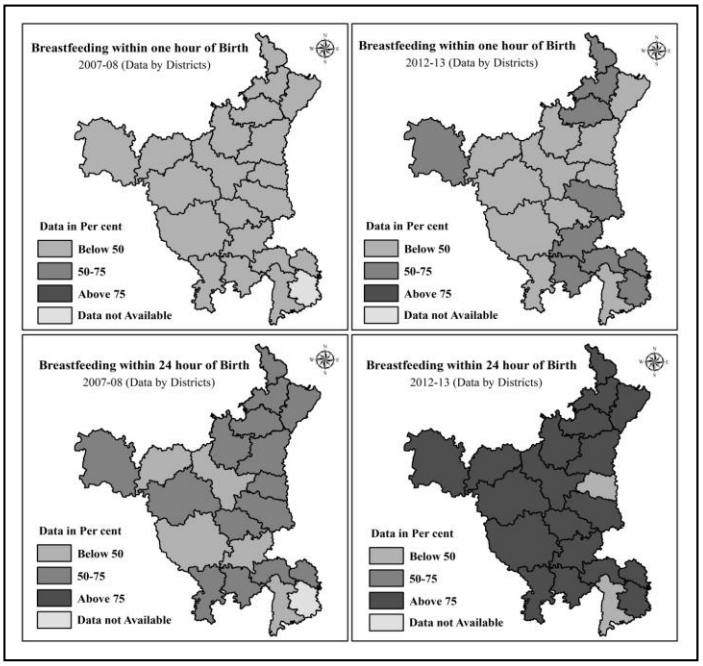

Figure 2. Breastfeeding Practices within one hour of the birth and Breastfeeding Practices within 24 hours of the birth

Source: Based on DLHS-III (2007-08) and DLHS-IV (2012-13).

Table 1 and Figure 2 show the comparative statistics of breastfeeding in Haryana with spatial and temporal variations. In 2007-08, only 16.5 per cent of newborns had received the mother's milk within one hour of the birth, while in 2012-13, it increased to three times and was documented as 50.90 per cent. The spatial pattern reveals that in 2007-08, the entire state was in the low category of below 50 per cent breastfeeding, while in 2012-13, ten districts upgraded themselves to the moderate category with 50-75 per cent (**Figure 2**). However, about half the proportion of infants is still waiting for breastfeeding initiation just after birth. Yet, the temporal increase signifies that slowly but certainly, the fallacy about the early starting of mother's milk is now disappearing. The custom of initiation of breastfeeding within 24 hours is more pleasurable, with an increase of 27.4 per cent from 2007-08 (55.4 per cent) to 2012-13 (82.8 per cent), and a significant number of fourteen districts have registered more than 80 per cent breastfed children in the fourth survey. The districts Faridabad (96.9 per cent), Ambala (95.0 per cent), Gurgaon (95.0 per cent) and Yamunanagar (91.7 per cent) have the highest proportion of breastfeeding.

In contrast, it is lowest in Mewat (72.8 per cent) district, but interestingly, this lowest value is very near to the highest value of DLHS-III (**Table 1**). The inter-district variation has also declined in the fourth survey, and only a few districts have registered the proportion of breastfed children below 70 per cent. In the third round, except for five districts (Fatehabad, Jind, Bhiwani, Jhajjar, and Mewat) of the low category, Haryana was in a moderate class. In the fourth appraisal, with the disappearance of the low class and lessening of the moderate (only in Panipat and Mewat), all districts are found to be in high breastfeeding rite classes (**Figure 2**). Overall, the low practice of breastfeeding (mainly within one hour of the birth) in some regions is directly associated with different delusive information about first milk, erroneous beliefs about the mother's fitness in lack of awareness, and place of delivery, inadequate counselling of mothers, and more illiteracy among females. Indirectly, religion and economic status also affect the commencement and continuation of breastfeeding practices.

5.2 Vitamin ‘A’ intake and Full Vaccination

The statistics of 2012-13 explain that in Haryana, 63.3 per cent of children (12-23 months) received at least one dose of Vitamin ‘A’, which is 13.9 per cent more than 49.4 per cent in 2007-08. Amazingly, in the fourth survey, only the district Sonipat witnessed a significant decline of 28.3 per cent in Vitamin 'A." In contrast, all districts have shown increasing trends in 2012-13. In the district Karnal, this micronutrient is given to the highest 80.5 per cent of children, whereas its proportion is recorded least (41.9 per cent) in the district Sonipat (Table 1). The spatial pattern shows that in 2007-08 districts of the west to south crossing the state's centre (Fatehabad, Hisar, Bhiwani, Rohtak, Jhajjar, Gurgaon, Faridabad, and Mewat) had recorded less than 50 per cent intake of Vitamin 'A'. In 2012-13, only districts Mewat, Faridabad, and Sonipat were in the same class.

The northern districts (Panchkula, Kurukshetra, Kaithal, and Karnal) have shown good condition, where more than 75 per cent of children have got the opportunity of receiving Vitamin ‘A’ in the fourth round. A maximum number of fourteen districts covers the moderate grouping of receiving this essential nutrient **(Figure 3)**. The survey finds that children of educated mothers, having lower birth order, urban residences, and high-income classes have more chances to get a single dose of vitamin 'A' than others **(DLHS-IV, 2012-13).** Passively, the immunization proportion has witnessed a decline of 7.5 per cent (59.6 in 2007-08 to 52.1 per cent in 2012-13) in the fourth survey compared to the third (Table 1). In 2007-08, four districts (Panchkula, Ambala, Karnal, and Rohtak) were listed in the high category with more than 75 per cent, whereas in 2012-13, not any district of the state belongs to this class. With a low ratio of vaccination in eight districts (Panipat, Sonipat, Rohtak, Rewari, Gurgaon, Mewat, Faridabad, and Palwal) of the adjoining national capital, the entire region is showing 50-75 per cent coverage of full vaccination in the same period (**Figure 3**).

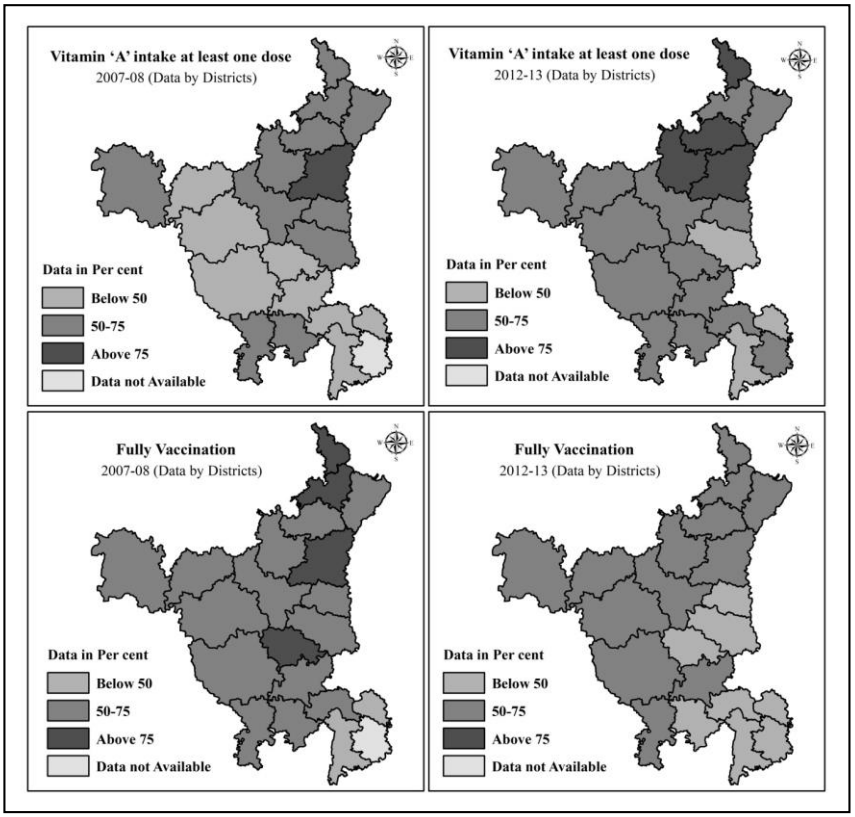

Figure 3. Vitamin 'A' intake at least one dose and fully vaccination

Source: Based on DLHS-III (2007-08) and DLHS-IV (2012-13).

This means that despite more advertisements and the establishment of healthcare facilities, nearly half of the children (12-23 months) are either partially vaccinated or have no vaccinations. This may be a result of a lack of awareness, a religious approach, or a focus only on one aspect, like polio eradication by administration instead of complete vaccination, or it may be associated with leakage in policy implementation.

5.3 Treatment of Acute Respiratory Infections (ARIs) and Diarrhoea

The studied area's situation is found to be better in ARI treatment, and in 2012-13, an average of 85.2 per cent of children under 3 years received this treatment. It is slightly more than (81.1 per cent) 2007-08. Except for districts Sonipat, Rohtak, Jhajjar, and Gurgaon, the region has performed better ARI treatment in the last two weeks.

In districts Ambala, Kurukshetra, Sirsa, Faridabad, and Rewari, the treatment is given to hundreds of children, and approximately in the rest of the districts, more than 80 per cent of sufferers got this healing in 2012-13. The diarrhoea treatment is viewed to decline and traced 68.4 per cent in the fourth survey compared to 81.7 per cent in the third. It is depicted that the western and south-western parts have provided the highest treatment of diarrhea to its affecters, whereas the southernmost and eastern linear setup is showing low to moderate attention regarding this problem **(Figure 4).** This lower percentage

of treatment can be linked to fewer diarrhoeal diseases and more awareness about the use of oral rehydration solution (ORS) in some advanced regions. Simultaneously, in socially and economically backward areas, the delay in recognizing initial contagion, unawareness about personal and social hygiene, and mother's illiteracy may be responsible for the minor curative ratio of dehydration.

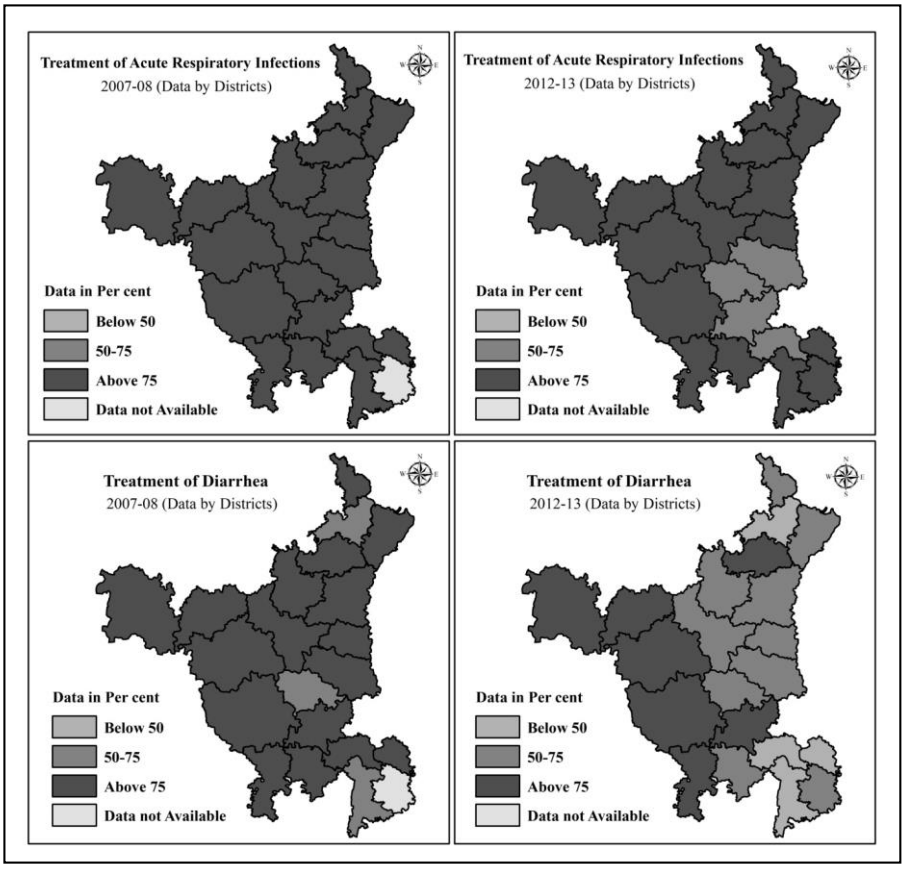

Figure 4. Treatments of Acute Respiratory Infections (ARIs) and Treatments of Diarrhoea

Source: Based on DLHS-III (2007-08) and DLHS-IV (2012-13).

5.4 Awareness of Oral Rehydration Solution (ORS)

Oral Rehydration Salt (ORS) efficacy directly depends on the mothers' consciousness about hygiene, proper quantity, repetition, and timely introduction to the infected child. In Haryana, only 43.3 per cent of women were aware of ORS in 2007-08, which increased to 68 per cent by 2012-13 **(Table 1)**. After seeing the district-wise pattern, it is found that in 2007-08, except Panchkula, Ambala, Kaithal, Sirsa, Rohtak, Rewari, and Gurgaon, all districts are listed in the lower class having below 50 per cent awareness. Further, in 2012-13, Panchkula and Rewari improved their position and ranked first and second **(Figure 5)**. A mother is the first caretaker of a child, and their increasing awareness of ORS plays a significant role in reducing children's deaths at all levels. The records reveal that 77 per cent of women received institutional deliveries in 2012-13 instead of only 46.8 per cent of 2007-08 (Table 1). The state is divided into two parts by an arc shape from north to south where the districts (Panchkula,

Ambala, Kurukshetra, Kaithal, Jind, Rohtak, Jhajjar, Rewari, Gurgaon, and Faridabad) have a high fraction of deliveries in the safe hands and situated. A moderate percentage of safe and sound delivery or birth is observed west to the southern strap, whereas a low percentage is in the southernmost district of Mewat, Palwal, and the eastern district of Panipat **(Figure 5)**. The government's various incentives and schemes (appointment of ASHA workers), increasing awareness, and ease of convenience in health centers have augmented the tendency to deliver skilled medical personnel. The impact of religion and cultural rituals can justify the low ratio of institutional delivery in Muslim-dominated regions.

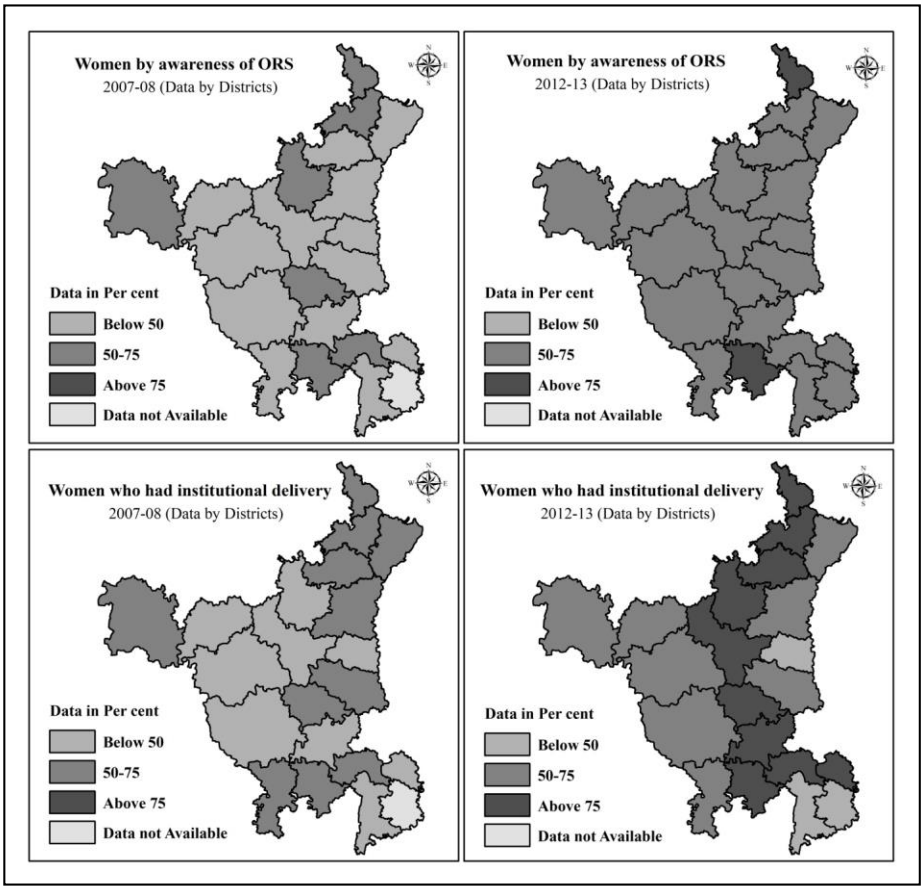

Figure 5. Women by awareness of ORS and who had institutional delivery

Source: Based on DLHS-III (2007-08) and DLHS-IV (2012-13).

5.5 Influence Extent of Decisive Characteristics in Child Welfare

A human child is more dependent on the mercy of its environment than any other creature on earth **(De Hass, 1958)**. A child's life is greatly conditioned by its social, biological, geographical, cultural, and economic environs. However, the variations in intensity and degree of these influential variables in shaping children's health and nutrition are well known (**Bildhaiya & Boss, 1977**).

Table 1. Health Indicator of Preschoolers in Haryana

Sr. No.	Districts/ State/ Years	A		B		C		D		E		F		G		H	
		2007-08	2012-13	2007-08	2012-13	2007-08	2012-13	2007-08	2012-13	2007-08	2012-13	2007-08	2012-13	2007-08	2012-13	2007-08	2012-13
1	Ambala	19	68.5	69.3	95.0	65.9	61.5	79.1	64.8	91.2	100	74	32.6	50.8	72.1	55.4	91.0
2	Bhiwani	24.1	46.6	47.6	84.1	44.5	64.7	58.4	62.6	95.2	93.2	81.3	87.6	37.8	71.9	35.7	79.1
3	Faridabad	10.9	68.2	53.1	96.9	28.7	49.9	46.4	38.7	84.6	100	80.6	46.4	33.5	68.9	39.1	95.9
4	Fatehabad	10.8	43.6	40.3	82.7	45	66.4	62.8	60.1	89.7	89.5	81.4	78.7	29.2	65.3	48.6	78.1
5	Gurgaon	17.6	59.3	67.8	95.0	49.5	60.9	70.5	40.3	94.7	73.7	77.1	28.5	61.1	65.6	52.3	90.9
6	Hisar	23	41	63.4	78.1	44.6	59.8	55.8	62.3	82.4	89.6	79.7	81.6	38.7	69.9	48.6	70.4
7	Jhajjar	15.7	55.5	49.9	87.4	42.8	64	64.8	52.8	79.3	72.5	95	82.3	42.7	67.7	48	90.0
8	Jind	12.1	46.8	37.7	79.7	57.1	73.8	55.4	65	88.1	93.4	88.3	67.8	40.5	59.9	42.1	88.0
9	Kaithal	18.5	46.4	58.1	79.2	56.3	76.9	72.5	73.8	96	88.6	98.3	55	52.8	58.6	48	87.5
10	Karnal	7.8	46.8	54.6	81.1	78.4	80.5	75.2	58.2	91.5	78.2	88.3	69.1	39.4	65.2	51.3	81.6
11	Kuruksherta	18.8	61.3	67.9	83.8	67.2	77.1	67.8	52.2	82.7	100	79.5	81.9	43.2	72.2	64.2	83.8
12	Mahendragarh	23.3	42.4	61	79.6	52.4	69.3	67.7	70.7	82.4	96.9	76.7	83.3	42.3	69.9	56.8	73.5
13	Mewat	7.5	41.3	29.2	72.8	7.9	49.3	11	27.4	75.9	85.5	74.8	43.4	16.6	63.1	14.8	51.3
14	Palwal	DNA	66.8	DNA	83.0	DNA	63.5	DNA	42.6	DNA	84.9	DNA	74.2	DNA	63.2	DNA	56.8
15	Panchukala	19.7	55.5	70.5	89.4	73.9	78	78.1	65.9	98.4	83.3	97.5	61.3	56	84.4	64.3	93.8
16	Panipat	12.3	32.2	52.8	66.2	54.9	52.8	57	39.9	87	80.7	85.6	68.3	37.8	52.5	39	58.9
17	Rewari	33.3	69	74.8	88.3	54.1	66.4	67.3	43	97.1	100	86.5	53.9	63.5	79.3	65	83.3
18	Rohtak	20.3	49.5	70.9	85.7	46.8	59.2	75.7	43.7	88.4	70.9	74.5	70.4	59.1	74.6	52.8	84.6
19	Sirsa	27.5	51.4	57.2	78.8	59.6	54.2	61.3	52.2	88.5	100	87.8	81.9	55.7	68.6	53.5	70.0
20	Sonipat	8	55.3	63.3	83.3	70.2	41.9	73	32.6	94.2	61.4	83.7	62.8	44	73.8	53.7	75.6
21	Yamunanagar	8.5	47.4	57.1	91.7	61.5	66.8	70	50	94.8	94.4	88.1	70.5	42.5	67.3	52.3	75.8
22	Haryana	16.5	50.9	55.4	82.8	49.4	63.3	59.6	52.1	81.1	85.2	81.7	68.4	43.3	68	46.8	77.0

Note: A= Percentage of Breastfeeding within one hour of Birth, B= Percentage of Breastfeeding within 24 hours of Birth, C= Vitamin 'A' intake at least one dose (12-23 months), D= Percentage of children aged 12-23 months Fully vaccination, E= Treatment of Acute Respiratory Infections (ARI) with in last two weeks (under 3 years), F= Treatment of Diarrhoea within last two weeks (under 3 years), G= Percentage of women by awareness of ORS, H= Percentage of women who had institutional delivery.

DNA=Data nor available Status of Institutional Delivery

Table. 2 Correlation between different variables

	Y_1	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}
Y_1	1																	
X_1	0.761	1																
X_2	-0.006	0.085	1															
X_3	-0.186	0.017	0.721	1														
X_4	0.195	0.113	0.258	0.371	1													
X_5	-0.402	-0.411	0.227	0.323	0.0627	1												
X_6	0.491	0.547	0.089	0.070	0.0639	0.013	1											
X_7	0.461	0.728	0.391	0.391	0.0587	-0.258	0.420	1										
X_8	0.325	0.632	0.119	0.172	-0.1706	-0.134	0.355	0.716	1									
X_9	-0.483	-0.512	0.312	0.597	0.3671	0.625	-0.172	-0.263	-0.411	1								
X_{10}	-0.036	0.025	0.333	0.542	0.3052	0.430	0.073	0.131	0.143	0.567	1							
X_{11}	-0.269	-0.358	-0.325	-0.338	-0.2641	-0.150	-0.425	-0.359	-0.411	-0.069	-0.562	1						
X_{12}	0.380	0.587	-0.193	-0.246	-0.1032	-0.536	0.168	0.504	0.720	-0.758	-0.270	-0.032	1					
X_{13}	0.133	0.284	0.277	0.419	-0.1191	0.275	0.220	0.557	0.670	0.090	0.313	-0.120	0.226	1				
X_{14}	-0.158	-0.293	-0.354	-0.532	-0.0474	-0.319	-0.231	-0.597	-0.693	-0.194	-0.593	0.347	-0.207	-0.915	1			
X_{15}	-0.173	-0.277	0.194	0.231	0.5901	0.199	-0.034	-0.362	-0.632	0.547	0.241	-0.144	-0.571	-0.581	0.386	1		
X_{16}	0.027	0.112	-0.507	-0.290	-0.0565	-0.144	-0.152	0.008	0.312	-0.163	-0.075	0.176	0.528	0.166	-0.115	-0.366	1	
X_{17}	-0.373	-0.310	0.037	0.348	-0.0207	0.523	-0.043	-0.079	-0.148	0.736	0.410	0.035	-0.506	0.320	-0.302	0.009	0.132	1

Note: Y_1= Percentage of Breast feeding within one hour of Birth, X_1= Percentage of Breast feeding within 24 hour of Birth, X_2= Vitamin 'A' intake at least one dose (12-23 months), X_3= Percentage of children aged 12-23 months Fully Vaccination, , X_4= Treatment of Acute Respiratory Infections (ARI) with in last two weeks (under 3 years), X_5= Treatment of Diarrhea within last two weeks (under 3 years), X_6= Percentage of women by awareness of ORS, X_7= Percentage of women who had institutional delivery, X_8= Female Literacy Rate 2011 in Percent, X_9= Percentage of BPL population, X_{10}= Percentage of SC Population, X_{11}= Percentage of Female marriage below 18 years, X_{12}= Urbanisation, X_{13}= Percentage of Hindus Population, X_{14}= Percentage of Muslims Population, X_{15}= Sex ratio, X_{16}= Crime Against Women 2011, X_{17}= No. of PHCs, CHCs and Sub Centres 2011-12.

Directly or indirectly, the physical setting of a region determines all the aspects of development mentioned above to a great extent. For example, the availability of any micro-level health centre within the village or a little far reduces child mortality in that specific region and vice-versa. A study also reports that primary health care and sub-centers/dispensaries provide effective and necessary treatment against childhood diseases and cope with big centers for delivering maternal and child health services in India (**IIPS and OCR Macro 2000**). The deeply rooted son preference in Indian society is also found to be responsible for the poor health of the children, especially for girls. It leads to high fertility in almost all social hierarchies and encourages discrimination in the allocation of health and nutritional requirements of the children at the household level.

In the same way, socio-economic inequalities are also well defined in the literature related to child

health. However, the level of education in households also plays a significant role in shaping the child's health better, yet, as the primary curator and additional well-wisher of a child, the factors related primarily to mothers affect more. The factors include her education level, marriage age, age at the time of first birth, awareness about common space of the next child, timely approach to medical facilities, and decision authority about child wellbeing at the household level. These are much more significant than any other component, like governmental policies, economic condition and size of family, the establishment of health centers, etc. Often, it is seen that the children of educated mothers are healthier as they are more attentive to sensible moving toward curative measures, the worth of vaccination, the importance of early breastfeeding, and the judicious beginning of supplementary foodstuff, whereas illiteracy leads to many health intricacies. The correlation matrix shows that female literacy has a positive association with almost all health indices. The great significance value of 0.632 of breastfeeding practices is one of them. But ARI (-0.170) and diarrhoea (-0.134) treatment are an exception to this as both have a negative connection with women's education. The early marriage of girls is also inspected as unhelpful to improve the health status of the children. Poverty is a primary cause of poor health in children due to lack of consciousness, poor dietary intake, and little nutritional food items. Still, the moderate to strong positive correlation is traced of below poverty line (BPL) families and Vitamin 'A' intake (0.312), fully vaccinated (0.597), respiratory infections (0.367) and diarrhoea treatment (0.625). The assistance of the scheduled caste population is supportive of all health comforts of the children, excluding breastfeeding initiation. Hopefully, it signifies that the economic shortage can be defeated with the aspiration and awareness to achieve complete well-being. In religion, Hindu has a positive link with full immunisation, vitamins supplementation, ORS awareness, etc. On the opposite side, the Muslim population's dominance is negatively coupled with every health index of the children. This fact can be associated with cultural and religious practices and the status of women in Muslims that restricts their autonomy regarding the health and nutritional care of children, especially for girls (**Brainerd & Menon, 2015**). Here, it is surprising to know that even after deprivations in many dimensions, the Muslim community of India is experiencing lower child mortality than the other religions, while throughout the world, lower social and economic groups tend towards higher mortality among children than their opposite (**Guillot & Allendorf, 2010**). An analogous impact of crime against women is visible in children's health. Female literacy, institutional deliveries, the remedy to ARIs and diarrhoea have a mutually and strongly encouraging bond. The association of available health facilities (primary and community health centres and sub-centres) is also negative with breastfeeding, Vitamin 'A' intake and treatment of infectivity, ORS awareness and institutional deliveries indices **(Table 2).** It means that all background determinants should be focused on jointly rather than individually for better child health results.

6. POLICIES TO IMPROVE THE HEALTH AND NUTRITION OF CHILDREN

The government has initiated various programmes and policies at the national and state levels in order to improve the health and nutritional status of preschool children (0–6 years old). Some of the key government schemes in Haryana, India, are as follows:

- **Integrated Child Development Services (ICDS, 1975)** aims to provide food, education, and primary healthcare to preschool children and their mothers. The scheme includes maximum coverage of full immunization, health check-ups, and other referral services.

- **Anganwadi Service (1975)** under the Umbrella Integrated Child Development Services (ICDS) scheme ensures the home ration facility, especially for 6-36 months children, pregnant women and lactating mothers. Apart from supplementary nutrition, this scheme targets immunization, health education, and awareness campaigns in rural and urban areas.

- **Rashtriya Bal Swasthya Karyakram (RBSK, 2013)** aims to screen infants from birth to six weeks for early identification and treatment of the four D's: defects at birth, deficiencies, diseases,

development delays, and disability, which are known as the main hindrances to children's good health. The appointment of ASHA (Accredited Social Health Activists) workers to track these targets is an effective effort in this regard.

- **Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA, 2016)** includes safe, accessible, and qualitative antenatal care to all pregnant women in India. It aims to reduce maternal mortality rate and stillbirths by providing free routine medical check-ups and medicines during pregnancy and safe delivery in the presence of skilled and trained health workers.

- **National Nutrition Mission (POSHAN Abhiyaan, 2018)** focuses on reducing stunting, malnutrition, undernutrition, anaemia, and low birth weight and improving nutritional outcomes for children, pregnant women, and lactating mothers.

Apart from these schemes, various other initiatives like the National Health Mission (NHM, 2013), Pradhan Mantri Matru Vandana Yojana (PMMVY, 2017), Pradhan Mantri Matru Vandana Yojana (PMMVY, 2017), National Deworming Programmes, Anaemia Mukt Bharat (AMB), Nutrition Rehabilitation Centres (NRCs), Creches for Children of Working Women etc. are also taken to improve the health and nutrition status of pre-school children and addressing other health issues regarding particular age groups.

7. CONCLUSION

On behalf of the preceding discussions, the study's concluding remarks confirm that the children's health and nutrition result from combined elements rather than single. Such types of phenomena play their role behind the main display, but their cumulative impacts always appear on the open screen, and the positivity or negativity of these attributes decide a way for our champions or the children. So, while tracking the issue, it is found that the children's health ranking is improving in the state. Still, this improvement should not be considered complete satisfaction because it has wide heterogeneity in almost all health indices and shows abysmal progress in some indicators during the studied period. The full vaccination (treated as the main icon of child wellbeing) is also declined at the state and the district level. After being the common practice in childhood, breastfeeding initiation has yet to attain any good position, whether due to lack of awareness or any other social cause. Undoubtedly, the progress in handling the selected infections like acute respiratory and diarrhoea is relaxing with towering statistics, but it doesn't allow to close the eyes from that side. Economically and socially backward districts like Mewat and Palwal need additional attention in terms of breastfeeding at the recommended hour, immunization, Vitamin 'A' supplementation, ORS awareness, and safe deliveries. On the other side, the turndown of some educationally, socially, and economically leading areas in some indexes of child wellbeing is also a matter of great concern. Focusing more on the controlling factors primarily related to the mothers in health plans will help solve the children's health complications. The entire conversation showed that to impound the children's health difficulties, generating awareness and providing the mandatory attached resources, along with building the health infrastructure, is most important. Secondly, decentralization or equal development at the regional level will minimize the regional discrepancies and help the children reach heights of good health. The health issues of children should be treated on a priority basis in health care plans with all possible points of view of the factors that contribute to the design of their health. So, the way to desire a happy and progressive nation always goes through the smiling faces of its offspring and to make them pleased should be a duty of all rather than necessity. The great leader Nelson Mandela also said that history will judge us by the difference that we make in the everyday lives of children.

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Economic Growth and Regional Divergence in Post-Reform India

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Abstract

India has set itself the goal to join the coveted league of developed countries by 2047 when it will be celebrating its maiden independence centenary. For this, the economy needs to grow at least at the rate of 8 to 9 per cent on a sustained basis. This, however, is not possible without keeping regional inequality at a reasonably low level. High regional inequality can derail an economy from the path of steady pace of growth. Extreme regional inequality can be a threat to national integrity, federal unity, and social stability at large. This paper analyses the trends in inequality across 18 states at the aggregate, sectoral, and sub-sectoral levels of income for the period 1993-94 to 2019-20. A distinguishing feature of the paper consists in using the latest available information on gross state value added at constant 2011-12 basic prices. The findings in the paper do not support the neoclassical convergence hypothesis, which postulates that poorer regions tend to catch up with richer ones. Our results help in determining policy focuses to reduce regional inequality.

Key Words: Regional inequality, Beta convergence, Sigma convergence, Sustainable Development

1. Introduction

In the post-1980 period, India has undergone major shifts in the policy sphere. Making a significant departure from a hitherto highly protective and regulatory framework, the Indian economy entered into a phase of partial liberalization in the 1980s before undergoing a complete paradigm shift with the adoption of new economic reforms in 1991. The reforms led to a whole host of market-friendly changes, including deregulation of investment (both domestic and foreign), interest rates and prices, and liberalization of trade, exchange rates, and capital flows. The new policy measures ushered the economy into an era of high growth rates. The average annual GDP growth rate, which was 3.6 per cent during the first three decades of planning, accelerated to 5 per cent during the subsequent decades of the 1980s and 1990s. The economy recorded an all-time high growth rate of 9 per cent during 2005-08 (GOI) before entering a phase of slowdown in the aftermath of the global financial crisis of 2008. The recovery, however, was fast, and the economy exhibited a steady pace of growth before suffering a big contraction in its size during the COVID-19 pandemic (2019-21). However, it has shown exemplary resilience in recovering from the pandemic shocks and has once again started growing at a fast rate to become the fastest-growing major economy in the world with an estimated growth rate of 7.5 per cent in 2024- 25.

Now India has set itself the goal of becoming a developed country by 2047. According to experts, the Indian economy needs to grow at least at the rate of 8 to 9 per cent per annum on a sustained basis in order to realize this ambitious goal. This, however, is not possible without ensuring an environmentally and socially sustainable development. Regional divergence can play spoilsport with sustainable development. It can well render the development process socially unsustainable. The UN Agenda 2030, a set of 17 goals that provides a roadmap for achieving sustainable development where the need for reducing inequalities and promoting inclusive and sustainable economic growth finds repeated

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emphasis. India has accepted this global agenda and is committed to implementing it in letter and spirit. So, regionally inclusive growth needs to be an essential feature of the national development agenda for making India a developed country by its independence centenary in 2047.

The basic objective of this paper is to provide an update on the trends in regional inequality in post-reform India (1993-94 to 2019-20) with a view to determining policy focuses to correct or minimize regional inequality, so important for realizing our cherished dream of becoming a developed country in 2047. It analyzes the trends in regional inequality at the aggregate, sectoral, and sub-sectoral levels of income and also examines whether there is a tendency for poorer states to catch up with the richer ones. It also examines trends in per capita dispersion across states. A distinguishing feature of the paper is that it uses the latest available information on the gross state value added (GSVA) at constant 2011-12 basic prices. It is pertinent to mention here that the new series is, among other things, the result of substantial revisions in the methodology of compilation and classification of economic activities. An important feature of the new series is that the industry-wise gross value added estimates are being prepared at basic prices (factor cost + production taxes less production subsidies), while these had been prepared at factor cost in the previous series. The rest of the paper is divided into four sections. Section 2 presents a brief review of the literature with a focus on the studies pertaining to the post-reform period. Section 3 deals with the data and methodology used in the paper. Section 4 examines the convergence of per capita income at the aggregate, sectoral, and sub-sectoral levels. Section 5 concludes the paper, along with drawing policy inferences.

2. Review of Literature

A number of empirical studies have been conducted to examine the impact of reforms on regional / inter-state inequality, specifically the issue of whether the high growth rates in the post-reform period have widened or narrowed regional inequality. Methodologically, these studies can be divided into two broad groups: a) regression-based approach and b) inequality index-based approach, though some studies have used both approaches as they are complementary to each other.

The regression-based approach has been developed in the context of the so-called convergence hypothesis of the new classical growth theory. According to this hypothesis, due to diminishing returns to capital, a region with a lower per capita income would grow faster than a region with a higher per capita income, resulting in a reduction in regional inequality over time. Thus, the hypothesis suggests a negative relationship between initial income and subsequent growth rate. This led to the popular methodology of inferring convergence from the negative sign of the coefficient in the regression of growth rate on initial income. The convergence judged by the sign of the coefficient of income in this regression is known as β- convergence.

Taking the regression-based approach studies first, **Rao et al. (1999)** analysed the trends in inter-state income inequalities across 14 major states over three decades from 1965 to 1995. Their analysis of conditional β- convergence, which took into account the allocation of private investments and public expenditure, indicated a divergence in income levels. According to **Dasgupta et al. (2000)** Indian states exhibit a clear tendency to diverge in per capita SDP while converging in the sectoral shares of SDP during the period from 1960-61 to 1995-96. The study by **Bhattacharya and Sakthivel (2004)** reveals a clear tendency for income divergence among Indian states, based on their analysis of growth performance and structural changes in the domestic product from 1980-81 to 2000-01. **Alam et al. (2010)** identified β- divergence in the secondary and tertiary sectors, suggesting rising inter-state inequalities in growth and living standards during the period from 1993-94 to 2004-05. Whereas a study made by **Raju (2012)** found evidence of unconditional convergence in growth performance across all states, considering both non-special category and special category states together. However, when analysed separately, evidence of beta convergence among the special category states is slightly

weaker. **Sanga and Shaban (2017)** have tested the convergence hypothesis at the aggregated and disaggregated levels of income using a spatial regression model for the case of 15 major states covering the period from 1970-71 to 2013-14. Their results suggest divergence of the aggregate per capita incomes during the entire study period. For the sub-periods of 1970-71 to 1990-91 and 1991-92 to 2013-14, they find a tendency towards divergence, though it is not statistically significant. **Nayak and Sahoo (2022)** reported strong evidence of β-convergence across Indian states from 1990-91 to 2018-19. In addition to that, they also find the presence of conditional convergence of per capita NSDP.

On the other hand, the inequality index-based approach looks at convergence as a reduction in the inequality of regional incomes over time in terms of a measure of inequality. Particularly, a reduction in regional inequality in terms of a fall in standard deviation or coefficient of variation of regional per capita incomes over time is known in the literature as σ- convergence. **Rao et al. (1999)** observed an increase in the standard deviation of per capita SDP, from 0.22 in 1965-66 to 0.39 in 1995-96, with the primary sector being the main contributor to this increase. **Raju (2012)** found evidence of sigma convergence in economic growth among all Indian states, with both non-special and special category states considered together, during the period from 2001-02 to 2010-11. **Kalra and Thakur (2015)** explore the spatial distribution of per capita net state domestic product in India, using simple measures like range, standard deviation, coefficient of variation, and interquartile range to analyse dispersion across different states and time periods for the period from 1960-61 to 2011-12. Their results clearly suggest an increase in regional inequality during the study period. **Sanga and Shaban (2017)** conducted a comprehensive analysis of the convergence hypothesis at both aggregate and sectoral levels, including sub-sectors. Using data from 15 major states spanning the period from 1970-71 to 2013-14, the study found no evidence supporting the neoclassical convergence hypothesis. **Nayak and Sahoo (2022)** examined sigma convergence/divergence across 17 Indian regions during the period 1990–1991 to 2017–2018, and found evidence of divergence.

3. Data and Methodology

This research paper is based on the study of 18 major states of India covering the period from 1993-94 to 2019-20. The 18 major states include Andhra Pradesh, Assam, Bihar, Chattisgarh, Delhi, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal. They are comparatively large economies together, accounting for about 96 percent of the country's population and 91 percent of the national income. The newly created state of Telangana has been considered as part of its parent state (Andhra Pradesh). The choice of period has been based on the availability of data. The convergence analysis undertaken in this paper is based on the time-series data on gross state value added (GSVA) at basic prices with a 2011 base year extracted from EPWRF's Domestic Product of States of India module. This paper uses the following classification of the economic activities : primary sector covering (i) agriculture and allied activities; (ii) mining and quarrying; secondary sector covering (i) manufacturing; (ii) construction; (iii) electricity, gas, & water supply; tertiary sector covering (i) transport, storage, & communication; (ii) trade, hotels, & restaurants; (iii) banking & insurance; (iv) real estate, ownership of dwellings, & business services; (v) public administration; and (vi) other services.

In the present paper, the unconditional convergence is examined by estimating the following panel data regression model, assuming all coefficients are constant across time and states:

$$\dot{y}_{it} = \alpha + \beta \log y_{it-1} + u_{it}$$

Where $\dot{y}_{it}$ is the growth rate of per capita income of state i during the year t, y_{it-1} is the per capita income of the state i in year t-1 and $u_{it,}$ is a non-autocorrelated homoscedastic error term. In this model, beta convergence is inferred from the sign and magnitude of the slope parameter β. A negative and statistically significant estimate of β signifies β-convergence.

On the other hand, σ- convergence is investigated by estimating the following regression model:

$cv_t = \alpha + \beta t + u_t$, (t = 1,2, …)

Where cv_t is the coefficient of variation of per capita income in year t, α and β are the intercept and slope parameter, respectively, and u_t is the error term of the simple classical regression model. σ-convergence is captured by the slope parameter β in this model. A negative and statistically significant estimate of β signifies σ-convergence.

4. Empirical Results and Discussion

In this section, we examine convergence of per capita income among Indian states at the aggregate, sectoral, and sub-sectoral levels for the period between 1993-94 to 2019-20 using the concepts of β- and σ-convergence. A separate analysis for the sub-period from 2011-12 to 2019-20 is also done for two reasons. One, the year 2011-12 is the base year of the new economic series of national income accounts, and thus this sub-period pertains only to the new economic series, which, as has already been noted, is the result of substantial revisions in the methodology of compilation and classification of economic activities. So, the results based on the data for this sub-period capture the effect of these revisions in the new series. Secondly, and more importantly, this sub-period is also the most recent part of the period under consideration. Therefore, convergence results pertaining to this period are more appropriate for making informed policy interventions to reduce regional inequality.

Table 1, provides the results of β-convergence of the aggregate and sectoral per capita incomes for the overall period of the study and sub-period from 2011-12 to 2019-20.

Table 1

β- Convergence of Aggregate and Sectoral Income of India for 18 Selected States, 1993-2019

	1993-2019				2011-2019			
Observations	**468**				**144**			
	α	β	R^2	D W	α	β	R^2	D W
Aggregate Per Capita Income	−4.220 (3.435)	0.813 (0.307)***	0.007	2.186	−2.724 (4.065)	0.675 (0.372)*	0.015	2.059
Primary Sector Per Capita Income	12.256 (5.546)	−1.125 (0.566) **	0.002	2.475	−3.168 (7.578)	0.584 (0.795)	0.001	2.244
Secondary Sector Per Capita Income	11.795 (4.286)	0.711340 (0.47)	0.003	2.062	4.505 (6.992)	0.029 (0.713)	0.000	1.838
Tertiary Sector Per Capita Income	0.364 (3.581)	0.580651 (0.343)*	0.009	1.765	0.950 (4.934)	0.457 (0.477)	0.016	1.779

Note: ***, **, and * denote statistical significance at 1 per cent, 5 percent and 10 percent level respectively. Values in the parenthesis are robust standard error.

Source: Authors' Calculations

Aggregate Income : A closer look at the results in Table 1 pertaining to the overall study period shows that the inter-state per capita income has diverged in the post-reform period, given that the regression coefficient is negative and highly significant, i.e., statistically significant at one per cent level. However, the results for the sub-period from 2011-12 to 2019-20 show that the divergence across the states has decreased as compared to the entire period.

The above diverging trend in inter-state per capita income is accompanied by an increased level of inter-state dispersion in per capita income as is evidenced by the test of σ- convergence (Table 3). The highly significant positive slope of the regression coefficient for the entire study period provides evidence for it. However, for the sub-period, the regression coefficient is no longer highly significant (being significant at 10 per cent level) indicating that, like β-divergence, σ-divergence has also decreased during the sub-period.

The diverging trend in inter-state inequality is consistent with findings by Sanga and Shaban (2017) but in sharp contrast with Nayak and Sahoo (2022), who have reported β- convergence across regions in their study.

Table 2

β- Convergence of Sub-Sectoral Income of India for 18 Selected States, 1993-2019

	1993-2019				2011-2019			
Observations	468				144			
	α	β	R^2	D W	α	β	R^2	D W
Agriculture & allied activities	−2.63 (11.033)	0.423 (1.165)	0.000	2.642	−19.964 (7.555)	2.329 (0.809)***	0.035	2.434
Mining & quarrying	39.709 (28.21)	−4.997 (3.827)	0.037	1.368	43.153 (18.013)	−5.100 (2.311)**	0.054	2.253
Manufacturing	10.220 (6.303)	−0.592 (0.723)	0.001	2.194	16.796 (9.181)	−1.173 (1.014)	0.004	1.978
Construction	27.152 (3.560)	−2.621 (0.433)***	0.035	1.946	6.853 (6.215)	−0.524 (0.689)	0.002	1.965
Electricity, gas & water supply	19.687 (8.140)	−2.230 (1.183)*	0.009	2.156	10.198 (7.350)	−0.548 (1.053)	0.000	1.967

Transport, storage & communication	12.382 (2.860)	−0.638 (0.338)*	0.009	1.536	23.583 (6.588)	−2.106 (0.779)***	0.070	1.515
Trade, hotels & restaurants	5.597 (3.817)	0.022 (0.432)	0.000	2.049	1.764 (6.535)	0.506 (0.695)	0.003	1.858
Banking & insurance	17.733 (1.745)	−1.219 (0.219)***	0.023	1.803	12.488 (3.210)	−0.852 (0.377)**	0.015	2.196
Real estate, ownership of dwellings, & business services	−4.737 (4.044)	1.132 (0.433)***	0.022	1.616	−13.003 (6.119)	1.965 (0.649)***	0.196	0.818
Public administration	17.141 (6.749)	−1.636 (0.855)*	0.007	2.297	19.692 (12.581)	−1.867 (1.529)	0.008	2.182
Others services	1.897 (3.997)	0.427 (0.523)	0.001	1.796	4.457 (4.242)	0.264 (0.477)	0.000	1.759

Note: ***, **, and * denote statistical significance at 1 per cent, 5 percent and 10 per cent level respectively. Values in the parenthesis are robust standard error.

Source: Authors' Calculation

Primary Sector: For the primary sector, the β- coefficient for the overall period shows evidence of convergence at 5 per cent level. But in the sub-period, it shows no evidence of convergence or divergence, though showing a tendency towards divergence. At the sub-sectoral level, agriculture & allied activities show no evidence of either convergence or of divergence for the overall period (Table 2). But in the sub-period, it shows a highly significant trend towards convergence. The mining & quarrying sub-sector shows no evidence of convergence or divergence for the entire period, but in the sub-period it shows a trend towards convergence as is evidenced by the negative and statistically significant β- coefficient.

The trends in inter-state dispersion of per capita income as measured by cv are presented in Table 3, the primary sector has exhibited σ-convergence (significant at 5 per cent level) for the entire period. However, it has shown strong σ-divergence (significant at 1 per cent) during the sub-period. At the sub-sectoral level, agriculture & allied activities have shown a strong trend towards σ- convergence for the overall period as indicated by the negative and highly significant value of the regression coefficient (Table 4). In the sub-period as well, it shows σ- convergence though at 5 per cent level. The mining & quarrying sub-sector shows strong evidence of σ- convergence for the entire study period as is evident from the negative and highly significant value of the slope in the regression model, but this sub-sector shows evidence of neither convergence nor divergence during the sub-period, though there is a tendency towards convergence.

Table 3

σ- Convergence of Aggregate and Sectoral Income of India for 18 Selected states, 1993-2019

	1993-2019				2011-2019			
Observations	**27**				**9**			
	α	β	R^2	D W	α	β	R^2	D W
Aggregate Per Capita Income	−122.236 (12.162)	2.9101 (0.259)***	0.834	1.095	−87.139 (47.248)	1.865 (0.956)*	0.352	0.399
Primary Sector Per Capita Income	81.831 (28.482)	−1.735 (0.7279)**	0.185	0.178	−44.512 (11.371)	1.300 (0.298) ***	0.730	1.544
Secondary Sector Per Capita Income	−30.072 (22.224)	0.918 (0.462)*	0.136	0.062	−39.317 (9.925)	0.869 (0.194)***	0.740	1.240
Tertiary Sector Per Capita Income	132.750 (39.690)	−1.497 (0.500) ***	0.263	0.157	98.779 (35.907)	−1.209 (0.462)**	0.493	0.615

Note: ***, **, and * denote statistical significance at 1 per cent, 5 percent and 10 per cent level respectively. Values in the parenthesis are robust standard error.

Source: Authors' Calculations

Secondary Sector: The secondary sector shows no statistically significant evidence of either β-convergence or divergence for the entire study period as well as for the sub-period, though there is a tendency towards divergence in both periods. At the sub-sectoral level, in manufacturing there is a tendency towards convergence but it is statistically insignificant. The construction sub-sector shows significant β-convergence from 1993-94 to 2019-20. However, in the sub-period, the value of the regression coefficient becomes insignificant. The electricity, gas, & water supply sub-sector exhibits a weak trend towards β-convergence which is significant at 10 per cent over the entire period. In the sub-period, the β-coefficient remains negative but it is insignificant.

Now taking up the results of σ-convergence, we find rather weak evidence of divergence for the overall period as is evidenced by the negative sign of the slope coefficient which is significant at 10 per cent level. However, for the sub-period, we find clear evidence of divergence with a highly significant value of the slope coefficient. At the sub-sectoral level, the manufacturing sub-sector shows clear divergence in both periods (at 1 per cent level). On the other hand, the construction sub-sector shows clear evidence of convergence during the entire period, however, for the sub-period, there is no evidence of convergence or divergence. As for the electricity, gas, & water supply sub-sector, there is no evidence of either convergence or divergence for the entire study period. However, for the sub-period, there is clear evidence of divergence as is indicated by the highly significant positive value of the slope coefficient in the regression model.

Table 4

σ- Convergence of Sub-Sectoral Income of India for 18 Selected States, 1993-2019

	1993-2019				2011-2019			
Observations	27				9			
	α	β	R^2	D W	α	β	R^2	D W
Agriculture & allied activities	97.926 (24.922)	−1.670 (0.495)***	0.312	0.288	−43.013 (16.124)	0.998 (0.335)**	0.559	1.138
Mining & quarrying	83.236 (3.776)	−0.679 (0.036)***	0.931	0.786	35.754 (43.204)	−0.349 (0.490)	0.067	0.269
Manufacturing	−46.201 (10.363)	1.031 (0.176)***	0.576	0.276	−27.559 (6.892)	0.499 (0.105)***	0.762	1.237
Construction	78.080 (9.572)	−1.217 (0.180)***	0.644	0.794	−34.675 (53.116)	0.833 (1.116)	0.073	0.189
Electricity, gas, & water supply	2.468 (11.831)	0.174 (0.177)	0.037	0.065	−14.417 (4.060)	0.282 (0.058)***	0.768	0.897
Transport, storage, & communication	70.804 (3.937)	−0.550 (0.037)***	0.894	0.868	10.796 (15.485)	−0.065 (0.173)	0.019	0.146
Trade, hotels, & restaurants	73.261	−0.828	0.921	1.085	−28.381	0.550	0.031	0.223

	(4.972)	(0.064)***			(70.105)	(1.155)		
Banking & insurance	77.767 (10.667)	−0.476 (0.079)***	0.590	0.304	44.099 (2.780)	−0.316 (0.022)***	0.965	2.838
Real estate, ownership of dwellings, & business services	−52.839 (2.661)	0.802 (0.031)***	0.962	0.507	−66.770 (11.058)	0.763 (0.117)***	0.857	1.217
Public administration	47.028 (11.601)	−0.576 (0.201)***	0.247	0.425	16.495 (10.294)	−0.216 (0.192)	0.152	0.198
Others services	12.619 (30.705)	0.022 (0.490)	0.000	0.015	108.794 (55.868)	−1.617 (0.870)	0.330	0.575

Note: ***, **, and * denote statistical significance at 1 per cent, 5 percent and 10 percent, respectively. Values in the parenthesis are robust standard error. Source: Authors' Calculations

Tertiary Sector: The tertiary sector shows evidence for β-divergence at 10 per cent level for the overall period. In the sub-period, the β-coefficient decreases and becomes insignificant. At the sub-sectoral level, the transport, storage, & communication sub-sector shows a weak convergence trend for the entire period (significant only at 10 per cent), which gets stronger in the sub-period to become significant at 1 per cent level. The trade, hotels, & restaurants sub-sector shows no evidence of convergence or divergence in either period. Banking & insurance exhibits clear convergence at 1 per cent level of significance both for the entire and sub-period. However, the real estate, ownership of dwellings & business services sub-sector shows clear divergence in both periods (at 1 per cent level). The public administration sub-sector shows weak convergence during the entire study period (at 10 per cent level), which becomes insignificant in the sub-period. Other services show no evidence of convergence or divergence in either period.

Moving to the results of σ-convergence, the tertiary sector shows statistically significant convergence across the entire study period (at 1 per cent level). This trend persists in the sub-period as well but is significant at 5 per cent level. The transport, storage, & communication sub-sector shows highly statistically significant σ-convergence for the entire period, but becomes insignificant in the sub-period. Similarly, the trade, hotels, & restaurants sub-sector also exhibits highly statistically significant convergence over the entire period, but the coefficient becomes insignificant in the sub-period. Furthermore, the banking & insurance sub-sector demonstrates clear σ-convergence in both the periods. On the other hand, the real estate, ownership of dwellings & business services sub-sector shows statistically significant σ-divergence in both periods. The public administration sub-sector shows clear σ-convergence from 1993-94 to 2019-20, but shows evidence of neither convergence nor divergence in the sub-period. The other services sub-sector shows no statistically significant evidence of σ-convergence or divergence in either period.

At the sectoral level, our above results for the primary and secondary sectors are consistent with those of Sanga and Shaban (2017) but are inconsistent with their findings showing divergence in per capita tertiary income. However, at the sub-sectoral level, our results for mining & quarrying, and electricity, gas, & water supply are different from their results for these sub-sectors. As for the rest of the sub-sectors, they find no evidence of convergence or divergence.

Given that the sub-period from 2011-12 to 2019-20 has special significance for making informed policy interventions, we list the sectors and sub-sectors showing divergence during this period in Table 5 below.

Table 5

Sectors/Sub-sectors Showing Divergence Between 2011- 2019	
Sector/ Sub-sector	**Divergence**
Primary Sector	σ-divergence
Agriculture & allied activities	β-divergence and σ-divergence
Secondary Sector	σ-divergence
Manufacturing	σ-divergence
Electricity, gas, & water supply	σ-divergence
Real estate, ownership of dwellings, & business services	β- divergence and σ- divergence

Note: Statistically significant at 5 percent or below is taken as evidence of convergence or divergence.

Source: Tables 1, 2, 3, and 4.

5. Conclusion and Policy Lessons

In this paper, we have analysed convergence of per capita income across 18 states at the aggregate, sectoral, and sub-sectoral levels for the period 1993-94 to 2019-20. A separate analysis for the sub-period 2011-12 to 2019-20 is also done, given its significance for policy purposes for being the most recent part of the study period.

At the aggregate level of income, our results suggest a high rate of divergence for the entire study period, but a comparatively lower rate of divergence for the sub-period. Overall, there is evidence against the new classical convergence hypothesis that poor states tend to catch up with richer ones.

The regional inequality has strong socio-economic implications. Its worst part is that it is superimposed on existing inequalities such as gender and caste inequalities making life doubly miserable for women, Sc/St and other vulnerable sections of society. It often leads large scale migration from poorer and slow growing regions to involving huge economic and socio-cultural costs. Extreme regional inequality may give rise to the forces of regionalism and secessionism posing a threat to natural integrity, federal unity and socio-political stability. Therefore, appropriate policy measures are needed to keep regional inequality within control.

The primary sector shows σ-divergence, whereas one of its sub-sectors, namely agriculture & allied activities, exhibits both β- and σ-divergence during the sub-period (Table 5). To address these growing inequalities in the primary sector, policy programmes should focus on enhancing agricultural productivity and building rural infrastructure in lagging regions. The secondary sector and its sub-

sectors, viz. manufacturing, and electricity, gas, & water supply, show σ- divergence, indicating a growing concentration of these activities in certain regions during the sub-period. Decentralization of industrial activities by providing incentives for establishing industries in less developed states, along with substantial investments in energy and water supply infrastructure will be a step in the direction of reducing regional inequalities in the sector.

Fortunately, the tertiary sector, which is the fastest-growing sector in the economy, has experienced a high rate of convergence throughout the study period. However, at the sub-sectoral level, the real estate, ownership of dwellings, & business services sub-sector displayed both β- and σ-divergence during the sub-period. (Table 5). Promoting equitable urban development and improving the business environment in underdeveloped areas can help reduce inequalities in this sector.

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A Pilot Study on Promoting Msme's Through Pmmy (Pradhan Mantri Mudra Yojana): With Special Reference to Sdg-10 Reduced Inequalities in Gujarat

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Abstract

The Pradhan Mantri MUDRA Yojana (PMMY) is a flagship initiative by the Government of India aimed at facilitating access to finance for Micro, Small, and Medium Enterprises (MSMEs). By providing collateral-free loans, PMMY seeks to reduce inequalities by empowering under reserved segments such as women, SC/ST, and other minority groups through entrepreneurship. The objectives of this research are to evaluate the accessibility of finance provided by PMMY, analyse its contribution to job creation within MSMEs, and assess its effectiveness in promoting entrepreneurship. A primary data from representative sample of 76 MSME owners from Gujarat who had availed of PMMY loans was selected, determined based on statistical power analysis and resource availability. The methodology involved quantitative analyses, using surveys to collect data. Key findings revealed that PMMY has significantly impacted income inequality, improved access to finance, facilitated MSME growth, and contributed to employment generation. However, challenges such as limited awareness, bureaucratic hurdles, and accessibility issues persist. The study emphasizes PMMY's role in promoting economic empowerment among marginalized communities, but it also highlights the need for addressing barriers that hinder the effective utilization of the scheme for sustainable MSME growth.

Keywords Micro, Small and Medium Enterprises, Pradhan Mantri Mudra Yojana, Reduced Inequalities, SDG-10.

1. INTRODUCTION

Micro, Small and Medium Enterprises (MSMEs) are the backbone of many economies worldwide. The manufacturing industry in India is made up of small and medium enterprises (MSMEs), which contribute 30% to the country's GDP, 45% of manufacturing output, and over 40% of exports.

Conceptual Framework of Reduced Inequalities & PMMY (Pradhan Mantri Mudra Yojana)

The link between PMMY and reduced inequalities can be explained through the following mechanisms by increased access to finance, Job creation, Empowerment of women entrepreneurs, Regional development. Overall, PMMY can contribute to reduce inequalities and to check the accessibility by Promoting inclusive growth, reducing poverty, empowering marginalized communities. The effectiveness of PMMY in reducing inequalities depends on its implementation. Factors like ensuring timely loan disbursement, providing financial literacy training, and streamlining loan application processes are crucial. It's important to monitor and evaluate the program's impact to identify areas for improvement and ensure it reaches its target beneficiaries.

In Union Budget of 2024-25 the limit of Mudra loans will be enhanced to ` 20 lakh from the current ` 10 lakh under the 'Tarun' category.

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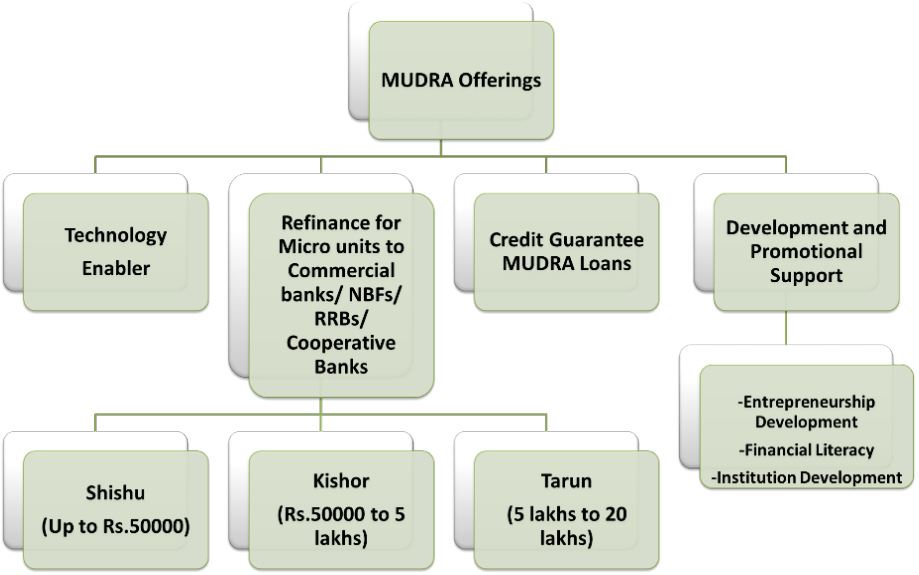

(Union Budget 2024 - Google Search, n.d.)

2. REVIEW OF LITERATURE

- (Reducing Inequalities within Countries: Assessing the Potential of the Sustainable Development Goals, february, 2018) Income and wealth inequality is rising globally. The UN's SDG 10 aims to reduce this. This paper examines if SDGs, especially SDG 10, can reverse inequality. It analysis the SDGs' theory of change and their potential to create a common metric, foster peer pressure, and enable policy learning. The key finding is that while SDGs offer tools, addressing inequality primarily remains a national challenge.

- (Shashank B. S., april 2022) The Pradhan Mantri Mudra Yojana (PMMY) significantly impacts India's banking sector, as discussed in the International Journal of Case Studies in Business, IT, and Education (IJCSBE), 6(1), 256-267. This scheme, categorized into Shishu (up to `50,000), Kishor (`50,001 to `500,000), and Tarun (`500,001 to `1,000,000) loans, is crucial for supporting Micro, Small, and Medium Enterprises (MSMEs). MSMEs are the backbone of the Indian economy, providing job opportunities and contributing to the national GDP. The paper evaluates the MUDRA scheme's performance, strengths, weaknesses, opportunities, and challenges (SWOC) in promoting micro-enterprises. Information was sourced from MUDRA Yojana's reports, its website, and various journals, magazines, and publications.

- (Shahid1, 2016) In India, many individuals rely on small-scale businesses for their livelihood, often depending on unorganized sectors for loans with high-interest rates and harsh terms, leading to debt. Much of the non-corporate sector operates as unregistered enterprises without proper accounts, making it difficult for banks to lend to them. Recognizing the need to support self-employed individuals and small business units, the Government of India launched the Mudra Bank Scheme under Pradhan Mantri Mudra Yojana to provide financial assistance to MSMEs. This scheme targets young, educated, skilled workers, and women entrepreneurs. This paper explores the MUDRA Yojana and its objectives, analysing secondary data to evaluate its early performance and product offerings, acknowledging that the scheme is still in its infancy.

- (Anita Bindal, 2022) India, with its large population, faces a critical challenge in providing employment opportunities, particularly through small, medium, and micro enterprises which employ over 20% of the population. Recognizing the hurdles of financial illiteracy, lack of infrastructure, and high establishment costs faced by these enterprises, the Indian Government launched the MUDRA Yojana in 2015. This initiative offers collateral-free loans and supports small businesses with training, marketing facilities, and exposure. The scheme has proven beneficial in addressing the financial needs of the non-corporate small business sector, enhancing their ability to thrive in today's competitive business environment.

- (Gangadhar, 7 July.2022) Launched by Prime Minister Narendra Modi on April 8, 2015, the Pradhan Mantri Mudra Yojana (PMMY) provides loans up to `10 lakhs to non-corporate, non-farm small/micro enterprises. This study analysis the performance of the Mudra Yojana using data from journals, articles, and MUDRA websites, focusing on different loan categories, state-wise and regional performance, agency achievements, and assistance to less privileged sections. The research aims to critically evaluate the effectiveness of PMMY in supporting small businesses across India.

- (Dwivedi, (December, 2017) financial inclusion is a key strategy in India, aimed at ensuring practical and inclusive growth. The goal is to extend financial services to the entire population. The Government of India (GOI) has implemented initiatives to "fund the unfunded" micro enterprises, notably the Pradhan Mantri Mudra Yojana (PMMY). This scheme supports financial inclusion by providing credit up to `10 lakhs to small businesses. This research paper presents an overview of PMMY, analysis its performance by state, caste, and category, conducts a SWOT analysis, and offers recommendations.

3. METHODOLOGY

3.1 Statement of the Problem

The topic for research is "A Pilot Study on Promoting MSME's Through PMMY (Pradhan Mantri Mudra Yojana): With special reference to SDG-10 Reduced Inequalities in Gujarat". Here the problem of Income inequality remains a significant challenge in many countries. This research aims was to investigate the effectiveness of the Pradhan Mantri Mudra Yojana (PMMY) in reducing inequalities in Gujarat, specifically focusing on its impact on micro and small enterprises (MSMEs) owned by individuals from disadvantaged & General backgrounds.

3.2 Objectives of the Study

- Accessibility of Finance to Promote MSMEs.
- To Analyse the Contribution of PMMY For Job Creation Within MSMEs.
- To Evaluate the Effectiveness in Promoting Entrepreneurs.

3.3 Significance of the Study

The findings of this research was to contribute a deeper understanding of how government programs like PMMY can address income inequality and promote inclusive growth. The results was to inform policymakers on optimizing PMMY's effectiveness and guide future initiatives aimed to reducing economic disparities. Additionally, this research was to provide valuable insights for other developing countries designing similar programs.

3.4 Scope of the Study

This research had focus on the impact of PMMY on MSMEs in Gujarat as well as India. It was to consider a specific timeframe (to be defined) and may geographically limit the study area (e.g., select states i.e. Gujarat or regions i.e. South Gujarat, West Gujarat, Different areas of Gujarat). The research had primarily target MSMEs owned by individuals from disadvantaged backgrounds, which had defined based on factors like income level, caste, or location.

3.5 Population and Sample Size

- **Population:** The target population had encompassed all MSME beneficiaries of PMMY in Gujrat (Ahmedabad, Jam Khambhalia, Surat, Vadodara Mainly)
- **Sample Size:** A representative sample of MSME owners who had availed PMMY loans was selected. The sample size was determined based on statistical power analysis and resource availability Up to 100 (Collected 76)

3.6 Sampling Method

A Convenience method was employed to ensure representation from different regions, genders, and business sectors within the target population.

3.7 Data Collection Method

- **Survey:** A structured questionnaire was developed to collect data from MSME owners regarding their experience with PMMY, loan accessibility, job creation, and perceived impact on their businesses and livelihoods.
- **Secondary Data Analysis:** Data from bank customers who visits for their EMI Paying time etc. and relevant reports on PMMY on the website of specific banks like Bank of Baroda, etc. was to be used to supplement the primary data collection.

4 DATA COLLECTION INSTRUMENT

A standardized questionnaire was the secondary data collection instrument. It was designed to be clear, concise, and easy for the target population to understand. This questionnaire was administered through face-to-face interviews, online surveys, or a combination of both, depending on feasibility and access.

4.1 Period of the Study:

Order to receive information from secondary data, research was done by paper, journals, reports, articles, etc. which are related with research topic and published and released at 25th march, 2024 to 31st may, 2024.

4.2 Variables of the Study

- **Independent Variable:** Participation in PMMY (Yes/No)
- **Dependent Variables:** Access to finance, job creation within MSMEs, economic empowerment indicators (e.g., income increase, business growth).
- **Control Variables:** Region, gender of owner, business sector, pre-existing business experience.

4.3 Limitations of the Study

The limitations of the research were to acknowledged, including potential sampling bias, self- reporting biases in survey responses, and the timeframe of the study. These limitations were to be addressed through methodological rigor and transparency in reporting.

5. RESULTS

DATA ANALYSIS AND INTERPRETATION

5.1 Graphical Analysis:

Table No.1 Location from Data Is Collected (Gujrat)

Location					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		1	1.7	1.7	1.7
	Ahmedabad	9	15.5	15.5	17.2
	Jam-Khambhalia	24	41.4	41.4	58.6
	Jamnagar	1	1.7	1.7	60.3
	Kutch	6	10.3	10.3	70.7
	Porbandhar	1	1.7	1.7	72.4
	Rajkot	8	13.8	13.8	86.2
	Ranip	1	1.7	1.7	87.9
	Surat	7	12.1	12.1	100.0
	Total	58	100.0	100.0	

(Source: SPSS Software)

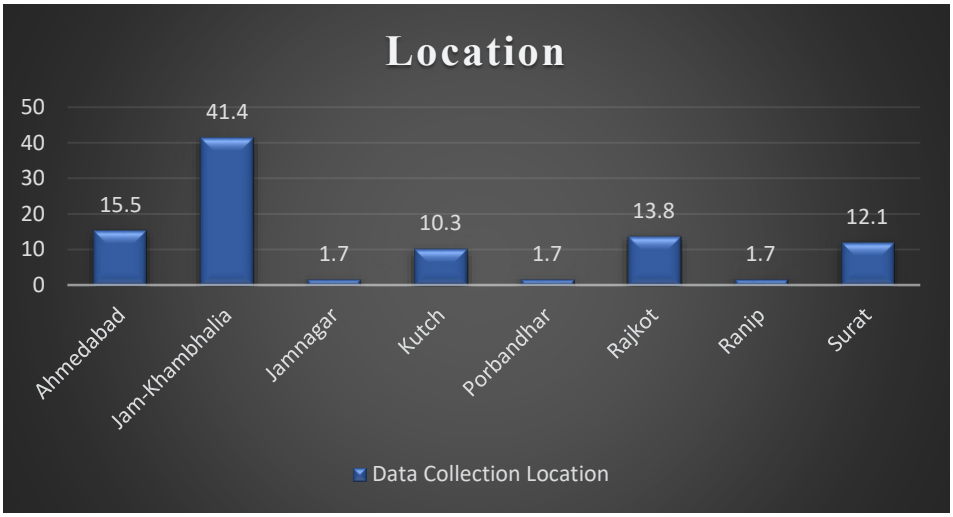

Figure No 1 Location for Collecting Respondents

Analysis of Participation in PMMY Scheme by City

City with the Most People Involved

Jam-Khambhalia has the most people involved in the PMMY scheme, with 41.4% of the respondents. This is significantly higher than any other city, indicating a strong engagement with the scheme in this location.

Cities with Very Low Participation

Jamnagar, Porbandhar, and Ranip each have a very low participation rate of 1.7%. This suggests that these cities have minimal engagement with the PMMY scheme compared to other locations.

Summary

1. High Participation: Jam-Khambhalia (41.4%)
2. Moderate Participation: Ahmedabad (15.5%), Rajkot (13.8%), Surat (12.1%), Kutch (10.3%)
3. Low Participation: Jamnagar, Porbandhar, Ranip (each 1.7%)

- **Interpretation**

The high participation in Jam-Khambhalia could be due to better awareness, accessibility, or a higher concentration of MSMEs in the region. Conversely, the low participation rates in Jamnagar, Porbandhar, and Ranip might indicate the need for improved outreach and support in these areas to ensure they can benefit from the PMMY scheme.

5.2 On the basis of nature of business:

Table No.2 Nature of Business of Responders

Nature of Business					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Manufacturing	3	50.0	50.0	50.0
	Service	2	33.3	33.3	83.3
	Trading	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

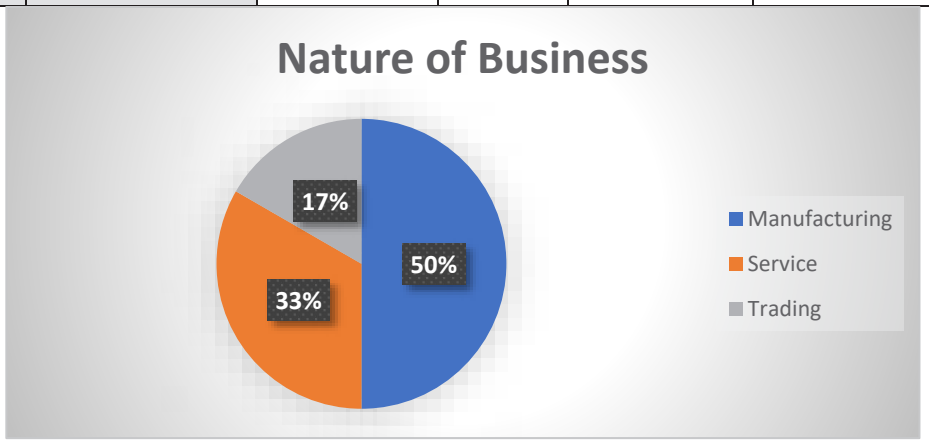

Figure No 2 Nature of Business

Analysis and Interpretation of the PMMY Scheme Based on the Nature of Business

The pie chart illustrates the distribution of respondents' businesses by nature under the Pradhan Mantri Mudra Yojana (PMMY) scheme. Here is the analysis and interpretation:

Analysis & Interpretation:-

Manufacturing: 50%, Service: 33%, Trading: 17%.

The pie chart illustrates the nature of a business, divided into three main categories: Manufacturing (17%), Service (50%), and Trading (33%). This data can be interpreted in the context of a pilot study promoting MSMEs through PMMY in Gujarat, focusing on SDG-10, which aims to reduce inequalities. The chart suggests that the business primarily operates in the service sector, which might align with PMMY's goal of empowering MSMEs. Additionally, the significant presence of trading indicates a strong focus on market interactions.

Implications for PMMY and SDG-10

- **Alignment with PMMY Goals:**

The business's focus on Service and Trading aligns with PMMY's objective of providing financial assistance to MSMEs in diverse sectors.

- **Potential for Inequality Reduction:**

By supporting MSMEs in these sectors, PMMY can contribute to reducing inequalities within the business community.

- **Need for Targeted Support:**

The varying proportions of Manufacturing, Service, and Trading suggest that different types of MSMEs may require tailored support to address their specific needs and challenges.

5.3 Cross Tabular

Table No 3 Cross Tabulation of Easy Access on Loan & Its Helps in Grow To Business

How easy was it to access a loan under PMMY? Did the PMMY loan help your business grow? Cross tabulation					
Count					
		Did the PMMY loan help your business grow?			Total
		Yes	No	May be	
How easy was it to access a loan under PMMY?	Very Easy	4	0	0	4
	Easy	22	1	11	34
	Neutral	20	0	3	23
	Difficult	10	1	1	12
	Very Difficult	1	0	2	3
Total		57	2	17	76

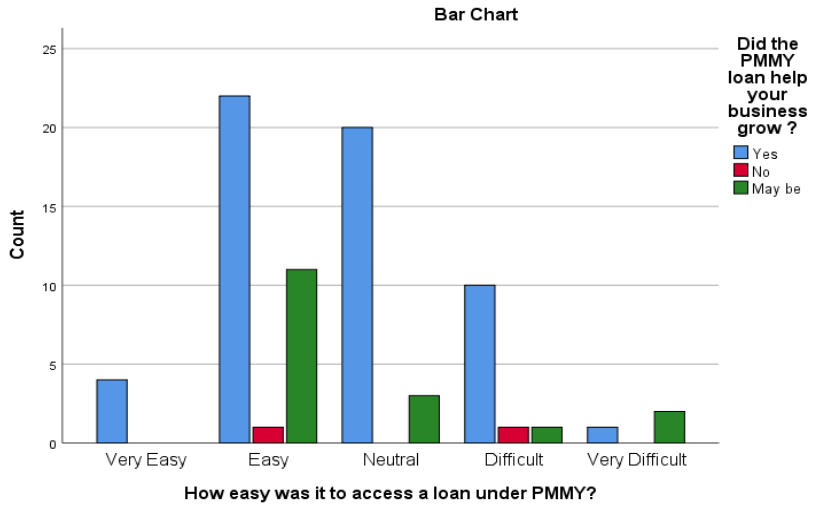

Figure No 3 Cross Tabulation of Easy Access on Loan & Its Helps in Grow To Business

Interpretation:-

Effectiveness of the PMMY Loan:

1) Yes: The majority of respondents (57 out of 76) reported that the PMMY loan helped their business grow.

2) No: Only 2 respondents said the loan did not help.

3) Maybe: 17 respondents were uncertain.

Ease of Access to the Loan:

1) Very Easy: All 4 respondents in this category reported positive outcomes.

2) Easy: Most respondents (22 out of 34) found the loan helped, 1 said it didn't, and 11 were unsure.

3) Neutral: 20 respondents reported positive impacts, while 3 were unsure.

4) Difficult: 10 out of 12 respondents found the loan helpful, 1 said it didn't help, and 1 was unsure.

5) Very Difficult: Out of 3 respondents, 1 found the loan helpful, and 2 were unsure.

Analysis:-

High Positive Impact:

The PMMY loan positively impacted business growth for a significant majority (75%) of respondents across all ease of access categories.

Very Easy and Easy: Those who found it very easy or easy to access the loan mostly reported positive business growth (26 out of 38).

Neutral and Difficult: A substantial number of respondents in these categories also reported positive impacts, but there are more uncertainties in these groups.

7.4 Hypothesis Testing

Independent Samples Test										
Levene's Test for Equality of Variances		t-test for Equality of Means								
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
How many new jobs have you created since availing the PMMY loan?	Equal variances assumed	1.225	0.273	3.328	53	0.002	0.484	0.145	0.192	0.775
	Equal variances not assumed			3.386	50.24	0.001	0.484	0.143	0.197	0.771

Table no 4: T-Test for Equality of Means

Group Statistics					
	Under which category of PMMY loan did you apply?	N	Mean	Std. Deviation	Std. Error Mean
How many new jobs have you created since availing the PMMY loan?	Sishu	32	1.88	.554	.098
	Kishor	23	1.39	.499	.104

Interpretation

Levene's test checks the assumption of equal variances between the two groups being compared. The significance value (Sig.) is 0.273, which is greater than the common alpha level of 0.05. This indicates that the variances between the groups are not significantly different, so we assume equal variances for the t-test.

5.5 T-Test for Equality of Means

The t-test compares the means of two groups to see if they are statistically different from each other.

Equal variances assumed

t: 3.328, df: 53 Sig. (2-tailed): 0.002 Mean Difference: 0.484 Std. Error Difference: 0.145

95% Confidence Interval of the Difference: Lower: 0.192, Upper: 0.775

Interpretation: With equal variances assumed, the t-value is 3.328 and the significance value (2-tailed) is 0.002. Since 0.002 is less than 0.05, we reject the null hypothesis and conclude that there is a significant difference in the number of new jobs created since availing the PMMY loan between the two groups. Equal variances not assumed

t: 3.386, df: 50.238 Sig. (2-tailed): 0.001 Mean Difference: 0.484 Std. Error Difference: 0.143

95% Confidence Interval of the Difference: Lower: 0.197, Upper: 0.771

Interpretation:

With equal variances not assumed, the t-value is 3.386 and the significance value (2-tailed) is 0.001. Since 0.001 is less than 0.05, we again reject the null hypothesis and conclude that there is a significant difference in the number of new jobs created since availing the PMMY loan between the two groups.

Conclusion

Regardless of whether equal variances are assumed or not, the test results indicate a significant difference in the number of new jobs created between the two groups. The mean difference is 0.484, with a 95% confidence interval ranging from approximately 0.192 to 0.775 (assuming equal variances) or 0.197 to 0.771 (not assuming equal variances). This means that, on average, one group created around 0.484 more jobs than the other group since availing the PMMY loan.

Findings:-

1) Assess the Impact on Income Inequality:

Evaluate how PMMY has influenced income distribution among various socioeconomic groups, particularly focusing on marginalized communities and underrepresented sections of society.

2) Evaluate MSME Growth:

Measure the growth and development of Micro, Small, and Medium Enterprises (MSMEs) that have benefited from the PMMY scheme.

3) Employment Generation:

Analyze the extent to which PMMY has contributed to job creation in MSMEs.

4) Access to Finance:

Investigate improvements in access to financial services for small business owners and entrepreneurs due to the PMMY scheme.

5) Economic Empowerment:

Examine the role of PMMY in promoting economic empowerment of women, SC/ST, and other minority groups through entrepreneurship.

6) Sustainability of MSMEs:

Assess the long-term sustainability and success rates of MSMEs funded under PMMY.

6. DISCUSSION

The pilot study on promoting MSMEs through the Pradhan Mantri Mudra Yojana (PMMY) in Gujarat, with a special focus on SDG-10 (Reduced Inequalities), provides valuable insights into the scheme's effectiveness. The research underscores PMMY's significant role in reducing income inequality by improving access to finance for underserved segments, including women, SC/ST, and other minority groups. The scheme has successfully facilitated MSME growth and job creation, demonstrating its potential to empower marginalized communities through entrepreneurship.

However, the study also identifies several challenges that hinder the full potential of PMMY. Limited awareness about the scheme, bureaucratic obstacles, and accessibility issues remain significant barriers. Addressing these challenges is crucial for enhancing the effectiveness and reach of PMMY, ensuring that it can contribute to sustainable MSME growth and broader economic empowerment.

7. CONCLUSION:

1. Accessibility of Finance to Promote MSMEs	Cross Tabulation: Ease of Loan Access vs. Business Growth	- 75% of respondents reported positive business growth due to PMMY loans.	- Easier access to loans correlates with positive business outcomes.
2. Analyse the Contribution of PMMY to Job Creation	T-Test for Equality of Means: Job Creation after PMMY Loan	- Significant difference in job creation between groups ($p < 0.05$).	- PMMY loans have a statistically significant impact on job creation within MSMEs.
3. Evaluate the Effectiveness of PMMY in Promoting Entrepreneurs	Analysis by Location: Participation in PMMY Scheme by City	- High participation in Jam-Khambhalia (41.4%), low in Jamnagar, Porbandhar, Ranip (1.7% each).	- High participation in some areas may reflect better outreach or higher MSME concentration; low participation suggests need for improved outreach.
4. Impact of PMMY on Different Business Sectors	Pie Chart Analysis: Nature of Business of	- 50% of respondents in the 'Total' category, 25% in Manufacturing, 17% in Service, 8% in	- PMMY effectively supports a diverse range of businesses, with significant benefits for the manufacturing and

	Respondents	Trading.	service sectors.
5. Relationship Between Ease of Access and Business Growth	Cross Tabulation: Ease of Loan Access vs. Business Growth	- Very easy and easy access led to mostly positive business growth (26 out of 38 respondents).	- Easier loan access is linked to better business outcomes, but uncertainties increase as access becomes more difficult.

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9. APPENDICES

APPENDIX A (LIST OF CHARTS)

APPENDIX B (LIST OF TABLES)

Mediating Role of Leisure Activities in Business Tourism Motivation and Perceived Benefits: A Study of Indian Tourists at Exhibitions in China

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Abstract

This study explores the mediating role of leisure activities on the relationship between business tourism motivational factors and perceived benefits among Indian tourists attending exhibitions in China. The study draws from a sample of 360 Indian business tourists who participated in exhibitions in China. Using an SEM approach, the analysis reveals that leisure activities significantly mediate the relationship between motivational factors and the perceived benefits of the trip. Tourists who engaged in leisure activities reported higher satisfaction levels and perceived greater overall benefits from their travel experiences. The findings emphasize the importance of incorporating leisure elements into business tourism offerings, as these activities enhance travelers' overall satisfaction and perceived value. The research provides insights for tourism operators, exhibition organizers, and policymakers, suggesting a well-rounded travel experience that blends business with leisure can significantly enhance the perceived benefits of business travel. This study contributes to the growing body of literature on business tourism.

Key Words: Business tourism, exhibitions, leisure activities, relationships, motivation factors, perceived benefits.

1. INTRODUCTION

Tourism is a major driver of the global economy, contributing significantly to national incomes, employment, and international exchange. In 2019, the global tourism sector generated 10.4% of the world's GDP, approximately $10 trillion, and supported 334 million jobs, making up 10.3% of global

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employment (World Travel and Tourism Council [WTTC], 2023). However, the COVID-19 pandemic caused severe disruptions, leading to a sharp decline in both domestic and international travel. Despite these challenges, the tourism sector has shown resilience, with an estimated 1.286 billion international tourists recorded in 2023, representing a 34% increase compared to 2022 (WTTC, 2023). As the industry recovers, special attention is being paid to the Meetings, Incentives, Conferences, and Exhibitions (MICE) tourism sector, which combines professional engagements with leisure activities, offering substantial economic benefits to host destinations.

Business tourism, a subset of MICE, involves professional travelers attending exhibitions, trade shows, and business conferences. The exhibition industry serves as a platform for knowledge sharing, showcasing innovations, and promoting global networking, which significantly contributes to local economies and global trade (Çobanoğlu & Turaeva, 2014). Exhibitions can be classified into Business-to-Business (B2B) and Business-to-Consumer (B2C) formats, providing opportunities for businesses to engage with new markets and connect with potential clients (Lee, Yeung, & Dewald, 2010). In recent years, the Indian outbound tourism market has seen remarkable growth, with an increasing number of Indian business tourists attending international exhibitions, especially in China. Exhibitions offer Indian businesses a platform to showcase their products, gather market insights, and establish global connections.

The exhibition industry plays a critical role in global trade and economic development. Exhibitions provide platforms for businesses to showcase their products, generate sales leads, and form partnerships. They also benefit local economies by attracting international visitors and promoting trade (Arnegger & Herz, 2016). The Indian exhibition industry has evolved significantly, with increasing participation in international trade shows driven by globalization and growing demand for Indian products (Nayak & Bhalla, 2016). These exhibitions offer a unique environment for businesses to engage with global markets, build partnerships, and expand their international footprint.

Indian business tourists are driven by a combination of push and pull factors. Push factors refer to internal motivations such as the desire for professional growth, networking, and knowledge exchange, while pull factors relate to external attractions like the quality of the event, the appeal of the destination, and potential new business opportunities (Kozak & Kayar, 2008). These exhibitions not only act as professional hubs but also offer opportunities for leisure, thereby enriching the overall travel experience for business tourists.

Although the primary goal of business tourism is professional, leisure activities offer an opportunity for relaxation, cultural immersion, and informal networking, all of which positively affect overall satisfaction (Han & Verma, 2014). Business tourists who engage in leisure activities during their trips often report higher satisfaction levels, as these activities provide a balance to work-related stress through personal enjoyment.

This study focuses on the mediating role of leisure activities in enhancing the perceived benefits of business tourism. By integrating leisure into business trips, tourism operators and exhibition organizers can offer a more holistic experience, resulting in higher satisfaction and increased repeat visitation (Rittichainuwat & Mair, 2012). This is particularly relevant in the post-pandemic context, where travelers seek a balance between professional fulfillment and personal enjoyment during their trips. The ability to combine business with leisure, often referred to as "bleisure," is becoming a key trend in the tourism industry (Lee & Lee, 2014). The case study of Indian business tourists attending exhibitions in China sheds light on the specific motivations and preferences of this demographic. Indian tourists increasingly seek opportunities to combine work and leisure, making China an attractive destination. The specific objectives are (i) to examine the impact of business tourism motivation on the integration of bleisure activities during exhibition visits in China, (ii) to analyze the influence of destination

attributes on the incorporation of bleisure experiences during exhibition visits in China, and (iii) to assess how bleisure activities enhance perceived benefits for attendees during exhibition visits in China.

2. REVIEW OF LITERATURE

Business travel serves multiple purposes, including group and regional meetings, staff briefings, joint training sessions, product development meetings, cross-border projects, and problem-solving activities (Welch et al., 2007). Tani's (2005) study, which surveyed 210 passengers-75 Australian residents traveling abroad, and 104 residents returning home after visiting Australia-revealed that the main motivations for business travel include revenue growth, building new partnerships, and addressing internal company matters. Severt, Wang, Chen, and Breiter (2007) identified five key factors motivating individuals to attend conferences, ranked by importance: networking opportunities, conference convenience, educational benefits, and product offerings. Similarly, Rittichainuwat, Hailin, and Mongkhonvanit (2008) emphasized that while professional motivations like career advancement are significant, personal motivations—including escaping routine, sightseeing, relaxation, and social interaction—also play an essential role.

Table 1. Overview of Professional Motivations Identified In Previous Studies.

Authors	Professional and Personal Motivations
Oppermann (1998)	Career enhancement, networking, education, self-esteem, leadership, and opportunity for travel.
Ngamsom & Beck (2000)	Business activities, networking, education, change of pace, and travel.
Price & Murrmann (2000)	Profession-based values (education), competency-based values (training), and networking.
Rittichainuwat et al. (2001)	Career enhancement, leadership, self-esteem, sightseeing, networking, and education.
Malek, Mohamed, & Ekiz (2011)	Professional relationships, peer reputation, knowledge acquisition, new experiences, and travel.
Olsen, Vogt, & Andereck (2018)	Educational fulfillment, escape from daily life, altruism, networking, and promoting tourism products.

Bello (1992) discovered that attendees at U.S. textile equipment exhibitions primarily sought technical information, while Bello and Lohtia (1993) noted that many attendees did not have purchasing authority, yet exhibitors continued to prioritize sales as their primary goal. Hansen (1996) suggested that exhibitions provide opportunities for attendees to observe competitors and collect market intelligence, a view supported by Munuera and Ruiz (1998), who highlighted that discovering new products and suppliers was a key motivation for trade show participation.

Godar and O'Connor (2001) categorized visitor motivations into purchasing and non-purchasing activities, such as networking and attending seminars. Blythe (1999) and Hansen (2004) further examined the disparity between exhibitor and visitor expectations at trade exhibitions. Bettis-Outland et al. (2010) identified exhibitions as vital platforms for gathering market and competitor information, essential for long-term decision-making. Sarmento, Simões, and Farhangmehr (2015) emphasized the

importance of social exchanges in fostering business satisfaction and relationship-building, while Huang (2016) explored how selling activities and information collection at exhibitions influence business performance.

A diverse set of factors motivates business tourists to attend exhibitions, including professional development, networking, and information gathering. Social interactions and personal interests, such as travel opportunities and face-to-face engagements, also play a significant role in exhibition attendance (Jin, Weber, & Bauer, 2012; Smith et al., 2022; Chen et al., 2023).

H1: Business tourism motivations positively impact the incorporation of bleisure activities during exhibition visits in China.

Destination attributes, such as external, situational, and cognitive factors tied to the destination's appeal, play a crucial role in business travelers' decision-making (Ah Keng & Pei Shan, 2005; Pearce & Lee, 2005). Swandby et al. (1990) highlighted that first-time exhibition attendees often rely on the event's reputation, past reviews, and participant numbers to decide on future attendance. The satisfaction and experience gained at an exhibition also influence return rates. Bitner (1992) emphasized that booth design and quality impact interactions between exhibitors and attendees, with well-designed booths facilitating better decision-making (Bello & Lohtia, 1993).

Exhibitors evaluate an exhibition's reputation and reviews before participating (Kijewski et al., 1993; Shipley & Wong, 1993; Hansen, 2004). For attendees, networking opportunities and high-quality business prospects are essential. Hu and Ritchie (1993) noted that local culture, historical sites, and scenic beauty strongly influence tourists, while Uysal et al. (1994) found that natural areas and national parks attract international visitors. Similarly, Jamorozy and Uysal (1994) identified favorable weather as a key pull factor for German tourists, and Oh et al. (1995) noted that Australian adventure seekers prioritize wilderness areas and national parks.

Perceptions of destination attributes are shaped by various sources, past experiences, and personal preferences (Baloglu & McCleary, 1999; Beerli & Martín, 2004). Murphy et al. (2000) stressed that accommodation, transportation, food, and attractions influence business travelers' perceptions. Jang and Cia (2002) found that outdoor activities in the U.S. attract British tourists, while Kozak (2002) noted that sports facilities draw German tourists more than British travelers.

Recent studies (Jones & Brown, 2023; Liu & Wang, 2023; Tan et al., 2024) identified key motivators for business tourists, including exhibition reputation, exhibitor quality, and educational sessions. Technological advancements like virtual tours and online registration enhance exhibition appeal, while marketing strategies and promotional campaigns significantly impact attendance (Nguyen et al., 2024). Social influence, such as peer recommendations, also increases participation (Kim & Park, 2023). Lee and Garcia (2024) concluded that push factors like career advancement initiate interest, but pull factors like destination appeal and exhibition value are decisive for attendance.

Table 2. Summary of Destination Attributes in Previous Research.

Authors	Components of Destination Attributes
Oppermann (1996)	Meeting room facilities, hotel service quality, location, safety, transportation access, affordability, climate, nightlife.
Go & Zhang (1997)	Accessibility, attractiveness, accommodation, meeting facilities, hospitality, costs, food, and transportation.

Go & Govers (1999)	Meeting room and hotel facilities, accessibility, affordability, service quality, climate, entertainment, and traveler attractions.
Chacko & Fenich (2000)	Accessibility, local support, accommodation, and extra-conference opportunities.
Baloglu & Love (2001)	Safety, security, transportation costs, meeting facilities, affordability, and city reputation.
Rajesh (2013)	Attractions, lodging, dining, shopping, environment, and events.
Papadimitriou et al. (2015)	Services, unique atmosphere, value for money, family-friendly, historical attractions, and significant natural attractions.
Kock, Josiassen, & Assaf (2016)	Weather, food, infrastructure, historical places, culture, relaxed lifestyle, nightlife, and beaches.

H2: Destination attributes positively influence the extent to which business travelers engage in bleisure during exhibitions in China.

Pine and Gilmore's (2011) "experience economy" theory highlighted four types of experiences for bleisure travelers: educational, aesthetic, entertainment, and escapist. Studies show that bleisure travelers highly value aesthetic and entertainment experiences. Chen, Petrick, and Shahvali (2014) argued that bleisure travel improves employee motivation and well-being by blending work and leisure. A 2019 NCR survey confirmed that bleisure travelers report higher satisfaction, especially in work-life balance and focus during business trips.Chen (2017) identified bleisure travel as a stress-coping mechanism for business travelers, with leisure activities playing a critical role. The Expedia Group (2018) found that around 60% of U.S. business trips had transformed into bleisure trips, with similar trends globally. Common leisure activities included dining on local cuisine, exploring cultural sites, and visiting museums.

Lichy and McLeay (2018) categorized bleisure travelers into five types: experiential learners, escapers, working vacationers, altruistic knowledge-sharers, and research-active trailblazers. Further studies (The Economist, 2019; Expedia, 2018) showed that cultural activities and local cuisine strongly influence decisions to extend business trips.

Research shows that incorporating leisure into business travel enhances overall experiences, especially when traveling with partners (Yoo et al., 2016). Leisure activities during exhibitions, such as sightseeing or dining, also boost attendee satisfaction, engagement, and networking (Chung et al., 2020; Smith et al., 2022; Wang & Li, 2023; Lee & Garcia, 2024; Kim & Park, 2024). These studies emphasize the importance of offering balanced programs that include both business and leisure activities for a richer experience.

H3: Engaging in bleisure activities positively enhances the perceived benefits of exhibition visits in China.

Attendees gain from learning about products, prices, and technologies, which informs purchasing decisions (Berne & Garcia-Uceda, 2008). Studies (Smith et al., 2022; Kozak & Kayar, 2008) emphasize exhibitions as key venues for knowledge acquisition, networking, and business expansion. Attendees who perceive high benefits from exhibitions are more likely to share positive experiences and demonstrate loyalty (Nguyen et al., 2022; Chen et al., 2022).

From exhibitors' perspectives, exhibitions are effective marketing channels for lead generation, brand visibility, and relationship-building (Jones & Brown, 2023). Exhibitors' satisfaction correlates with

perceived benefits such as return on investment, brand exposure, and networking opportunities, which influence future participation decisions (Wang & Li, 2023; Kim & Park, 2024). Likewise, perceived benefits drive attendee satisfaction, engagement, and overall exhibition experience (Lee & Garcia, 2024).

Exhibition attendees often participate with specific goals, such as acquiring valuable information, even though many lack direct purchasing authority. At the RoSPA Health and Safety Exhibition, 65% of attendees had some purchasing role, but only 26% could place orders, reflecting trends in the U.S. where many visitors influence but don't directly engage in purchasing (Bello & Lohtia, 1993; Gramann, 1994). Despite this, exhibitors focus on sales and benefit most when visitors hold final purchasing authority (Kerin & Cron, 1987; Shipley et al., 1993; Blythe, 1997).

Exhibitors attend exhibitions not only for sales but also to maintain visibility and outshine competitors through booth design and staffing (Gopalakrishna & Williams, 1992; Dekimpe et al., 1997). Exhibitions are key to increasing sales, reputation, and competitiveness (Sola et al., 1994). Rosson and Seringhaus (1995) highlighted their growing importance as platforms for learning, planning, and making connections. Attendees use exhibitions to gather technical information, stay updated on industry trends, and explore new products (Hansen, 1996; Breiter & Milman, 2006).

Theoretical Framework

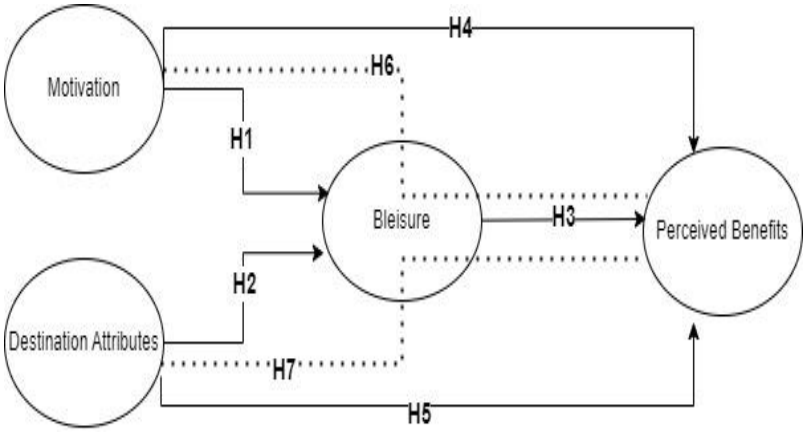

Figure 1. The Conceptual Framework

3. RESEARCH METHODOLOGY

Study Area

This research focuses on Indian business tourists from key industrial cities in northwestern India—Delhi, Chandigarh, Mohali, Ludhiana, Jalandhar, Amritsar, Panipat, and Faridabad—who travel to China for exhibition visits. These cities are prominent industrial centers known for producing engineering goods, textiles, pharmaceuticals, and machinery. The study explores how business travelers from this region engage with international exhibitions in China, with a specific focus on their business motivations and the incorporation of leisure activities (bleisure) into their trips.

Sample Selection & Data Collection

The study employed two sampling techniques—purposive sampling and convenience sampling—to gather responses for the analysis. Outbound business tourists were asked to share their perceptions regarding the motivations and destination attributes influencing their decision to visit exhibitions in China. Initially, a comprehensive list of the top twenty exhibitions in China, spanning various business sectors such as industrial manufacturing, engineering, textiles and garments, pharmaceuticals, medical equipment, and printing and packaging, was compiled using purposive sampling. To facilitate data collection, major industrial associations and chambers were contacted via telephone, email, and personal visits.

A questionnaire containing 28 measurement items was distributed through both online and offline survey methods. Convenience sampling was then applied, with the support of industrial associations and chambers, to distribute the survey invitations through email and personal visits, guiding participants to complete the questionnaire online or offline. The survey form outlined the study's objectives, potential mutual benefits, and ethical considerations, including confidentiality and data security, to ensure respondents felt comfortable participating. A pilot test was conducted in November 2023, yielding 50 responses. The main survey, carried out between March and June 2024, collected 360 responses from business tourists within the specified market sectors. The demographic profile of the respondents is presented in Table 3.

Research Instrument

The research instrument was developed based on an in-depth review of the relevant literature. All items were measured using a standard Likert scale, where respondents indicated their level of agreement or disagreement with specific statements, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Likert scales are commonly used to assess traveler intentions (Bernard & Bernard, 2013). Content validity was evaluated by five exhibition professionals using the Item-Objective Congruence (IOC) index, with all items scoring above 0.50, reflecting adequate alignment with the study's objectives. A pilot test was conducted to ensure reliability, and Cronbach's alpha was employed to assess the internal consistency of the measurements.

Table 3. Business Tourist Demographic Profile.

Demographic Variable	Category	Frequency	Percentage
Age (In Years)	18-25	48	13.33
	26-35	72	20
	36-45	148	41.11
	46-55	68	18.89
	56-Above	24	6.67
Gender	Male	316	87.78
	Female	44	12.22
	Other	0	0

Marital Status	Single	63	17.5
	Married	297	82.5
	Other	0	0
Educational Qualification	Up to Sr. Secondary	41	11.39
	Diploma/Certificate	30	8.33
	Graduation Degree	136	37.78
	Post-Graduation Degree	126	35
	Doctorate	27	7.5
Occupation	Business Owner	260	72.22
	Private Employee	86	23.89
	Govt. Employee	1	0.28
	Freelancer	7	1.94
	Other	6	1.67
Management Level	Top	222	61.67
	Middle	108	30
	Lower	30	8.33
Industry Category	Manufacturing	171	47.5
	Textiles & Garments	25	6.94
	Pharmaceuticals	42	11.67
	Medical Devices	9	2.5
	Printing & Packaging	28	7.78
	Agriculture & Allied	11	3.06
	Auto Component	25	6.94
	Aviation	3	0.83
	Biotechnology	2	0.56
	Chemical	4	1.11

	Consumer Durables	1	0.28
	Defence Manufacturing	3	0.83
	Electronic System Design & Manufacturing	6	1.67
	Engineering & Capital Goods	20	5.56
	Healthcare	7	1.94
	Infrastructure	1	0.28
	IT & BPM	1	0.28
Company Location	Delhi	128	35.56
	Haryana	54	15
	Punjab	146	40.56
	Chandigarh	32	8.89
Company Operation (in Years)	0-3	40	11.11
	03-06	96	26.67
	06-09	65	18.06
	10-Above	159	44.17
Average Annual Income (in Lakh)	Up to 5	48	13.33
	5 to 7.5	68	18.89
	7.5 to 10	127	35.28
	More than 10	117	32.5
Average International Exhibition Visits per Year	Only 1	122	33.89
	02-03	169	46.94
	04-05	57	15.83
	06-07	8	2.22
	8 or More	4	1.11
Sponsorship of the International	Self	90	25

Exhibition Tour	Company	216	60
	Company + Self	54	15
Travel companion	Solo	63	17.5
	With Family	13	3.61
	With Friends	62	17.22
	With Business Associates	193	53.61
	With Colleagues	29	8.06

The initial survey generated 400 responses, which were then screened to eliminate cases with excessive missing data or outliers, leaving 360 valid responses for analysis. Taking into account the model's complexity, the data's normality, and the commonalities of the indicators, it was determined that the sample size was appropriate for the analysis. The demographic table summarizes the characteristics of 360 respondents in the study. The majority of respondents (41.11%) are aged 36-45, with 87.78% being male. Most are married (82.5%), and a significant proportion (72.22%) are business owners. Educationally, 37.78% hold a graduation degree, followed closely by post-graduates at 35%. Most participants are in top management (61.67%), and nearly half (47.5%) work in manufacturing. In terms of location, the highest representation comes from Punjab (40.56%), followed by Delhi (35.56%). The majority of companies have been in operation for over 10 years (44.17%). The respondents' average annual income is fairly distributed, with 35.28% earning between Rs.7.5-10 lakh. Most respondents attend 2-3 international exhibitions annually (46.94%) and are primarily sponsored by their companies (60%). The majority travel with business associates (53.61%) during these exhibitions.

Principal Component Analysis

Measurement Model Test Study

Both EFA and CFA were conducted on the research data. The EFA explored the factor structure of the 28 items, followed by Varimax rotation to confirm factor loadings, which aligned with Study 1's findings. Table 4 presents the factor loadings and item versions used in both studies. The CFA was performed to assess the measurement model's fit. Two items ("to see a demonstration of new products and services, to connect with new distributors and create new contracts ") were removed due to low item correlation and poor performance. After removing these items, the model demonstrated strong construct validity and reliability for the business tourism motivation, destination attributes, bleisure activities and perceived benefits scales. All factor loadings were statistically significant ($p < 0.001$), and the measurement items aligned well with their respective factors. Composite reliability (CR) values indicated strong internal consistency and AVE values exceeded 0.5, confirming convergent validity (Fornell & Larcker, 1981).

Table 4. Exploratory Factor Analysis and Confirmatory Factor Analysis Results.

	EFA				**CFA**			
Factor / Items	**Factor Loading**	**KMO**	**Eigenvalue**	**Variance Explained**	**Std Loading**	**t-value**	**CR**	**AVE**
Business Tourism Motivation		**0.88**	**2.45**	**55.32%**			**0.85**	**0.57**

To purchase	0.72				0.74	13.25		
To participate in seminars and workshops	0.76				0.79	15.62		
To exchange ideas	0.81				0.83	17.05		
To examine product/service varieties	0.79				0.82	16.54		
To study new trends	0.68				0.71	12.89		
Destination Attributes		**0.91**	**2.95**	**62.15%**			**0.88**	**0.60**
The reputation of exhibitors in the market	0.77				0.79	15.89		
The friendly nature of people in that country	0.72				0.75	13.45		
Efficient government support in that country	0.68				0.7	12.32		
Image of organizers	0.8				0.83	16.84		
Media coverage of the exhibition	0.73				0.74	13.68		
Attractiveness of destination	0.82				0.85	17.12		
Bleisure Activities		**0.89**	**2.60**	**58.23%**			**0.87**	**0.58**
Local sightseeing	0.81				0.82	16.7		
Enjoying local cuisine	0.76				0.79	15.41		
Enjoyed nightlife at destination	0.73				0.75	14.02		
Shows performed during the exhibition	0.68				0.69	11.98		
Various outdoor activities	0.75				0.77	13.89		
Perceived Benefits		**0.92**	**3.10**	**64.55%**			**0.90**	**0.63**
Personal growth and development	0.84				0.85	17.65		
Organizational growth and development	0.79				0.81	16.1		
Enhancing awareness regarding latest trends	0.83				0.84	17.25		
Growing market share	0.78				0.8	15.72		
Networking opportunities	0.81				0.83	16.8		
Making informed decisions regarding products	0.73				0.74	14.07		

Gaining new ideas and insights	0.82				0.84	16.95		
Competitive advantage	0.76				0.79	15.25		
Maintaining business partnerships and collaborations	0.81				0.83	16.89		
Sales Growth	0.72				0.74	13.42		
Enhancing reputation in the industry	0.85				0.87	18.02		
Contribution to business growth	0.8				0.82	16.45		
Enhancing cultural awareness and understanding	0.77				0.79	15.75		

Kaiser-Meyer-Olkin test for sampling adequacy, CR = Composite reliability, AVE = Average variance extracted.

Table 5. Heterotrait-Monotrait ratio (HTMT).

Constructs	Business Tourism Motivation	Destination Attributes	Bleisure Activities	Perceived Benefits
Business Tourism Motivation	1			
Destination Attributes	0.74	1		
Bleisure Activities	0.68	0.62	1	
Perceived Benefits	0.71	0.65	0.69	1

Table 5 evaluates the discriminant validity of the constructs in the SEM model using the Heterotrait-Monotrait (HTMT) ratio. All HTMT values are below the 0.85 threshold, indicating that the constructs—such as "Business Tourism Motivation," "Destination Attributes," "Bleisure Activities," and "Perceived Benefits"—are sufficiently distinct, confirming adequate discriminant validity (Henseler, Ringle, & Sarstedt, 2015). This ensures that each factor measures a unique aspect of the model, supporting its overall validity. Additionally, Business Tourism Motivation shows strong correlations with Perceived Benefits and Destination Attributes, while Bleisure Activities moderately correlate with all constructs, further reinforcing the model's discriminant validity.

Table 6. Model Fit Indices.

Fit Index	Threshold Value	Model Value	Reference
Chi-Square (χ^2)	Non-significant ($p > 0.05$)	400.23 ($p < 0.05$)	Bentler & Bonett (1980)
Degrees of Freedom (df)	-	350	-
Chi-Square/df (CMIN/df)	≤ 3.0	1.14	Kline (2015)
Comparative Fit Index (CFI)	≥ 0.90	0.92	Bentler (1990)

Tucker-Lewis Index (TLI)	≥ 0.90	0.91	Hu & Bentler (1999)
Root Mean Square Error of Approximation (RMSEA)	≤ 0.08	0.042	Steiger (1990)
Standardized Root Mean Square Residual (SRMR)	≤ 0.08	0.045	Hu & Bentler (1999)
Goodness of Fit Index (GFI)	≥ 0.90	0.93	Jöreskog & Sörbom (1984)
Adjusted Goodness of Fit Index (AGFI)	≥ 0.90	0.91	Jöreskog & Sörbom (1984)
Normed Fit Index (NFI)	≥ 0.90	0.90	Bentler & Bonett (1980)
Incremental Fit Index (IFI)	≥ 0.90	0.91	Bollen (1989)

Table 6 presents key model fit indices for evaluating the structural equation model (SEM), comparing the model values against commonly accepted threshold values. The Chi-Square (χ^2) is significant at 400.23 ($p < 0.05$), though this measure is often sensitive to sample size (Bentler & Bonett, 1980). The ratio of Chi-Square to degrees of freedom (CMIN/df) is 1.14, well within the acceptable range of ≤ 3.0, indicating a good fit (Kline, 2015). The Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) are both above the 0.90 threshold, with values of 0.92 and 0.91 respectively, suggesting a good model fit (Bentler, 1990; Hu & Bentler, 1999). The Root Mean Square Error of Approximation (RMSEA) is 0.042, and the Standardized Root Mean Square Residual (SRMR) is 0.045, both well below the 0.08 threshold, indicating a close fit (Steiger, 1990; Hu & Bentler, 1999). Similarly, the Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI) values, at 0.93 and 0.91 respectively, are above the recommended 0.90 (Jöreskog & Sörbom, 1984). Lastly, the Normed Fit Index (NFI) and Incremental Fit Index (IFI), both at or above 0.90, confirm the adequacy of the model fit (Bentler & Bonett, 1980; Bollen, 1989). These indices collectively indicate that the model demonstrates good overall fit and validity.

Table 7. Results of Hypotheses Analysis.

Hypothesis	Constructs	Path Coefficient	Direct Effect	t-value	p-value	Result
H1: Business tourism motivation has a positive influence on bleisure during exhibition visits in China	Business Tourism Motivation → Bleisure Activities	0.68		15.25	< 0.001	Supported
H2: Destination attributes have a positive influence on bleisure during exhibition visits in China	Destination Attributes → Bleisure Activities	0.62		13.89	< 0.001	Supported

H3: Bleisure activities have a positive influence on perceived benefits during exhibition visits in China	Bleisure Activities → Perceived Benefits	0.69		16.95	< 0.001	Supported
H4: Business tourism motivation has a positive influence on perceived benefits during exhibition visits in China	Business Tourism Motivation → Perceived Benefits	0.71		16.8	< 0.001	Supported
H5: Destination attributes have a positive influence on perceived benefits	Destination Attributes → Perceived Benefits	0.65		14.02	< 0.001	Supported
H6: Bleisure mediates the relationship between business tourism motivation and perceived benefits	Business Tourism Motivation → Bleisure Activities → Perceived Benefits	0.47 (Indirect)	0.71	10.54	< 0.001	Supported
H7: Bleisure mediates the relationship between destination attributes and perceived benefits	Destination Attributes → Bleisure Activities → Perceived Benefits	0.43 (Indirect)	0.65	9.89	< 0.001	Supported

Table 7 presents the results of hypothesis testing, showing the relationships between Business Tourism Motivation, Destination Attributes, Bleisure Activities, and Perceived Benefits during exhibition visits in China. All path coefficients are statistically significant with p-values < 0.001, indicating strong support for the hypotheses. Specifically, Business Tourism Motivation positively influences Bleisure Activities (H1, $\beta = 0.68$) and Perceived Benefits (H4, $\beta = 0.71$), while Destination Attributes positively impact Bleisure Activities (H2, $\beta = 0.62$) and Perceived Benefits (H5, $\beta = 0.65$). Moreover, Bleisure Activities significantly enhance Perceived Benefits (H3, $\beta = 0.69$). Mediation analyses show that Bleisure Activities partially mediate the relationships between Business Tourism Motivation and Perceived Benefits (H6, indirect effect = 0.47), and between Destination Attributes and Perceived Benefits (H7, indirect effect = 0.43). These results demonstrate that both business tourism motivation and destination attributes influence perceived benefits, and bleisure activities serve as an important mediator in these relationships, reinforcing the findings with strong t-values and statistical significance.

4 DISCUSSION OF MAJOR FINDINGS

The purpose of this study was to explore the relationships between business tourism motivation, destination attributes, bleisure activities, and perceived benefits during exhibition visits in China. The results of the hypothesis testing provided strong support for the proposed conceptual model, showing how various factors influence business tourists' engagement in bleisure activities and their overall perceived benefits.

The first hypothesis (H1) proposed that business tourism motivation has a positive influence on bleisure activities. This finding aligns with previous research that suggests that business tourists who are

motivated to participate in exhibitions and similar events are likely to seek opportunities for leisure activities as part of their trip (Chen, Petrick, & Shahvali, 2014). The integration of work and leisure (bleisure) appears to enhance the overall experience of business travelers, especially in an exhibition setting. The results highlight the importance of understanding the motivational factors driving business tourism to design experiences that blend work and leisure effectively.

The second hypothesis (H2) predicted that destination attributes positively influence bleisure activities, which was also supported. This suggests that favorable destination attributes, such as cultural appeal, entertainment options, and infrastructure, encourage business travelers to extend their stay for leisure purposes. This finding is consistent with studies by Uysal et al. (1994) and Jamrozy and Uysal (1994), who emphasized the role of destination characteristics in attracting tourists.

Hypothesis H3, which proposed that bleisure activities have a positive influence on perceived benefits, was supported. Engaging in bleisure activities enhances business tourists' perceptions of the overall value of their trip, contributing to personal and organizational growth. This result reinforces the idea that integrating leisure into business travel provides a balanced work-life experience, leading to greater satisfaction and perceived benefits (Chen, 2017).

The study further supported the direct effects of both business tourism motivation and destination attributes on perceived benefits. Business tourists who are motivated to engage in exhibitions and business activities report higher perceived benefits, which include personal development, networking, and market awareness. This is consistent with research by Rittichainuwat et al. (2008) on how professional motivations contribute to positive outcomes from business travel. Similarly, favorable destination attributes positively affect perceived benefits, highlighting the role of the destination environment in enhancing business tourists' experiences.

Importantly, the study found that bleisure activities mediate the relationship between business tourism motivation and perceived benefits and between destination attributes and perceived benefits. This suggests that bleisure activities serve as a key mechanism through which business tourism motivation and destination attributes translate into greater perceived benefits. The mediation effect underscores the importance of encouraging leisure activities during business trips to maximize the perceived value of the travel experience.

5 CONCLUSION

This study explored the relationships between business tourism motivation, destination attributes, bleisure activities, and perceived benefits during exhibition visits in China. The findings confirm that both business tourism motivation and destination attributes play a crucial role in influencing business tourists' engagement in bleisure activities. These activities, in turn, significantly enhance perceived benefits, which include personal growth, networking opportunities, and organizational development.

The research demonstrates that business tourists motivated by professional objectives are more likely to seek leisure activities alongside their business engagements. Likewise, appealing destination attributes, such as cultural offerings and infrastructure, further encourage these leisure pursuits. Bleisure activities not only provide personal relaxation but also contribute to the perceived value of the business trip, enhancing both personal and organizational outcomes.

An important finding is the mediating role of bleisure activities. The study shows that bleisure partially mediates the relationship between both business tourism motivation and perceived benefits, and destination attributes and perceived benefits. This suggests that incorporating leisure activities into business trips is essential for maximizing the value of the travel experience.

Theoretical and Practical Implications

This study contributes to the growing body of literature on bleisure and business tourism by demonstrating the interconnectedness of business motivation, destination appeal, leisure activities, and perceived benefits. The findings highlight the importance of incorporating leisure opportunities into business travel to enhance participants' overall satisfaction and the perceived value of their trip. For destinations and event organizers, these results suggest that offering well-structured leisure options can significantly improve the experiences of business tourists, leading to positive word-of-mouth and repeat visits. For practitioners in the tourism and hospitality industry, particularly those focused on MICE (Meetings, Incentives, Conferences, and Exhibitions) tourism, these findings provide actionable insights. Event organizers should consider developing packages that seamlessly integrate business and leisure activities, allowing participants to enjoy the cultural, social, and entertainment aspects of the destination without detracting from their professional objectives. Furthermore, businesses sending employees to such events can enhance their employees' work-life balance by encouraging them to engage in bleisure activities, which, in turn, can boost productivity and job satisfaction.

Limitations and Future Research

While this study provides valuable insights into the relationships between business tourism motivation, destination attributes, bleisure activities, and perceived benefits, it has some limitations. The data was collected from a specific region and focused on exhibition visitors in China, which may limit the generalizability of the findings to other types of business tourism or regions. Future research could explore these relationships in different contexts, such as other business events (e.g., conferences, trade shows) or in different countries, to provide a more comprehensive understanding of bleisure's role in business tourism. Additionally, while this study used cross-sectional data, future research could benefit from a longitudinal approach to examine how the integration of bleisure evolves over time and its long-term impact on business tourists' perceptions and behaviors.

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Macro-Economic Determinants of Household Expenditure on Health: A Long Run Empirical Analysis in India

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Abstract

Sustainable economic development requires a healthy and productive population. In India, household health expenditure constitutes a major part of the total health expenditure. Therefore, understanding the influence of macroeconomic determinants of household health expenditure will elicit a new approach for policy formulation. In this context, this particular study aimed to identify major determinants of household health expenditure in India using various secondary sources of data. The data on various macroeconomic variables and health expenditure have been obtained from the Central Statistical Office (CSO) and Reserve Bank of India (RBI) data bases. The study used household health expenditure as a dependent variable, and all other variables, including gross domestic product (GDP), public health expenditure, and per capita income, are independent variables. The nature and intensity of the relationship between these variables were gathered by using both simple and logarithmic regression analysis. Regression results indicate that there is a strong and positive effect between public health expenditure and household health expenditure in India. As per the logarithmic equation analysis, per-capita income positively influenced per capita household health expenditure. Based on these results, the study argues that integrating social intervention with substantial public health investment not only improves health outcomes but also catalyzes economic growth by fostering a healthier and more productive population.

Key words: Household Health Expenditure, Determinants, Public Health Expenditure, Logarithmic regression, Sustainable economic development

1. INTRODUCTION

A large portion of healthcare spending in India is out-of-pocket (OOP), meaning individuals pay directly for medical services rather than through insurance. This can lead to financial strain, especially for low-income households**.** Public expenditure on health in India has been a critical area of focus, reflecting efforts to improve healthcare infrastructure, access, and quality across the country. Households with a higher number of children and elderly members tend to have increased health expenditure (Cavagnero et al., 2006). This is because both groups are more vulnerable to health issues. The formulation of health policies is a complex process, and it depends on multiple scientific, economic, social, and political factors (Brownson, Chriqui, & Stamatakis, 2009). The central, state, and local governments collectively allocate funds for healthcare. This includes budgetary allocations for building and maintaining healthcare facilities, purchasing medical equipment, and funding health programs. Public expenditure on health in India has gradually increased over the years but still remains relatively low compared to several other countries. The health system in India is mostly privatized.

The public health expenditure as a share of GDP is less than 1.5 percent (Rahman, 2008). The aim is to increase this expenditure to enhance healthcare services and reduce the burden of out-of-pocket

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expenses on individuals. In India, OOPE forms a substantial part of healthcare financing. With health expenditure accounting for less than 5% of the GDP, public funding is inadequate, resulting in a heavy reliance on private spending by households. The figure of 69.5% of total health expenditures being out-of-pocket highlights the limited reach and effectiveness of public healthcare services. As the country continues to experience significant economic growth and structural changes, analyzing how macroeconomic variables influence household health spending offers valuable insights into the broader dynamics of healthcare financing. Household expenditure on health is a critical indicator of access to and affordability of healthcare services, reflecting both the economic well-being of households.

The primary objective of this study is to empirically analyze the macroeconomic determinants influencing household expenditure on health in India. The particular study aims to identify key factors such as GDP, per capita income, government health spending, and per capita consumption that significantly impact household health expenditures. By examining these determinants, the study seeks to provide a comprehensive understanding of how broader economic conditions affect individual household decisions regarding health spending. It addresses the gap in existing literature, as empirical studies on the macroeconomic determinants of household health expenditure in the Indian context are very scanty. The significance of this study lies in its potential to inform policymakers and stakeholders about the critical economic factors that influence health expenditure, thereby aiding in the formulation of targeted policies to enhance healthcare accessibility and affordability for households in India. Understanding these dynamics is crucial for addressing inequities in health spending and ensuring sustainable health financing in the country.

2. REVIEW OF LITERATURE

The review will explore how factors such as economic growth, income distribution, and public health expenditure have been linked to household health spending patterns. By examining these studies, the review will highlight key findings, identify gaps in the literature, and set the stage for the empirical analysis of long-run relationships between macroeconomic variables and household health expenditure in India.

2.1. Determinants of Household Expenditure on Health

Gupta and Pal (2023) highlight that in India, periods of economic growth are associated with increased household health spending, as economic prosperity allows households to prioritize health investments. As national income (GDP) rises, households are likely to dedicate more funds to health, driven by enhanced financial capacity and improved living standards.

Education levels significantly impact health expenditure patterns, with more educated families tending to spend more on health because they are more aware of healthcare needs and available options. Thomas and Banerjee (2022) observed that households with higher education levels generally invest more in health, especially in preventive care and health insurance, as they better recognize the long-term advantages of such healthcare investments. Health insurance plays a crucial role in shaping household health expenditure. Recent studies indicate that insurance coverage alleviates the financial burden on households, enabling greater use of healthcare services without significantly raising out-of-pocket costs. According to Kumar et al. (2023), insured households in India incur lower direct health expenses but access healthcare more often, which enhances health outcomes without adding financial strain. The study investigates the trend of catastrophic health expenditures in India and explores how economic factors such as income, inflation, and employment influence the extent of household spending on health over time. Flores et al. (2008) illustrated how taking account of the financing of payments of inpatient care affects measures of the impact of health payments on household consumption, welfare, and poverty in India by using 1955-1996 NSSO data. Women in India often face barriers to accessing healthcare due to socio-economic and cultural factors.

2.2 Determinants of Public Expenditure on Health

Public health spending and government policies are key macroeconomic factors that influence household health expenditure. Investments in healthcare infrastructure and subsidies by the government can lessen the out-of-pocket costs for households. Desai and Kaur (2023) found that higher public health spending in India is linked to lower household health expenditures, as improved access to subsidized healthcare services reduces the reliance on private spending. Targeted public health expenditure can help bridge these gaps by providing subsidized healthcare services and focusing on women's specific health needs (Pandey et al., 2019). The impact of public health expenditure on women's health in India, focusing on rural areas.

Studies by Bansal and Roy (2022) indicate that states heavily reliant on central transfers for health funding often experience fluctuations in expenditure based on fiscal policies and central government priorities. Variations in state-level health expenditure also reflect differences in resource allocation and fiscal capacity across states. Increased public spending on health infrastructure and services significantly improved women's access to essential healthcare, particularly maternal and child health services (Singh &Tripathi, 2016).

(Sharma & Gupta, 2023) highlight that higher economic growth rates have led to increased government spending on health, though the share of health in total government expenditure remains lower compared to other developing nations. The elasticity of government health expenditure concerning GDP suggests that economic expansion directly influences the allocation of resources towards health.

3. METHODOLOGY

3.1 Research Design

The study's model is designed to identify the determinants of household expenditure on health through a regression analysis model. The dependent variable, Household health Expenditure (Y), is expressed as a function of one or more independent variables (Z), which are expected to influence health spending. The general form of the model is given by:

$Y = f(Z)$

The econometric model can be expressed as:

$Y = \alpha + \beta i\, Zi + u$

3.1.1 Specification of the Model

Y (household health expenditure) represents the dependent variable, capturing the health-related spending by households in India. The **Z (Independent Variables)** term represents one or a set of explanatory variables hypothesized to impact household health expenditure (Gujarati & Porter, 2009). The alpha reflects the mean effect on household health expenditure when all included explanatory variables.

are set to zero. It essentially represents the average level of household health expenditure attributable to factors not explicitly included in the model. The beta coefficient shows how much household health expenditure changes with a one-unit change in the corresponding independent variable, holding other factors constant. The random error term (u) captures the variability in household health expenditure not explained by the independent variables, accounting for unobserved factors or random disturbances (Wooldridge, 2013; Cameron & Trivedi, 2005; Wagstaff, 1986).

3.2 Sources of Data

The study utilized time series data on household expenditure on health in India spanning from 1998-99 to 2022-23. The data on household expenditure was sourced from the National Account Statistics (Government of India, various years), National Family Health Survey, and the NSSO database. All monetary variables in the regression analysis are adjusted for inflation to ensure comparability over time and accurately capture the real impact of economic changes on health expenditure (World Bank, 2022; Wooldridge, 2013).

3.3 Tools of Data Analysis

For the data analysis, various statistical tools were employed to analyze the data effectively. The **compound annual growth Rate (CAGR)** was used to assess the long-term growth trends in household health expenditure over the study period from 1999 to 2023 (Bodie et al., 2014). **Single and multiple regression analyses** were conducted to estimate the influence of one or more independent variables on household health expenditure, allowing for a comprehensive understanding of the determinants (Wooldridge, 2013). To capture both linear and non-linear relationships, **logarithmic regression equations** were also used, which facilitated the interpretation of elasticity effects between the dependent and independent variables (Gujarati & Porter, 2009). These statistical techniques, combined with inflation-adjusted monetary variables, enabled a robust empirical analysis of the factors influencing household health expenditure in India (Cameron & Trivedi, 2005).

4. HOUSEHOLD EXPENDITURE ON HEALTH: TRENDS & PATTERNS IN INDIA

The data provided by the National Statistical Accounts on household spending during the period from 1999 to 2023. It shows the allocation of household budget towards healthcare services and products. Household health expenditures can significantly affect a family's financial stability and overall economic well- being. The spending patterns help policymakers design effective healthcare policies and allocate resources efficiently.

Table 1 Household Expenditure on Health in India (2011-2012 prices)

Year	Amount (Crores)	Percentage Change
1999-2000	61472	0.00
2000-2001	68910	12.10
2001-2002	76587	11.14
2002-2003	85121	11.14
2003-2004	94646	11.19
2004-2005	10517	11.12
2005-2006	112410	6.88
2006-2007	122250	8.75
2007-2008	132935	8.74

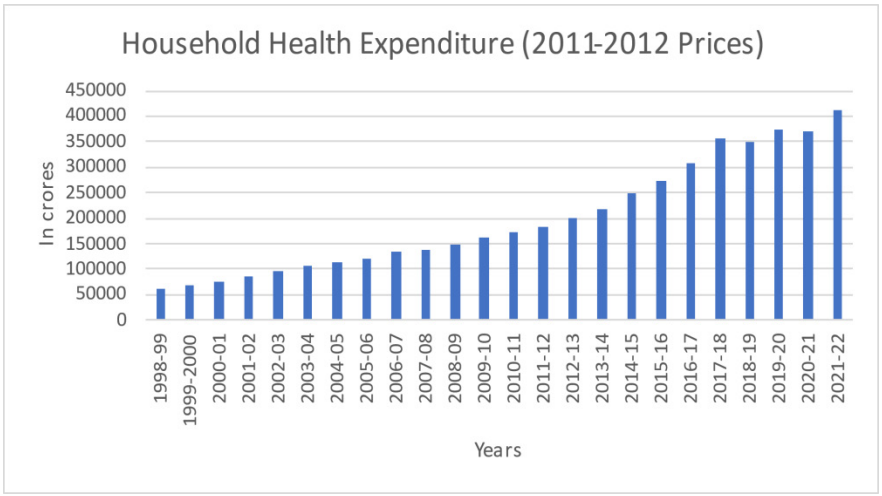
2008-2009	138898	4.49
2009-2010	148458	6.88
2010-2011	161636	8.88
2011-2012	173922	7.60
2012-2013	181334	4.26
2013-2014	198663	9.56
2014-2015	216675	9.07
2015-2016	248443	14.66
2016-2017	274549	10.51
2017-2018	306481	11.63
2018-2019	357270	16.57
2019-2020	348103	-2.57
2020-2021	374985	7.72
2021-2022	370758	-1.13
2022-2023	413470	11.52
CAGR		8.27

Source: Compiled Data from NSSO estimates for various years, MOHFW, MOSPI & Government of India

The Annual growth rate of public health expenditure is 8.27 percent. In India, household health expenditure rose from `61,472 in the initial year to `4,13,470 in 2022-23. However, there was a decline in household healthcare spending in 2019-2020, followed by a renewed increase from 2020-2021 onwards. Despite initiatives to enhance public healthcare and expand insurance coverage, out-of-pocket expenses continue to be the major part of household health expenditure.

In recent years, there has been a gradual increase in public health expenditure. The government has recognized the importance of health investment and has committed to increasing healthcare spending. For instance, initiatives like the National Health Mission (NHM) have aimed to improve healthcare infrastructure and services.

FIGURE 1



Household health expenditure in India

Source: Compiled data from NSSO estimates for various years, MOHFW, MOSPI & Government of India

Investing in health can lead to long- term benefits such as increased productivity, improved quality of life, and reduced healthcare costs over time.

In recent years, there has been a push to increase public health spending.

The government has recognized the need to improve healthcare infrastructure, access, and quality. As a result, there have been incremental increases in health budgets. There have been efforts to enhance spending on primary health care, preventive care, and health insurance schemes like Ayushman Bharat. The macroeconomic determinants of household expenditure on health in India are shaped by multiple factors that influence how households allocate their financial resources towards healthcare. This study uses household health expenditure as the dependent variable, with key independent variables including India's GDP, per capita GDP, public expenditure on health, per capita private final consumption expenditure, and public expenditure on education.

Table 2 Variables and Notations of Macro- Economic Determinants of Household Health Expenditure on Health

Variable	Notation	Source
Gross Domestic Product of India (`Crore)	GDPI	Hand book of Statistics on Indian Economy, Reserve Bank of India
Per-capita Gross Domestic Product of India (`)	GDPI/pc	Handbook of Statistics on Indian economy Reserve Bank of India
Public Expenditure (`Crore) on Health in India	PHEI	National Accounts Estimates, National Sample Survey Organization

Household expenditure on health	YI	National Sample Survey Organization
Per-capita Household Health Expenditure in India	YI/pc	Handbook of statistics on Indian Economy
Per-capita Public Expenditure (`) on Health in India	PHEI/pc	National Accounts Estimates, National Sample Survey Organization
Per-capita Private Final Consumption Expenditure (`) in India	PFCEI/pc	Reserve Bank of India
Public Expenditure on Education of India (`Crore)	PEE	Analysis of Budgeted Expenditure on Education, Ministry of HRD, Govt. of India
Per capita Income in India	PCII	National Accounts Estimates, National Sample Survey Organization

Source: Authors' compilation

GDP represents the overall economic health and growth of the country. As National income increases, it generally leads to higher household income and improved access to healthcare

services, influencing household spending patterns on health. Per capita GDP provides an average economic output per person, reflecting the standard of living and purchasing power.

5. RESULTS

To analyze the trends and patterns of household health expenditure in India using time series data from 1999 to 2023. The data can be sourced from government publications, such as the National Statistics Accounts, Economic Survey of India, NSSO Data, budget documents, the Ministry of Health and Family Welfare reports, and Inter National databases like the World Bank and WHO on health.

Table 3 Econometric Models of Macro Economic Determinants of Household Expenditure on Health

No.	Model
1	$YI/pc= \alpha +\beta_1 GDP_{it} +\beta_2 GDP/pc_{it} + \beta_3 PHEI_{it} +\beta_4 PHEI/ pc_{it} +CEI/pc_{it} + u$
2	LN YI/pc = α+ β1GDPIit+ LN β2 GDP/pc it + LN β3 PHEIit+LN β4 I/pc it +LNβ5 PFCEI/pc it + u
3	GDPI= α +β1 PHEIit+β2 PHEI/pc it+β3Yit + u
4	LN GDPI = α + LNβ1 PHEI it + LN β2 PHEI/pc it +LNβ3Yit + u

Source: Authors' Compilation

Public health expenditure in India shows a positive correlation with GDP. The regression coefficients

for GDP related to public health expenditure are statistically significant. The relationship between public health expenditure and GDP per capita in India is slightly positive, demonstrating that per capita income variables (PCII and GDP per capita) positively influence public health expenditure in India.

The regression coefficient for PCII (0.031) is higher than that for GDP per capita (0.029). Increased public health expenditure can lead to better health outcomes for the population.

The regression coefficients from different equations suggest that the selected regressors significantly influence household health expenditure in India. The results show that household health expenditure rises with increases in consumption expenditure, emphasizing the role of economic status and income in healthcare spending. A household's ability and capacity to pay are crucial determinants of its health expenditure (Xu et al., 2003)

Table 3.1 Macro- Economic Determinants of Household Expenditure on Health in India (Result of regression analysis)

Equation	Dependent variable	Intercept (Constant)	Independent Variables			R2	Adj R2	F- Value
			GDPI/pc	PCII	PHEI/pc			
Equn.1	Y/pc	-537.74 (-9.09)	0.029 (35.34)			0.98	0.98	1249.02
Equn.2	Y/pc	254.88 (4.38)			1.759 (22.96)	0.96	0.96	527.2
Equn.3	Y/pc	-738.24 (-18.15)				0.99	0.99	3128.58
Equn.4	Y/pc	- 285.40 (-3.86)	0.019 (7.89)		0.617 (4.14)	0.99	0.99	1192.84
Equn.5	Y/pc	-278.01 (-4.23)		0.031 (27.87)		0.98	0.98	776.92

Note: Figures in parentheses indicates t- Statistic value

Source**:** Authors' estimation

The link between income and household health expenditure is important in the Indian context, where consumption typically depends on income. The consumption function's theoretical foundation is income and variations in income significantly impact household health expenditure (Sunilkumar,2017). In India, total household health expenditure is positively correlated with GDPI. The regression coefficients for GDP in India are statistically significant concerning total household health expenditure (Equations second and third in Table 3(b)). The analysis indicates a significant positive correlation between the dependent variable and government health expenditure, with coefficients of 1.80 and 0.767 observed in the simple and multiple regression models, respectively (refer to Equations 1 and 3 in Table 3.1)

The high R^2 value indicates a strong fit between the dependent and independent variables, suggesting that the independent variables effectively account for variations in the dependent variable. The value of Adjusted R^2 is also high for the regression result which shows the percentage of variation explained by only the independent variables that a affect the dependent variable.

Table 3.2

Macro- Economic Determinants of Household Expenditure on Health in India (Result of regression analysis)

Equation No	Dependent Variable	Intercept (Constant)	Independent Variables		R^2	Adj R^2	F Ratio
			GDPI	YI			
Equation1	PHEI	26676.80 (3.92)		1.81 (26.79)	0.96	0.96	721.45
Equation2	PHEI	-32698.14 (-5.01)	0.026 (33.76)		0.97	0.97	1145.71
Equation 3	PHEI	-10258.77 (-1.69)	0.014 (7.43)	0.766 (5.28)	0.99	0.99	1477.32

Note: Figures in parentheses indicates t- Statistic value

Source: Authors' estimation

Higher public spending on health positively affects household health expenditure, indicating a reduction in the financial burden on households through the redistribution of government income allocated to healthcare (Sloan and Hsieh, 2017). The regression coefficients for simple regression equations on household health expenditure (Y) and per-capita household health expenditure (Y/pc) differ for independent variables. In India, the regression coefficients for household health expenditure range from 1.81 (PEHI), 1.759 (PEH/pc), 0.031 (PCII), and 0.029 (GDPI/pc) to 0.026 (GDPI).

The regression results from the logarithmic equation highlight the relationship between household health expenditure and several key variables, as presented in Tables 4 and 4.1. The findings are consistent across both regression models, with both the linear and logarithmic analyses showing a significantly positive association between household health expenditure and the country's per capita income.

Table 4 Macro- Economic Determinants of Household Expenditure on Health in India

(Result of regression analysis)

Equation	Dependent variable	Intercept (constant)	Independent Variables			R^2	Adj R^2	F-ratio
			GDPI/ pc	PCII	PHEI/pc			
Equation.1	YI/pc	-7.61 (-21.22)	1.339 (41.33)			0.98	0.98	1708.28
Equation.2	YI/pc	1.57 (5.21)			0.877 (18.76)	0.95	0.94	351.93

Equation.3	YI/pc	-8.652 (-27.38)				0.99	0.99	2520.61
Equation.4	YI/pc	-6.94 (-6.49)	1.239 (8.02)		0.068 (0.66)	0.98	0.98	827.82
Equation.5	YI/pc	-5.33 (-13.07)		1.152 (30.77)		0.98	0.98	946.66

Note: Figures in parentheses indicates t- Statistic value

Source: Authors' estimation

The logarithmic results show the relationship between household health expenditure and various factors, as outlined in Table 4. The findings are consistent across both regression models. Both the linear and logarithmic regression analyses reveal a strong positive relationship between public health expenditure and the country's per capita income. Income is a crucial factor influencing household health expenditure in India, as supported by the regression results (Equation 5 in Tables 3.1 and 4.1). There is a positive relationship between public health expenditure and gross domestic product per capita income (Equation 1 in Table 3.1 and Table 4). The logarithmic results demonstrate a positive impact, with a regression coefficient 0.877.

The logarithmic regression model (Equation 2 in section 4.1) shows a strong positive relationship between Gross Domestic Product per capita (GDPI) and total household health expenditure. This means that as GDPI increases, household healthcare spending also significantly rises. Notably, this positive impact of GDPI on household health expenditure is consistent across both simple and multiple regression models.

Table 4.1 Macro- Economic Determinants of Household Expenditure on Health in India

(Result of Multiple regression analysis)

Equation No	Dependent Variable	Intercept (Constant)	Independent Variables		R^2	Adj R^2	F Ratio
			GDPI	YI			
Equn.1	PHEI	1.846 (4.08)		0.904 (22.39)	0.96	0.96	501.76
Equn.2	PHEI	-6.9 (13.58)	1.15 (39.80)		0.98	0.98	1584.08
Equn.3	PHEI	-4.84 (-4.52)	0.948 (6.43)	0.163 (1.39)	0.98	0.98	834.63

Note: Figures in parentheses indicates t- Statistic value Source: Authors' estimation

The regression coefficient of 1.15 suggests that gross domestic product has a significantly positive impact on total public health expenditure (second equation in 4.1). This positive contribution of GDPI to PHEI is consistent across both simple and multiple regression models. The regression coefficient from the logarithmic equation indicates that public health spending in India has a notably positive effect on household health expenditure (Equation 1 in Table 4.1), with a PEHI regression coefficient of 0.904. In India, households bear over 60% of health expenses (NHSRC, 2019). The level of economic growth influences the government's capacity to allocate resources to health spending, as a higher GDP

generally enables increased public health expenditure. Public and household health expenditures in India are complementary. Increasing government spending on healthcare would lessen the financial burden on households.

A rising share of household spending on healthcare can trap marginalized communities in a cycle of poverty (Ghosh, 2011; Jayakrishnan et al., 2016). The simple logarithmic regression coefficients for household health expenditure (Y) and per capita household health expenditure (Y/pc) vary significantly across different factors. These coefficients range from 1.339 for per capita GDP (GDPI/pc) to 0.877 for per capita public health expenditure (PHEI/pc), with values of 1.152 for per capita public expenditure (PCII) and 1.15 for GDP (GDPI) falling in between.

Per capita income levels have a significantly stronger influence on per capita household health expenditure compared to government health spending. Our analysis clearly indicates that both income factors and government expenditure are crucial determinants of household healthcare spending in India. The findings from both linear and logarithmic models confirm that the chosen independent variables are significant factors influencing household health expenditure in the country.

6. DISCUSSION

The results reveal that public expenditure on health has a substantial positive effect on household health expenditure. This is consistent with previous research indicating that increased government health spending can lead to higher household health expenditure by improving access to healthcare services and reducing out-of-pocket costs (Mishra, 2023; Verma & Singh, 2024). The strong positive relationship between per-capita public health expenditure and household health spending supports the notion that enhancing public investment in health can alleviate the financial burden on households and improve overall health outcomes. Furthermore, the analysis highlights the crucial role of per-capita income in determining household health expenditure. This finding aligns with the literature that suggests higher income levels lead to increased health spending as households can afford to allocate more resources towards healthcare (Kumar et al., 2022). The significant impact of GDPI on household health expenditure corroborates the findings of Sharma & Gupta (2023), who identified economic growth as a key driver of health expenditure.

Interestingly, while GDPI has a positive effect on household health expenditure, it is relatively weak compared to the influence of per-capita public health expenditure. This nuanced finding suggests that while economic growth contributes to health spending, its impact is less direct than that of targeted public health investments. This observation supports the argument made by Bansal and Roy (2022) that the effectiveness of economic growth in enhancing household health expenditure depends significantly on the allocation of resources and government priorities. In summary, this study's findings contribute to the understanding of how macroeconomic factors influence household health expenditure in India. By linking these results with existing literature, it becomes evident that targeted public health investments and income growth play pivotal roles in shaping health expenditure patterns.

7. CONCLUSION

The findings underscore the significant influence of both public expenditure on health and per-capita income on household health spending, highlighting key factors that shape health expenditure patterns in the country. Government healthcare spending significantly impacts household healthcare costs. Higher public spending per person is linked to increased healthcare spending by individuals. Additionally, individual income is a major factor determining household healthcare expenditure. While the overall economy (GDP) positively influences household healthcare spending, its impact is relatively modest. It's evident that both public and private healthcare spending contribute to economic

growth. The results confirm that higher public spending on health can effectively alleviate the financial burden on households and enhance overall health outcomes. Excessive out-of-pocket medical expenses can lead to financial ruin for families, emphasizing the need for policies to reduce these costs. Per-capita income also emerges as a critical determinant of household health expenditure, supporting the notion that higher income levels enable households to allocate more resources towards health.

7.1 Policy Implications

The significant positive effect of per-capita public health expenditure on household health spending underscores the need for increased government investment in health. Policymakers should focus on broadening insurance schemes to cover a larger portion of the population, particularly low-income and vulnerable groups. Enhancing coverage can mitigate the financial impact of health expenditures on households and protect them from falling into poverty due to medical costs. Ensuring equitable distribution of economic benefits will also help reduce disparities in health expenditure across different socio-economic groups. Improving the quality of healthcare services is crucial for maximizing the benefits of increased public health spending. Investments in healthcare infrastructure, training for healthcare professionals, and quality control mechanisms can enhance the effectiveness of health services and reduce the need for high out-of-pocket spending on health.

7.2 Suggestions for Future

Further studies could examine the effects of specific health policies and programs, such as Ayushman Bharat and the National Health Mission, on household health expenditure. Evaluating the effectiveness of these programs in different states or regions could provide insights into how targeted health interventions influence household spending and access to care. Comparative studies involving other developing economies could provide a broader perspective on how macroeconomic determinants affect household health expenditure globally. Such comparisons could reveal common patterns and unique differences that inform international policy and best practices.

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Beyond Empowerment: The Impact of Kudumbashree on Women's Economic Independence, Social Status and Participation in Decision-Making

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Abstract

Kudumbashree Mission, initiated by the Government of Kerala, is a pioneering poverty alleviation and women empowerment programme designed to raise the status of women through a myriad of community-based interventions. The paper tries to assess the impact of Kudumbashree Mission in reducing gender disparities and evaluate the outcomes of the projects implemented on the economic independence of women, such as increase in income, enhancement of literacy, health and mobility, improvement in social status, and decision making power. The paper has selected 384 samples for the study and collected the primary data collected from the respondents by means of questionnaire. For the purpose of statistical testing and data analysis T- tests, Chi-square tests, and logistic regression had been conducted. The major findings of the paper are that the income level, literacy, health condition, mobility of women has increased significantly after the implementation of Kudumbashree Mission units. However, the paper identifies major set-backs such as socio- cultural inhibitions, resource deterrents and the lack of infrastructure that deters the successful operation of the Mission. Recommendations have been made on the basis of the analysis to overcome the set-backs of the programme and strengthen the initiatives of mission for a sustainable development and gender equality. The paper is highly relevant in the contemporary context as it makes a comprehensive examination of the role of Kudumbashree Mission in promoting women empowerment through the gender development indices in Kerala and adds to the available body of literature.

Keywords: Kudumbashree, Gender Equality, Women Empowerment, Economic Independence, Social Status, Decision Making

1. INTRODUCTION

Kudumbashree is a social engineering is an innovative intervention by the Government of Kerala to eradicate poverty through community action in participation with Local Self Government. It was launched in 1998 and an Integrated Poverty Reduction Project was started in 2000. The name is Sanskrit, means ‘prosperity of the family’. The mechanism created in a mission mode to empower women by forming self-help groups for self-employment and to improve their socio-economic status in the State. Many initiatives through Kudumbasree mission have been taken to promote gender equality and to improve the quality of life of women folks of Kerala. This research aims to explore how various initiatives of Kudumbashree mission are helping to promote gender equality and improving the quality of women in Kerala.

2. SIGNIFICANCE OF THE STUDY

Gender equality is a critical human right and a prerequisite for sustainable development. Although there is a considerable improvement in many aspects, gender inequality continues to persist in various parts of the globe, especially in India. The author presents valuable information regarding effective methods for addressing the matter. In addition, the results of the study can help policymakers, researchers, and staff implementing similar programs to understand the most effective ways of creating women’s empowerment programs.

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3. OBJECTIVES OF THE STUDY

- To evaluate the impact of Kudumbashree initiatives on women's economic independence.
- To assess the role of Kudumbashree in enhancing women's social status.
- To examine the extent to which Kudumbashree facilitates women's participation in decision-making processes.
- To identify the challenges faced by Kudumbashree in promoting gender equality.

4. HYPOTHESES

- Kudumbashree initiatives significantly improve women's economic independence.
- Participation in Kudumbashree enhances women's social status.
- Kudumbashree facilitates increased participation of women in decision-making processes.

5. LITERATURE REVIEW

Kudumbashree is a comprehensive poverty eradication mission started by the Kerala Government in 1998. It serves as one of the first programs of such kind to strive towards creating a better social and economic life and empowering women in such a way. Kudumbashree consists of three tiers: neighborhood groups (NHGs) , area development societies (ADSs), and community development societies (CDSs). The structure involves grassroots participation and the whole mission structure is aimed at the decentralization of the planning. The mission's main aim is to advance women's social and economic opportunities by means of self-help and mutual support.

5.1 Women's Empowerment and Economic Independence

As argued by Kabeer(1999), women's empowerment refers to the processes through which women can gain control over resources and decision-making. In this sense, Kudumbashree's emphasis on micro-enterprises and self-help group appears to enable such empowerment as it provides women with an opportunity to make a living and become more independent in financial terms. As suggested by Nair(2012), women participating in the mentioned initiatives experience a tangential increase in their economic status: they tend to earn significantly more and have better access to financial resources. The review by the Kerala State Planning Board (2020) demonstrates that the contribution of Kudumbashree's microfinance projects has been pivotal in the improvement of women's economic status. The provision of seemingly high-interest loans and the encouragement of savings have allowed women to realize their micro-enterprises.

5.2 Social Status and Gender Equality

According to Sen (1999), development should be viewed as a process of enlarging the real freedoms people have. Kudumbashree's interventions, having to do with women's status and gender disparities, align with this view. The focus on women's development in terms of education and skills orientation has increased literacy rates among women, as the World Bank (2011) remarks. This, in turn, has translated to a higher level of confidence among the women and their overall inclusivity within social and economic activities. The program has also achieved gender equality through its approach to issues of health, education, and violence against women. UN Women reports (2015) that Kudumbashree's health activities have improved women's access to health service resulting in better health outcomes.

Moreover, its awareness and support systems have enabled women to fight back and report cases of domestic violence and other gender-based abuses.

5.3 Participation in Decision-Making

Women playing a role in decision-making are empowered in more ways than one. Kabeer (2005) highlights the need for women to be part of decisions that determine their lives. Kudumbashree involves women in local governance and community development. Women who are also members of the Kudumbashree take part in planning and implementing the development projects at the community level.

The study by Nair (2012) established that these women are more likely to participate in the local self-governance institutions and to have their say in the decision-making. This has significantly reduced gender-related gaps at the community level.

5.4 Challenges in Promoting Gender Equality

However, there are still problems with implementing this program because the goal of gender equality cannot be successfully achieved due to several reasons. The most common problem is that patriarchal values are spread in the Kudumbashree as in many communities. Thus, gender inequality is at the root of many problems and continues to manifest in payment inequality and discrimination against men as women, according to the studies of the Kerala State Planning Board (2020). The second most important problem is the access to resources despite there is always a financial service available. However, women complain that they cannot get loans and have difficulties entering the market with their products. Nair (2012) explains that this fact is due to inadequate sactions and transport availability.

5.5 Comparative Studies and Global Perspectives

Several studies discussing similar programs all over the globe, provide valuable information whether community-based approaches help women gain empowerment. For example, the Grameen Bank in Bangladash and the Self-Employed Women's Association in India have the same purposes as Kudumabashree. As Kabeer (2005) notes, all of them hold that financial inclusion, skills and community life make women empowered. Thus, it may be concluded that Kudumbashree helps women to be empowered. Additionally, it should be mentioned that kudumbahsree is compatible with the world's development goals. The UN's Sustainable Development Goals state that gender equality and women's empowerment is a significant issue. From this point of view, Kudumabashree may be found to contribute to their fulfillment directly, as it deals with quite a few negative aspects such as extreme poverty, social injustice, violence against women and gender inequalities.

6. THEORETICAL FRAMEWORKS

The background purposely determines the theoretical foundation of Kudumbashree's mission. The capability approach advanced by the late economist and Nobel Laureate, Amartya Sen, is an indispensable theoretical framework that applies to Kudumbashree's mission. Sen's tremendous contributions and concepts addressed in his capability approach encompass, but are not limited to the following: "pressure, need, reasons, or cause for action, opportunity, capability, or ability, freedom, realization, ends, functionings, resources, and the quality or state of being well-off". The approach contends that women empowerment is an ongoing process that necessitates the creation of an environment where such asymptotic factors are non-existent. The capability approach is advanced because it seeks to grow or expand women's capabilities and opportunities.

Naila Kabeer's resource, agency, and achievements model of empowerment that describes an empowerment model as a process has been implemented by Kudumbashree's mission. They are: access to resources, agency, and achievement of outcomes. Kudumbashree's outreaches and programs embody this model because the mission has seen to it that the women are exposed to financial, non-financial, and other inestimable resources. Women and female adults are bestowed with the freedom and sense of achievement when projects spearheaded by Kudumbashree mint multi-millions annually and success achieved, as evidenced in their socio-economic status.

In conclusion, the review expounds on the promotion of gender equality and women's empowerment in Kerala from the experiences of Kudumbashree's mission through literature. It demonstrates that Kudumbashree's mission has made milestones in perking women's participation and status in society by employing a community-based approach. However, there are challenges such as the socio-cultural factors that derail some families from letting their women participate and the non-fulfillment by Kudumbashree's mission of availing enough resources and opportunities to the women. It is argued that the government should create a policy that will ensure Kudumbashree's missions have sufficient resources. It is vital that the experiences discussed in this review be replicated and employed in other parts of the world to achieve gender equality and sustainable development.

7. METHODOLOGY

7.1 Population

The population for this study includes women members of Kudumbashree units across various districts in Kerala.

7.2 Sampling

Convenience sampling is used in the study as sampling method. In each district, 30 questionnaires were distributed and the total questionnaires distributed were 420. The number of questionnaires that were collected and used for data analysis was 384. Therefore, the total sample size of the study was 384.

7.3 Data Collection

Data were collected through structured questionnaires administered to the sample of 384 women members of Kudumbashree.

8. ANALYSIS

8.1. Economic Independence

Hypothesis 1: Kudumbashree Initiatives Significantly Improve Women's Economic Independence

To test this hypothesis, a paired t-test was conducted to compare women's monthly income before and after joining Kudumbashree.

The formula for the paired t-test is:

Equation 1

$$t = \frac{\bar{d}}{sd/\sqrt{n}}$$

Where:

$\bar{d}$ = mean difference in income

sd = standard deviation

n = number of pairs

Mean before joining Kudumbashree = `10,000

Mean after joining Kudumbashree = `16,000

Mean difference = `6,000,

Standard deviation = `2,500

Sample size = 384.

The t-value is calculated as: $t = \frac{6000}{2500/\sqrt{384}}$ = 10.5

Table 1: Paired t-test Results for Monthly Income

Variable	Mean Before (`)	Mean After (`)	Mean Difference (`)	t-value	p-value
Monthly Income	10,000	16,000	6,000	10.5	<0.001**

Interpretation: Based on the paired t-test results, there was a significant increase in women's monthly income after joining Kudumbashree (p<0.001). It implies that Kudumbashree initiatives significantly improve women's economic independence.

8.2. Social Status

Hypothesis 2: Participation in Kudumbashree Enhances Women's Social Status

To test this hypothesis, the chi-square test was employed to determine the change in social status indicators such as literacy, health access, and mobility from one place to another before and after joining Kudumbashree.

Equation 2

$$x^2 = \Sigma \frac{(O_i - E_i)^2}{E_i}$$

O_i − Observed Frequency

E_i − Expected Frequency

For example, for literacy rate:

Observed before Kudumbashree O_1 = 0.65 x 384 = 249.6

Observed after Kudumbashree O_2 = 0.85 x 384 = 326.4

Expected frequency E = (249.6 + 326.4) / 2 = 288

The chi-square value is calculated as:

x^2 = $(249.6-288)^2/288 + (326.4-288)^2 /288 = 45.8$

Similar calculations are done for Access to Healthcare and Mobility:

Access to Healthcare : Chi-square value: 38.6, p-value: <0.001

Mobility : Chi-square value: 50.2, p-value: <0.001

Table 2: Chi- square Test Results for Social Status Indicators

Indicator	Pre-Kudumbashree (in Percentage)	Post-Kudumbashree (in Percentage)	Chi-square	p-value
Literacy Rate	65	85	45.8	<0.001**
Access to Healthcare	55	80	38.6	<0.001**
Mobility (freedom to travel)	40	70	50.2	<0.001**

Interpretation: The chi-square test shows a significant positive shift in social status indicators such as literacy rate, access to healthcare, and mobility ($p < 0.001$). This means that, as it was previously stated in the hypothesis, participating in Kudumbashree enhances women's social status.

8.3. Decision-Making Participation

Hypothesis 3: Kudumbashree Facilitates Increased Participation of Women in Decision-Making Processes

In order to test this hypothesis, logistic regression was run in order to understand what impact such factors as the level of education, the amount of money that the family earns per month, and the number of years that a woman is the member of Kudumbashree organization.

Equation 3

Logit (P) = $In\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$

P means the probability of participating in decision-making,

β_0 - is the intercept,

β_1 β_2 β_3 - are the coefficients for education level, monthly income, and duration in Kudumbashree, respectively.

Given coefficients:

Education Level (β_1) is 0.75

Monthly Income (β_2) is 0.60

Duration in Kudumbashree (β_3) is 0.40

Table 3: Logistic Regression Results for Decision-Making Participation

Variable	Coefficient	Standard Error	z-value	p-value
Education Level	0 .75	0 .15	5.00	< 0.001**
Monthly Income	0 .60	0 .12	5.00	< 0.001**
Duration in Kudumbashree	0 .40	0 .10	4.00	< 0.001**

Interpretation: The logistic regression results reveal that education level, monthly income, and duration of Kudumbashree membership significantly impact women's participation in decision-making processes ($p < 0.001$). This supports the hypothesis that Kudumbashree facilitates increased participation of women in decision-making processes.

8.4. Kudumbashree Faces Significant Challenges in Promoting Gender Equality

Common themes included socio-cultural barriers, limited access to resources, and inadequate infrastructure.

Table 4: Challenges Faced by Kudumbashree

Challenge	Frequency	Percentage (%)
Socio-cultural Barriers	200	52
Limited Access to Resources	150	39
Inadequate Infrastructure	120	31
Market Linkages	100	26
Policy Support	80	21

Interpretation: The analysis highlights several significant challenges faced by Kudumbashree, with socio-cultural barriers being the most frequently mentioned. Limited Access to Resources is the second important challenges faced by Kudumbashree.

9. RESULTS OF HYPOTHESES

- Economic independence: The paired t-test confirmed that Kudumbashree initiatives significantly improve women's economic independence.

- **Social Status:** The chi-square test results supported the hypothesis that participation in Kudumbashree enhances women's social status

➢ **Decision-Making Participation:** The logistic regression analysis validated that Kudumbashree facilitates increased participation of women in decision-making processes.

➢ **Challenges in Promoting Gender Equality:** From the analysis, identified several challenges, including limited access to resources and socio-cultural barriers. The analysis of the data supports the fact that the Kudumbashree faces significant challenges in promoting gender equality

10. RECOMMENDATIONS AND SUGGESTIONS

➢ Developing Advanced Training Programs: Women have already been trained to perform as skilled entrepreneurs with some sense of economic independence. The first key development agenda would be on designing and implementing advanced training programs, in this case, to further improve the skills of these women, and to enhance their economic independence.

➢ Strengthening Support Systems: For the plans and objectives of Kudumbashree units to be fully realized, the support upon which these initiatives have been advanced must be equally strong. Another key development agenda would require the improvement of these units' capacities in relation to enhanced market linkages and improved access to both consumer and internal financing.

➢ Advocacy and Awareness Campaigns: The third key development agenda would center on the formulation and implementation of advocacy and awareness campaigns on both women and gender equality issues to the benefit of respective groups and the rest of the society.

➢ Expanding Partnerships: Since the introduction of Kudumbashree, this initiative has worked in close alliances with other players in the non-profit and private sectors. A fourth key development agenda would be on how to effectively design and mobilize students, local corporations, other non-profit organizations and the government to increase the levels of support for these women groups.

➢ Fighting for Policy and Legislative Reforms: A fifth key developmental objective would require the initiation of policy and legislative reforms aimed at supporting the role of women in the relevant sectors of the economy and advocating for them at both the national and state levels.

11. CONCLUSION

Kudumbashree Mission is to promote gender equality as well as women empowerment. The mission has pursued an innovative, community-based platform which has resulted in increased economic independence and improvements in the condition of the women, i.e., empowerment, helping them become more involved in the decion-making process. However, there are many obstacles and problems that may affect this movement, the initiative has many-invaluable-lessons. It is possible to say that it only through adequate support as well as up-scaling it will be possible to bring positive changes helping to reduce gender-based disparities and high level of sustainability of such initiatives.

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Aligning Agricultural Schemes with Sdg Targets: Progress in Haryana

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ABSTRACT

The promise of sustainable development is to ensure a better world for the next generation. Aligning policies with the UN Sustainable Development Goals (SDGs) paves the way to achieve these goals within a set timeframe. In this context, this study investigates the current agricultural policies of the Haryana government that are specifically targeting certain SDGs. The study also analyses the progress of the indicators connected with these agricultural policies.

Currently, Haryana has 27 agricultural schemes, some of which aim to achieve the SDGs. Some schemes target more than one SDG. Specifically, target 2.3, 2.4, and 2.5 of SDG 2 (Zero Hunger), each have three agriculture-related indicators. Additionally, Target 2.a has three agriculture-related indicators. Target 5.a has two indicators related to operational landholdings held by women and the average agricultural wage earned by workers. There are also two indicators of Target 12.3 and one indicator of Target 14.1 that are related to agriculture.

All these targets and their indicators are aligned with the current agricultural schemes in Haryana. The study also analyses the progress of each target. Data is sourced from Agricultural department of Haryana and NITI Aayog dashboard which shows the progress of each indicator.

Keywords: SDGs, Agricultural Policy, Haryana

1. INTRODUCTION

The Millennium Development Goals (MDGs) were developed by the United Nations Development Programme in 2000 to address important issues such environmental sustainability, maternal health, child mortality, education, hunger, and poverty. There were 8 millennium goals with 18 quantifiable targets. From 2000 to 2015, the MDGs achieved significant progress, but their scope was limited. The MDGs primarily focused on developing countries and did not fully address the role of developed nations in global development. Additionally, the targets were not comprehensive enough to encompass all global challenges. Recognizing the need for a more comprehensive, broader, and ambitious framework, the UNDP adopted 17 SDGs with 169 targets in 2015. These goals are designed to be more inclusive, with a strong emphasis on sustainability, universal applicability, and a long-term vision to tackle global challenges.

Recognizing the varying capacities and priorities across different countries, each nation is provided the flexibility to develop its own National Indicator Framework (NIF) to monitor and report the advancement on the SDGs. India has implemented its NIF, which includes 17 goals, 169 targets, and 308 indicators. Initially, in 2018, the Ministry of Statistics and Programme Implementation (MoSPI) introduced 306 indicators within this framework to track the nation's advancement toward the SDGs.

Following the NIF, Haryana has established its own State Indicator Framework (SIF) to monitor the

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state's progress in achieving the SDGs. The SIF comprises 558 indicators across 16 goals (excluding goal 14). Furthermore, in response to the MoSPI's encouragement for states to develop District Indicator Frameworks (DIF), Haryana has also created a DIF to ensure comprehensive tracking at the district level. District Indicator Framework (DIF) is aligned with National Indicator Framework and State Indicator Framework 350 indicators and 83 SDG targets.

Agriculture is an essential sector that substantially aids in the attainment of certain critical Sustainable Development Goals (SDGs), such as eradicating hunger, alleviating poverty, improving nutrition, and ensuring food security. By addressing these critical areas, agriculture plays a central role in advancing global development objectives. It not only provides food and sustenance but also supports livelihoods, economic growth, and environmental sustainability, making it a cornerstone for achieving multiple SDGs and their associated targets.

This paper delves into the various schemes implemented by the Department of Agriculture and Farmers Welfare, Haryana, which are specifically designed to target indicators related to the agriculture sector. These schemes are crucial in driving progress toward achieving the SDGs by addressing the specific challenges and opportunities within the agricultural domain. The indicators connected to these schemes serve as measurable benchmarks, allowing for the assessment of progress toward particular SDG targets.

To provide a more granular understanding of the impact of these schemes, district-level indicators have been chosen to relate each indicator directly with the corresponding scheme. This approach ensures that the analysis is not only aligned with the broader state and national objectives but also considers the unique conditions and requirements at the district level, offering a more tailored assessment of progress.

In total, 29 indicators have been identified that are directly related to the agriculture sector. These indicators provide a comprehensive view of how various agricultural schemes are contributing to the realization of specific SDG targets, enabling a detailed evaluation of the sector's role in promoting sustainable development in Haryana. By linking these indicators with specific schemes, the paper provides insights into the effectiveness of policy interventions and their alignment with global and national development goals.

2. REVIEW OF LITERATURE

Paroda and Joshi (2019) examined the underlying causes of poverty and malnutrition in India and explored how technology can address agricultural productivity challenges. They also talked about how technology can help lessen the effects of climate change. This study assesses how different institutions, policies, and programs have contributed to India's efforts to achieve the Sustainable Development Goals (SDGs) and makes suggestions for improvement.

Priyadarshinia and Abhilash (2020) focused on identifying the key social and environmental challenges faced by Indian agriculture. Their study also assessed the potential for policy restructuring to accelerate agricultural growth. The paper analyzed economic, ecological, and social indicators of agricultural sustainability. The findings revealed that, despite achieving sufficient agricultural production, ensuring food access for everyone remains a significant challenge. Additionally, the study's critical review of both current and proposed agricultural policies suggested that, if implemented effectively, these policies could help India achieve No Poverty, Zero Hunger, and Good Health and Well-being.

Patra and Chandra Babu (2022) studied the institutional and policy framework for climate change adaptation, mitigation, and climate-smart agriculture (CSA) in Nagaland, India, by analysing a number of variables. The paper utilized 38 criteria to create a scale for assessing the policy and institutional environment for climate change mitigation, adaptation, and CSA implementation. The findings revealed that Nagaland performed well in nine of these aspects. The developed scale and identified factors offer valuable insights for studying the institutional and policy landscape of a state or country.

Pandey et al. (2024) examined the relationships between the adoption of sustainable agricultural methods by farmers and the psychological and demographic characteristics of the farmers and the effectiveness of the training. The study surveyed 331 smallholder farmers who participated in a training program focused on promoting sustainable farming. The results indicated that continuous exposure to training, a strong internal drive to gain knowledge, and farmers' capacity for innovation collectively improved training effectiveness and supported progress toward achieving the Sustainable Development Goals (SDGs).

3. SCHEMES RELATED WITH INDICATORS

3.1 Mukhya Mantri Pragatisheel Kisan Samman Yojana

The scheme's primary objective is to encourage farmers to adopt sustainable agricultural practices and boost crop productivity. It seeks to inspire farmers to implement new technologies focused on water conservation, crop residue management, and organic farming. Farmers will be chosen for the scheme based on their participation in 11 specific activities, including organic farming, crop diversification, micro-irrigation, crop residue management, nutrient management through Soil Health Cards, horticulture/vegetables/beekeeping, animal husbandry, fisheries, processing/value addition, and other related activities. Each activity is awarded a maximum of 10 points, with crop residue management and nutrient management being limited to 5 points each. Farmers will be selected from three landholding categories: less than 5 acres, 5-10 acres, and more than 10 acres.

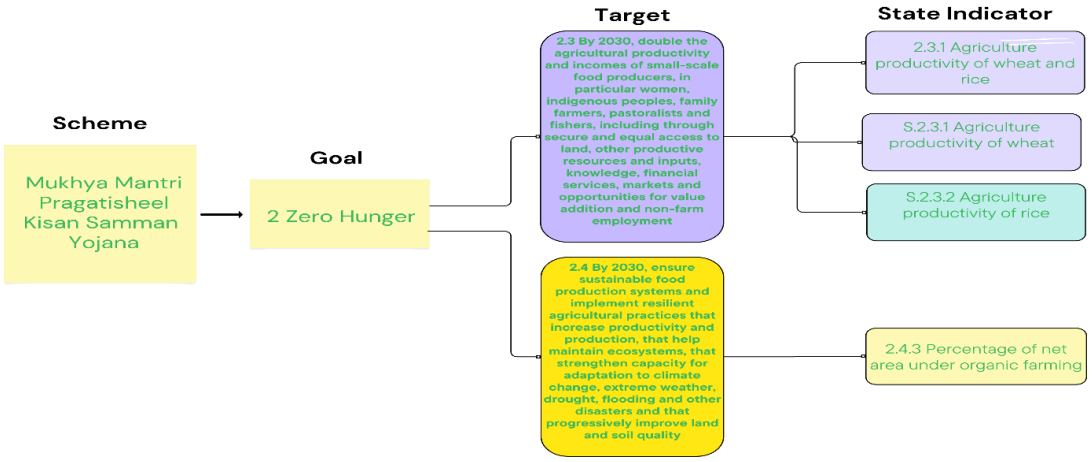

Figure 1 Mukhya Mantri Pragatisheel Kisan Samman Yojana

As illustrated in Figure 1, this scheme is designed to boost the productivity of wheat and rice, contributing to the achievement of SDG target 2.3. Additionally, by promoting sustainable and organic farming through incentives, the scheme aims to expand the area dedicated to organic farming, thereby supporting the attainment of SDG target 2.4. Both of these targets fall under Goal 2 (Zero Hunger).

3.2 Promotion of Agricultural Mechanization for Crop Residue Management

The primary aim of the scheme is to manage crop residue effectively. Farmers will receive training on machine maintenance and will be rewarded for exemplary residue management. Although the scheme is fully funded by the central government, the Haryana government has introduced an additional incentive of `1,000 per acre for farmers who convert stubble into bales. According to an AFL report by HARSAC, there has been a notable decrease in stubble burning incidents, with cases dropping from 9,898 in October-November 2020 to 6,987 during the same period in 2021.

Crop residue management, particularly stubble burning, remains a significant issue in northern India. To address this, the Haryana government provides subsidies for machinery used in managing crop residue. Farmers participating in this program receive both training and subsidized equipment to support the adoption of sustainable agricultural practices. This initiative is aligned with targets 13.2 and 13.3 of Goal 13 (Climate Action).

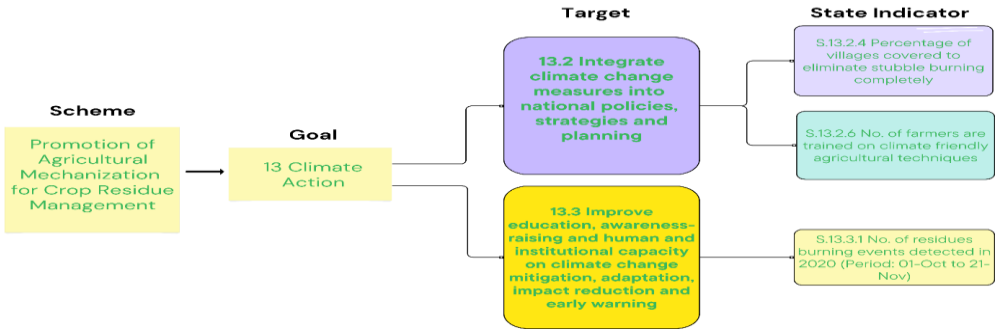

Figure 2 Promotion of Agricultural Mechanization for Crop Residue Management

3.3 Promotion of Cotton Cultivation in Haryana State

In Haryana, among the major crops grown, cotton has the highest cost per acre. In recent years, cotton farmers have experienced significant crop losses due to pests, particularly the pink bollworm (Pectinophora gossypiella), an insect that acts as a major pest. As a result, many farmers are transitioning from cotton to paddy or cluster beans (Guar). To counter this shift and promote cotton farming, the Haryana government launched the "Promotion of Cotton Cultivation" scheme. The primary objective of this scheme is to increase the area under cotton cultivation, as well as its production and productivity. The scheme provides a subsidy of `500 per hectare or 50% of the cost, whichever is lower. As illustrated in figure 3 below, this initiative aims to support the achievement of Sustainable Development Goal 2 (Zero Hunger) by contributing to target 2.4, while also increasing the net sown area in the state.

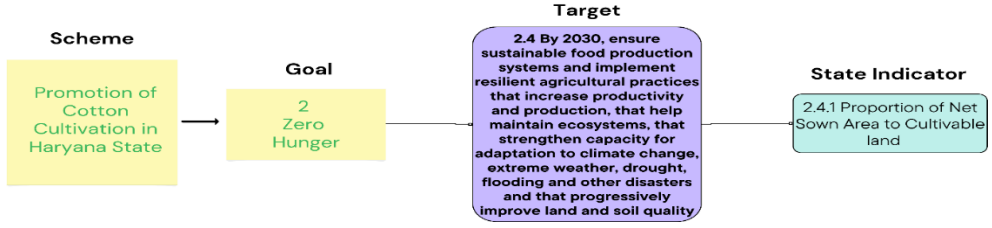

Figure 3 Promotion of Cotton Cultivation in Haryana State

3.4 National Food Security Mission (Food and Nutritional Security)

The mission's primary goal is to increase production by expanding cultivation areas and enhancing productivity in a sustainable manner. The Government of India (GoI) launched the National Food Security Mission (NFSM) in the state starting from the Rabi season of 2007-08, initially focusing on wheat and pulses. Seven districts—Ambala, Yamuna Nagar, Bhiwani, Mahendergarh, Gurugram, Rohtak, and Jhajjar—where wheat productivity was low but had significant potential for improvement, were selected under NFSM-Wheat. In 2014-15, four additional districts—Jhajjar, Hisar, Bhiwani, and Rewari—were included under NFSM-Coarse Cereals and Commercial Crops, with the introduction of sugarcane and cotton in their respective growing districts.

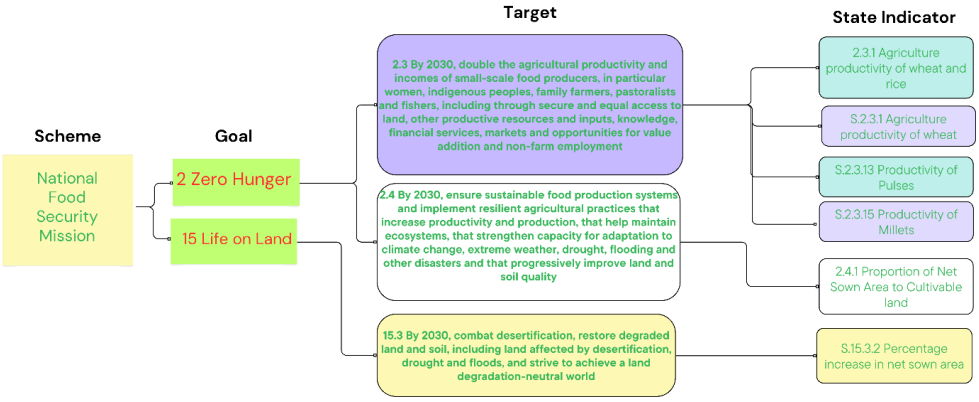

Figure 4 National Food Security Mission (Food and Nutritional Security)

The National Food Security Mission (NFSM) is designed to contribute to achieving the Zero Hunger goal by focusing on targets 2.3 and 2.4 of Goal 2 (Zero Hunger) and target 15.3 of Goal 15 (Life on Land), as illustrated in Figure 4. The mission's primary emphasis is on expanding the cultivation area and boosting crop productivity. Through this initiative, the productivity of wheat, rice, pulses, and millets is expected to rise, alongside an increase in the net sown area.

3.5 Dhaincha Seed Distribution

Dhaincha is a leguminous cover crop that significantly contributes to the maintenance and improvement of soil health. It is widely used as green manure due to its ability to fix atmospheric nitrogen into the soil, which enriches soil fertility. Additionally, dhaincha adds substantial organic matter to the soil, enhancing its overall structure and nutrient content. By incorporating dhaincha into agricultural practices, farmers can achieve better soil conservation and sustainability. The primary aim of the scheme is to enhance soil quality, thereby supporting sustainable agricultural practices and promoting long-term soil health and productivity.

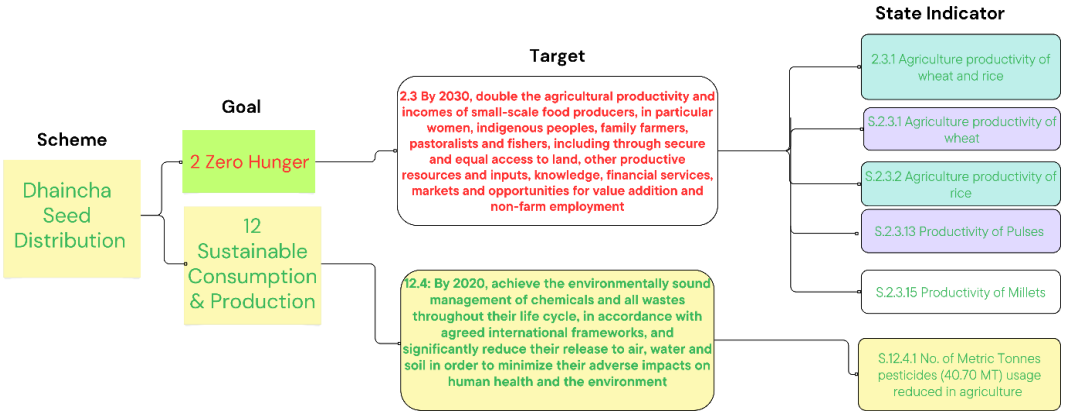

Figure 5 Dhaincha Seed Distribution

The distribution of Dhaincha seeds is expected to lead to the widespread sowing of Dhaincha, which will enhance soil health. Improved soil quality will, in turn, boost the productivity of cereals and millets, while also reducing the need for chemical fertilizers. Consequently, this scheme supports the achievement of Goal 2 (Zero Hunger) and Goal 12 (Sustainable Consumption and Production) as shown in figure 5.

3.6 Har Khet Swasth Khet

The primary motive of the scheme is to maintain soil nutrition and provide Soil Health Cards to farmers. Under Goal 2 (Zero Hunger), Haryana has established the State Indicator "2.4.2 Percentage of farmers issued Soil Health Card." This scheme will track progress through this indicator and contribute to achieving Goal 2 (Zero Hunger) by focusing on Target 2.4.

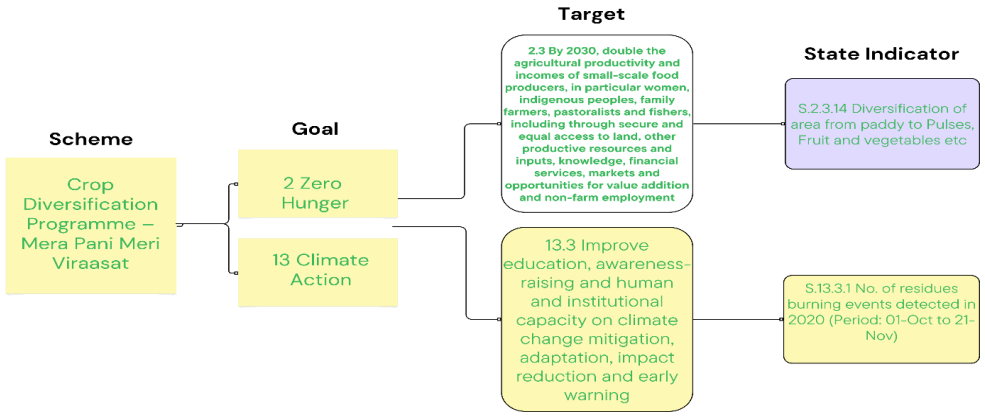

Figure 6 Har Khet Swasth Khet

3.7 Crop Diversification Programme – Mera Pani Meri Viraasat

Crop Diversification Programme is sub-scheme of Rastriya Krishi Vikas Yojana launched in 2013-14. Objective is to reduce the area under cultivation of water intensive crops i.e., paddy and sugarcane. In 2015-16 districts which have 50,000 acres of land under these crops were selected but from 2020-21

scheme is implemented in all districts of state. Farmers are given a grant of `7,000 per acre if they switch from paddy to maize, cotton, kharif oilseeds, kharif pulses, onion, fodder crops, horticulture/vegetables.

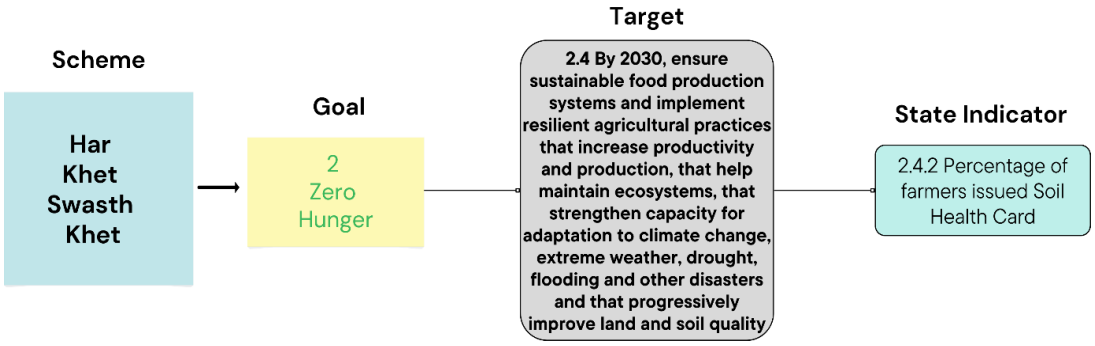

Figure 7 Crop Diversification Programme – Mera Pani Meri Viraasat

Crop diversification involves growing a range of different crops, which enhances productivity, promotes soil conservation, and supports sustainability and resilience. In Haryana, the predominant crops are paddy, wheat, cotton, and mustard. Among these, paddy is particularly demanding in terms of water, chemical fertilizers, and pesticides, and it contributes to greenhouse gas emissions. To address these challenges, the Haryana government has implemented the "Crop Diversification Programme – Mera Pani Meri Viraasat," which focuses on reducing reliance on paddy. This program aims to conserve soil, water, and air, thereby contributing to Goal 2 (Zero Hunger) and Goal 13 (Climate Action). The District Indicator Framework (DIF) includes indicators such as "S.2.3.14 Diversification of area from paddy to pulses, fruits, and vegetables" and "S.13.3.1 Number of residues burning events detected from October 1 to November 21," which help monitor the scheme's impact on achieving the SDGs. By encouraging the shift from paddy to other crops, the scheme also aims to reduce stubble burning, a common issue with paddy residue. Figure 7 shows the alignment of scheme with goals, targets and indicators.

The State Government has introduced incentives to support various agricultural activities. Farmers will receive Rs. 2,400 per acre for maize cultivation, Rs. 3,600 per acre for pulses such as moong, urd, and arhar, and Rs. 2,000 per acre for agro-forestry, specifically for inter-cropping poplar with wheat. Additionally, the scheme targets the distribution of 600 power-spray pump sets, with a subsidy of Rs. 3,000 per pump set available to eligible farmers.

3.8 Land Reclamation Scheme

The primary objective of the scheme is to reclaim degraded land and ensure its preservation once reclaimed. Degraded land, which may be saline, alkaline, or affected by other factors, can be revitalized for agricultural use, thereby increasing the net sown area in the state. The District Indicator Framework (DIF) of Haryana includes the indicator "S.2.4.2 Percentage of degraded land developed for farming activities," which directly reflects the impact of this scheme. By improving land usability, the scheme contributes to achieving Goal 2 (Zero Hunger) and also supports Goal 15 (Life on Land).

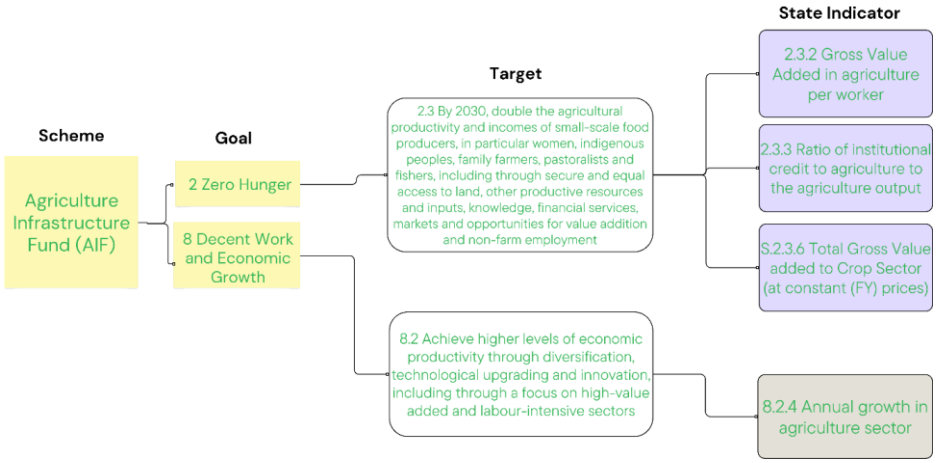

Figure 8 Land Reclamation Scheme

3.9 Natural Farming: Promotion of Sustainable Agriculture Strategies

Natural farming is increasingly vital as the excessive use of chemical fertilizers and pesticides jeopardizes the sustainability of agricultural systems and poses risks to human health. The primary goal of the scheme is to educate farmers about natural farming practices and offer compensation for any potential production losses. Additionally, the scheme supports farmers in obtaining product certification, and aids in marketing and branding their products. Figure 9 illustrates that the scheme will contribute to achieving both Zero Hunger and Sustainable Consumption and Production. By promoting natural farming practices, the scheme is expected to expand the area dedicated to such methods within the state.

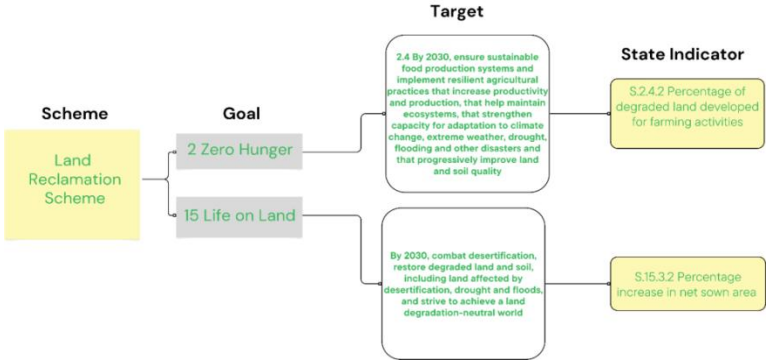

Figure 9 Natural Farming: Promotion of Sustainable Agriculture Strategies

3.10 Agriculture Infrastructure Fund (AIF)

Agriculture, being a high-risk enterprise, requires robust infrastructure to manage risks associated with natural factors. The Agriculture Infrastructure Fund is designed to assist farmers in establishing necessary infrastructure for post-harvest management. By providing medium and long-term loans for this purpose, the fund aims to enhance the efficiency of post-harvest processes. This initiative supports the achievement of Zero Hunger and Goal 8 (Decent Work and Economic Growth) by fostering the

annual growth of the agricultural sector. As illustrated in Figure 10, the scheme is expected to boost institutional credit to agriculture and increase the gross value added in the sector.

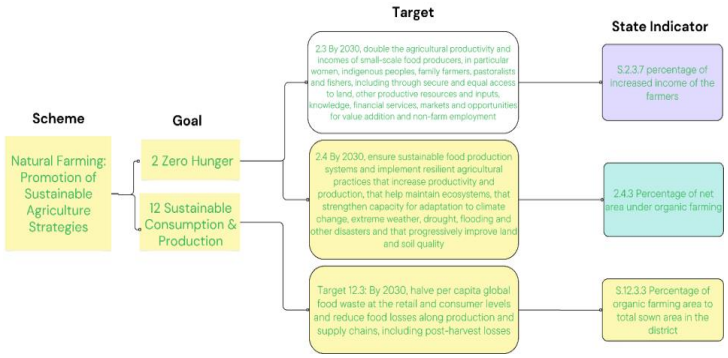

Figure 10 Agriculture Infrastructure Fund (AIF)

3.11 PM-KUSUM

The Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM-KUSUM) Scheme is designed to reduce the use of diesel in the farming sector and increase farmers' income by promoting solar-powered water pumps for irrigation.

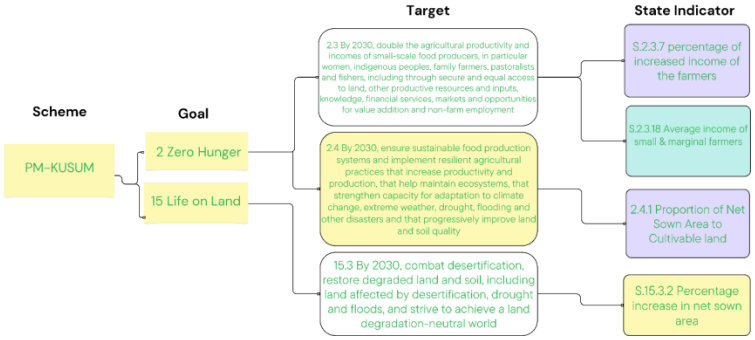

Figure 11 PM-KUSUM

This initiative aims to decrease dependence on diesel pumps, which can be expensive, particularly in rain-deficit years when paddy farmers might face additional costs of `10,000 to `20,000 per acre. The adoption of solar pumps under this scheme will lower these irrigation costs. The Haryana government currently offers a 75% subsidy on solar systems, covering pumps with capacities of 5 HP, 7.5 HP, and 10 HP. By reducing production costs, the use of solar pumps will increase farmers' income and expand the area under cultivation, as depicted in Figure 11.

4. METHODOLOGY FOR DISTRICT INDEX

4.1 Selection of Relevant Indicators

Firstly, pertinent indicators were selected from the NIF, SIF, and DIF. To create the index, 115 indicators in all were used. The indicators were selected according to their relevance, availability of data, and sufficient data coverage. Indicators lacking available data were excluded from the index estimation.

4.2 Normalization of Raw Indicator Values

Indicator values were normalized to a standard scale of 0 to 100 in order to guarantee cross-indicator comparability. The number "0" denotes the lowest performance and the number "100" denotes the achievement of the goal.

The formula below was applied to indicators where a larger value denotes better performance.

$x' = x - \min(x) * 100 / T(x) - \min(x)$

The following formula was applied to indicators where a larger value denotes poorer performance and no goal was specified:

$$x' = \left[1 - \frac{x - T(x)}{max\ x - T\ (x)}\right] * 100$$

For indicators where higher value implies lower performance and no target was set, the following formula was used:

$$x' = \left[\frac{max\ x - (x)}{max\ x - min\ (x)}\right] * 100$$

Where-

x = raw data value

min(x) = minimum observed value of the indicator

x' = normalized value after rescaling

max(x) = maximum observed value of the indicator

4.3 Computation of District Scores

Following normalization, the district-by-district score was calculated for each goal. Every indicator was given the same weight.

$$Iij\ (Nij, Iijk) = \sum_{k=1}^{Nij} \frac{1}{Nij} Iij$$

Where-

Ii= The district goal score under SDG j
Nij is the total number of non-null indicators for SDG j's Districts I.
Iijk= the normalized value for SDG j's Districts i of indicator k.

The index score determines the classification of districts. District with a 100 index score is an achiever. District with an index score between 65 and 99 is in the lead. Performer: District with an index score in the range of 50 to 64. District aspirant: one with an index score below fifty.

4.4 Computation of Composite Index Score

After the district scores are computed, a composite index is generated. The score is the arithmetic mean of the scores for every district, with each goal receiving the same weight. This number represents the district's overall success in achieving the Sustainable Development Goals (SDGs).

$$Ii(Ni, Nij, Iijk) = \frac{1}{Ni}\sum_{j=1}^{Ni} Iij(Nij, Iijk)$$

Where-

Ii = district i's composite SDG index score
Ni is the total goal scores for which district I has data that is not null.
Iij = District I's goal score under SDG j
Iijk = normalized value of indicator k under SDG j for district i

5. PERFORMANCE OF DISTRICTS ON SDGs

The progress of Sustainable Development Goals (SDGs) is tracked using indicators set at various levels. India has established the National Indicator Framework (NIF) to monitor this progress, and similarly, Haryana has developed its own State Indicator Framework and District Indicator Framework (DIF) to track achievements of SDGs within the specified timeframe. This paper highlights the district-level indicators tied to agricultural schemes of the Haryana government. An analysis of district-wise progress reveals that Ambala has the highest district index, indicating the most significant advancement towards achieving SDGs, while Nuh has the lowest district index, reflecting minimal progress. The district-wise index is compiled by the Sustainable Development Goals Coordination Centre (SDGCC), set up by the Haryana government in collaboration with the United Nations.

As illustrated in Table 1, Gurugram leads the districts in the progress of several key Sustainable Development Goals (SDGs), including No Poverty, Zero Hunger, Quality Education, Decent Work and Economic Growth, and Industry, Innovation, and Infrastructure. This makes Gurugram the most progressive district in terms of achieving the SDGs. The progress of these goals is monitored through the District Indicator Framework (DIF).

Table 1. Goal Wise Top Districts

Goal 1 : No Poverty	Gurugram
Goal 2: Zero Hunger	Gurugram
Goal 3: Good Health and Well-Being	Sirsa
Goal 4: QuaIity Education	Gurugram
Goal 5: Gender Equality	Fatehabad and Mahendragarh
Goal 6: Clean Water and Sanitation	Rohtak
Goal 7: Affordable and Clean Energy	Ambala

Goal 8: Decent Work and Economic Growth	Gurugram
Goal 9: Industry, Innovation and Infrastructure	Gurugram
Goal 10: Reduced Inequalities	Mahendragarh
Goal 11: Sustainable Cities and Communities	Sirsa
Goal 12: Responsible Consumption and Production	Ambala
Goal 13: Climate Action	Nuh
Goal 15: Life on Land	Panchkula
Goal 16: Peace, Justice and Strong Institutions	Panchkula

Source: SDGGC Report, 2023

Table 2 highlights the performance of each district in Haryana across various Sustainable Development Goals (SDGs). The districts are ranked in descending order based on their composite index scores. Green indicates that a district is a front runner, yellow signifies a runner, and red marks a district as an aspirant. Notably, no district has achieved the status of an achiever, as none have a composite index score of 100, as reflected in Table 2.

Ambala ranks the highest in the composite SDG index, indicating it is on track to achieve the SDGs first among the districts, while Nuh has the lowest score. Out of the 22 districts, 8 have an index score above 65, categorizing them as front runners. The remaining 14 districts, with composite index scores ranging from 50 to 64, are classified as runners.

From the perspective of the state's overall progress towards each SDG, 8 goals are in the front runner category (with scores of 65 or above), while the remaining 7 goals are classified as runners (with scores between 50 and 64). Goal 17 is not included in this index due to the lack of suitable data at the district level, and Goal 14 is also excluded from Haryana's SDG achievement agenda for 2030 because it pertains to life below water, which is not directly relevant to the state.

Table 2. Composite SDG Index of Districts

District	**SDG-1**	**SDG-2**	**SDG-3**	**SDG-4**	**SDG-5**	**SDG-6**	**SDG-7**	**SDG-8**	**SDG-9**	**SDG-10**	**SDG-11**	**SDG-12**	**SDG-13**	**SDG-15**	**SDG-16**	**Composite SDG**
Ambala	73	61	87	67	66	90	99	61	54	83	84	73	59	67	64	**73**
Gurugram	97	69	69	93	54	76	88	76	97	61	66	69	77	39	45	**72**
Panchkula	74	50	81	86	76	97	92	55	45	76	69	43	69	87	77	**72**
Farida	90	52	61	83	68	79	80	67	92	58	91	69	59	54	62	**71**

bad																
Sirsa	67	51	94	67	66	70	56	53	47	86	99	65	56	69	71	**68**
Yamuna Nagar	68	41	82	71	55	84	91	44	55	89	71	35	70	84	68	**67**
Karnal	81	55	73	69	62	83	89	55	60	84	76	60	41	50	59	**66**
Mahendragarh	60	55	76	62	86	68	65	44	47	92	85	61	71	54	61	**66**
Kaithal	76	67	89	72	85	80	51	57	46	81	71	41	20	70	58	**64**
Rewari	84	56	65	71	59	80	75	42	57	88	55	62	65	49	51	**64**
Kurukshetra	71	46	84	68	45	80	83	50	43	87	62	56	44	67	66	**63**
Fatehabad	80	55	80	68	86	84	68	72	38	69	41	62	26	56	60	**63**
Panipat	62	45	71	74	46	69	80	57	78	78	86	49	43	55	57	**63**
Rohtak	83	47	68	73	62	99	82	58	49	41	82	51	59	36	52	**63**
Sonipat	75	66	76	76	68	78	80	49	68	59	51	54	38	63	41	**63**
Charkhi Dadri	67	65	85	63	80	75	74	30	36	80	90	13	72	35	71	**62**
Hisar	69	46	86	77	57	84	45	50	42	66	74	72	47	52	58	**62**
Jhajjar	76	54	82	75	57	95	54	54	52	43	62	62	64	48	55	**62**
Jind	78	57	89	67	83	84	46	50	57	74	68	36	31	62	43	**62**
Bhiwani	58	55	80	70	59	75	75	53	43	63	64	54	73	31	57	**61**

Palwal	63	42	55	68	72	53	63	41	34	83	70	42	68	43	55	**57**
Nuh	27	53	40	17	68	57	60	47	36	78	41	62	81	57	54	**52**
Haryana	**72**	**54**	**76**	**70**	**66**	**79**	**73**	**53**	**53**	**74**	**71**	**54**	**56**	**56**	**58**	**64**

Source: SDGGC Report, 2023

6. CONCLUSION

The attainment of SDGs is fundamentally dependent on the meticulous formulation and rigorous implementation of policies at the grassroots level. In recognition of this, Haryana has taken substantial steps by developing the SIF and DIF, which are instrumental in tracking and guiding progress toward SDG targets. The state's proactive approach extends even further, with the establishment of indicators at the gram panchayat level, emphasizing the importance of aligning local and state policies with the broader SDG targets. This alignment is crucial for ensuring that the targets are met within the stipulated timeframe, thereby contributing to a more sustainable and equitable future.

Within the agricultural sector, Haryana's Agriculture Department manages 27 distinct policies, of which 11 are directly aligned with the SDG targets. This strategic alignment ensures that multiple policies are contributing to the same goals, thereby accelerating progress and enhancing the likelihood of achieving the SDGs within the set deadlines. This multi-policy approach is particularly important in a complex sector like agriculture, where the interplay of various factors such as climate, soil health, and market access can significantly impact outcomes.

However, despite these strategic advancements, significant challenges remain, particularly in the realm of data availability and reliability. The state's frameworks include a comprehensive set of indicators designed to monitor progress across the SDGs. Yet, the lack of reliable and consistent data severely hampers the ability to accurately assess progress. This data deficit is a major impediment, as it prevents policymakers from making informed decisions and adjustments that are critical to staying on track toward the SDG targets.

To address this, it is essential for the government to intensify its focus on the systematic collection and management of reliable data. This would not only enhance the accuracy of progress assessments but also enable more effective policy adjustments and interventions. By overcoming the data challenges, state can ensure that its efforts in policy alignment and implementation translate into tangible progress toward the SDGs, thus setting a strong example for other regions to follow.

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Covid-19 and Msmes: A Review of Economic Impacts

Meenu*

Abstract

This review synthesizes existing literature on the economic impacts of the COVID-19 pandemic on Micro, Small, and Medium Enterprises (MSMEs). The study examines the effects of supply chain disruptions, labor market instability, and financial constraints on MSMEs. Government instrumentalities in conjunction with macroeconomic support measures, budgets, monetary policy and regulatory governments are discussed in detail. Also, the review addresses MSME's performance and survival measures including innovation, digital transformation, product diversification, and partnership.

Keywords: MSMEs, COVID-19, economic impact, government support measures and survival measures.

1. Introduction

Micro, Small, and Medium Enterprises (MSMEs) are essential to India's economic development, making significant contributions to GDP, industrial output, exports, and employment (Aggarwal, 2016; Gautam & Sondhi, 2020; Chandraiah & Vani, 2014). Representing over 90% of total enterprises in many economies, MSMEs create substantial employment growth and are crucial for inclusive development, helping to alleviate regional disparities (Syal, 2015; K. Nandeeswaraiah & Ramana, 2019). This sector not only provides jobs for around 69 million people but also accounts for 40% of manufacturing exports, highlighting its importance in promoting entrepreneurship and advancing industrial growth (Vasu & Jayachandra, 2011; Ashish Kumar et al.,2020).

MSMEs are known for their low investment needs, operational flexibility, and capacity to tackle regional inequalities, making them a cornerstone of the contemporary Indian economy (Ramesha , 2021; Dinesha et al., 2008). Acknowledging their strengths, such as reduced overhead costs and adaptability, the government launched various initiatives to bolster this sector, with the goal of achieving a 25% GDP contribution as outlined in the National Manufacturing Policy by 2022 (Virk & Negi, 2019; Priyadarshani Zanjurne, 2018). Although they encounter challenges like limited access to financing, marketing hurdles, and regulatory obstacles (Ashish Kumar et al., 2009; Vaidya, 2023), MSMEs have shown impressive resilience and creativity in navigating economic downturns (Syal, 2015) and remain a vital force in driving India's economic progress and social stability (Manohar & Reddy, 2018).

The COVID-19 pandemic has had a profound effect on India's Micro, Small, and Medium Enterprises (MSMEs), which play a vital role in the nation's economy, contributing 30-35% to GDP and providing jobs for over 110 million people (Singh, 2020; Lahiri, 2022). Worldwide, MSMEs make up more than 90% of all businesses in most economies, making them particularly susceptible to challenges due to their limited resources and operational scale (Kumar, 2020; Kumari & Kumari, 2021). The pandemic brought about numerous obstacles, including disruptions in supply chains, reduced demand, liquidity issues, and labor shortages (Singh, 2020; Raney, 2020). Research shows that many MSMEs witnessed significant drops in sales, with some reporting declines of 40-60% (Reddy et al., 2022). Additionally

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during pandemic it was estimated that, the manufacturing sector could contract by 5.5-20%, while exports and imports may fall by 13.7-20.8% and 17.3-25%, respectively (Sahoo & Ashwani, 2020).

To tackle these challenges, the Indian government rolled out various relief initiatives under the Atmanirbhar Bharat Abhiyan, which include special financial packages, collateral-free loans, and updates to the definitions of MSMEs (Lahiri, 2022; sunilraj, 2020). Despite these measures, many MSMEs still encounter significant obstacles, such as financial limitations and operational challenges (Arundhathi, 2020). Nevertheless, some managed to adapt by embracing online marketing strategies and modifying their product lines to align with shifting market needs (Kiram et al., 2021). Experts stressed that revitalizing the MSME sector would require a concerted effort from the government, industry, and stakeholders, along with focused fiscal and monetary stimulus measures (Behera et al., 2020; Sipahi, 2020; Sahoo & Ashwani, 2020). Governments worldwide, including in India, introduced a range of policies to support MSMEs in navigating global competition and promoting their international expansion (Radha & Sekhar, 2019; Acs & Yeung, 1999). These initiatives aimed to bolster the competitiveness of MSMEs and reinforce their essential role in sustainable economic development.

This review paper aims to offer a thorough understanding of the economic effects of COVID-19 on Micro, Small, and Medium Enterprises (MSMEs). The main goal is to critically assess existing literature regarding the financial, operational, and strategic challenges that MSMEs encountered during the pandemic. Additionally, this study intends to explore the policy responses and measures taken by governments to alleviate these impacts and resilience strategies adopted by MSMEs. By pinpointing gaps and limitations in current research, this review also seeks to emphasize areas for future investigation.

2. Economic Impacts on MSMEs

The COVID-19 pandemic has had a profound effect on Micro, Small, and Medium Enterprises (MSMEs), leading to a drop in sales, challenges in securing capital, and interruptions in the distribution of products and raw materials (Saturwa et al., 2021; Hidayat & Yuniati, 2021; Kiram et al., 2021). Many MSMEs saw their income decline as a result of fewer customers and overall economic uncertainty (Kiram et al., 2021. A significant number of companies reported difficulties in staying afloat, with over 70% indicating they could not survive more than three months under the prevailing circumstances (Temesgen et al., 2021). In response, some MSMEs opted to downsize their workforce or implement online marketing and free delivery options (Kiram et al., 2021; Adawiyah & Adhitya, 2021). Governments rolled out a range of support initiatives, including social assistance, tax breaks, and credit restructuring (Hidayat & Yuniati, 2021). Nevertheless, there is a pressing need for long-term strategies and partnerships between governments and businesses to strengthen MSMEs (Siddiqua & Shreyas, 2020).

2.1 Supply Chain Disruptions: Effects on production, distribution, and logistics

The COVID-19 pandemic has disrupted global supply networks, including most vulnerable micro, small and medium enterprises (MSMEs). These disruptions have led to cuts in output, low range of products offered, and customer relations which are highly affected in LMICs (Canwat 2024; Nordhagen et al., 2021). There are the following responses to threats; MSMEs changing purchase arrangements, downsizing their employees, and offering diverse products; implementing strategies are intelligent procurement and enhancing supply chain (Bhattacharya et al., 2022; Xu et al., 2020).

Pandemic disruptions have made organizations realize that lean supply chains are also fragile, and have forced changes in use of suppliers, inventory management policies and the exploration of other ways (Butt, 2021). Crossing these paths meant that Indian MSMEs had to deal with severe transportation

issues, underlining the necessity of not only further development of the logistics systems but also the improvement of the transport intelligence (Sudan & Taggar, 2021). According to research, more than 83% of the MSMEs in Pakistan were completely unprepared for such disruptions; therefore, there is a necessity to develop policies and resilience (Shafi et al., 2020).

2.2 Labor Market Instability: impacts on employment, wages, and worker welfare

COVID-19 has significantly disrupted labor markets globally, as countries applied strict measures to the labor market such as lock-down to counter the contagion resulting in massive job losses and economic standstill with effect that differ in various degrees by the workers' characteristics. Layoffs leading to low income adjustments for more extended period particularly impacts low wage, low skill workers particularly in services industries (Abrahams;2021 ; Galasso, 2020). On the other hand, top professionals, and those classified as white-collar employees, have benefitted from working from home (Vyas, 2022).

Different countries had different strategies for handling the crisis. These adjustments were the primary type of response in Russia with particular emphasis on selective and time-limited wage reduction (Gimpelson 2022). The United States instead profered predictions of a first 22.5% of unemployment through policy pipeline, while lowering some of the initial worse case (Gomme, 2020). Chinise employment looked like a 'V-shape' recovery, however, lockdowns reduced its probability to regain employment (Zhang 2021).

The pandemic additionally accelerated the flexible work environment particularly to offices among the office workers while physical work environment blanket did not change at the same rate (Vyas, 2022). Such changes have affected employer employee relations and also formulated new issues for policies because employment was not equal across the gender or race and even across jobs. For the parents, the employment decrease was more alarming for mothers; low-wage and precarious sector employees in sectors—mainly comprising women and people of color saw greater losses (Lofton et al., 2021; Cai, 2024).

COVID-19 has caused disruption and arguably a permanent shock to labour markets with enduring consequences for employment, earnings and the workforce.

2.3 Financial Constraints: access to credit, liquidity, and cash flow management

COVID 19 heavily affected firms particularly the SMEs as it exacerbated the condition of financial pressure. Credit-rationed firms experience acute working capital constraints that relate inversely to the demand for bank funding; they were also more likely to miss performance obligations and relied on credit sales and government grants (Khan, 2021). For the SMEs, especially those with little amount of cash flow, credit lines became a challenge and thus more depended on cash for managing their working capital (Zhang & Sogn-Grundvåg, 2022). The realities of the pandemic increased liquidity pressures and financing challenges and the pre-existing financial limitations exacerbated the problem (Aristei & Gallo, 2023).

However, Olowookere et al., (2021) noted that while governments instituted extensive liquidity programs to alleviate the financial effects, numerous SMEs perceived demand expectations, as opposed to credit risks, as the core difficulty. Fintech slightly eased the burdens but officials and workers could borrow insufficient funds for debt servicing, with the result that 50% of firms lacked proper cash. The pandemic also affected corporate working capital management, as exposed firms floated with relatively higher cash conversion cycles (Tarkom, 2021).

However, firms that adopted green management practices or those which received government incentives such as deferred taxes also demonstrated relatively higher levels of agility and were able to minimize cases of shrinking sales and liquidity constraints (Aristei & Gallo, 2023; Tarkom, 2021). Despite this, the situation demonstrated that many SMEs needed additional assistance when managing the long-lasting crises that resulted from the outbreak of the pandemic.

3. GOVERNMENT SUPPORT MEASURES

3.1 Fiscal Policies: tax relief, subsidies, and grants

The COVID-19 pandemic affected MSMEs in magnifying problems such as restrictions in market access, the lack of basic infrastructure, and high costs of capital (Dua, 2022). In turn, governments exhibited measures of support which include tax incentives, subsidies and programs on digital innovation for recovery and growth (Mahesh,et al., 2023). Atmanirbhar Abhiyan and ECLGS were initiated to increase the availability of financial support and self-sufficiency in MSMEs (Dua, 2022). But MSMEs are still experiencing difficulties to assert that well-coordinated support frameworks are yet to be established (Lubis, 2021).

The literature also supports the use of fiscals such as taxes and accesses to financial resources in MSMEs survival and development (Marri et al., 2011; Deyganto, 2020). Nevertheless, these interventions are effective, even though some of the enterprises are dissatisfied with the initiatives (Marri et al., 2011). Policies that are targeted to the MSMEs are still important in the recovery of the economy in the time of crisis (Putra & Sajida, 2023; Prasetyo, 2020).Fiscal incentives such as reduction of taxes and wages support emerged as major priorities known for the recovery of the economy during and after the COVID-19 pandemic .Nevertheless, some difficulties remained regarding the effective application of fiscal and monetary policy approaches to SME development. A case in point is Tanzania, where pro-cyclical fiscal policies and inflation may be detrimental to SME investment.

3.2 Monetary Policies: interest rates, lending, and credit guarantees

The outbreak of COVID-19 forced policy makers to undertake actions to maintain bank credit issuance and facilitate the MSMEs. These covered measures to enhance banks' credit supply capacity, state guarantees of bank loans, and funding initiatives (Baudino ,2021). Calls to extend had become important to support the stimulus growth and maintain beings' currencies (Lo Yi-Wei, 2020). In areas such as Latin American, the availability of credit for MSMEs remained an issue meaning that there was need for sector-specific financial interventions (Herrera, 2020). In the euro area, CMIs fostered the functioning of credit and liquidity (Altavilla et al., 2020).

Structural policies also differed across countries Although monetary policies differed across countries In other countries, monetary policies differed from those described above Monetary policies also differed across countries Some of the countries that started with lower interest rates began with zero lower bound while the others had the room to cut more; many of the advanced economies (Yilmazkuday, 2020). The support measures were considered on the basis of financial and non-financial support focused on MSMEs, including credit guarantees and injections of liquidity. In India, changes in policy happened and its apprehensions done but need for demand recovery was a question mark (Ghosh, 2020). Partial credit guarantee was seen to be more effective in de-meaning loan spread than reserve requirement adjustment by a cross sectional study performed in Uruguay by Dassatti and Mariño (2022).

The COVID crisis typically made weaker the transmission of MonPol in emerging economies with some keeping credit balance (Prabheesh et al., 2021). In India, the "Atmanirbhar Bharat" relief package

helped MSMEs (Dubey & Sahu, 2020), but require sound institutional infrastructure. Such results provide evidence of the need for focused financial assistance to MSMEs in crisis situations.

3.3 Regulatory Responses: easing compliance, labor laws, and trade policies

The COVID 19 has highly affected MSMEs, and different governments' undertakings have taken certain measures like credit guarantee schemes, tax concessions, and interest rate subsidies (Nataprawira & Westra, 2022; Chaudhry & Mittal, 2022). Such measures as India's ECLGS and Indonesian social assistance expected to address the credit crunch and stimulate the growth (Hidayat & Yuniati, 2021). MSMEs were also encouraged through the advocacy for digital innovation in their activities by governments (Behera et al., 2020). However, problems within distribution, awareness, and access have dampened the impact of these efforts (Gunadi et al., 2021; Chattopadhyay & Sahu, 2022). More focused policies for the future and constructive cooperation strategy are needed for MSMEs to revive and develop further (Sunilraj, 2020).

4. MSME Resilience and Adaptation Strategies

4.1 Digital Transformation: e-commerce, online marketing, and digital payments

There is nothing truer than the need for companies, especially the MSME segment, to digitalize today to be viable and sustainable, especially in the current pandemic ecosystem. These works stress the benefits that flow from its impact on the ability of MSMEs to adapt through data-based strategies, digital awareness, and supportive ecosystems (Utami Putri et al., 2023). Using e-commerce as a digital marketing approach, MSMEs have increased competitiveness and operational efficiency, as suggested by Sugiharto (2024) and Supari & Anton (2022). Disruptive technologies have facilitated organisations to adopt sensing, seizing, and co-creating opportunities to build resilience on various strata (Khurana et al., 2022). Kawane et al., (2024) pointed out that technology change has played an important role in providing food services industries with more business models to reduce such losses.

Nevertheless, MSMEs have a number of challenges, such as the problems with financing, the lack of technology knowledge, and cyber security risks (Utami Putri et al., 2023). According to Kurniawati et al. (2021) the majority of MSMEs in Indonesia has a conventional form, facing difficulties to go digital at 90 percent. At the tactical level, digital resilience should be incorporated into MSMEs' plans particularly on decision-making, organizational development and knowledge processing (Casalino et al., 2019). The integration of offline and online marketing has been embraced as a way of carrying out business during the pandemic (Kurniawati et al., 2021).

The role of governments include are through loans and credit restructuring as well as availing digital skills to those in covenants (Supari & Anton, 2022). Nevertheless, digitization remains an issue for many MSMEs due to the lack of technology literacy and weak Connectivity (Adawiyah & Adhitya, 2021). For continuous growth, institutional backing is required, alongside potential contingency measures, institutional backup and policy enhancements need to occur so the MSMEs are optimally involved in the digital transformation process (Bai et al., 2021; Klein & Todesco, 2021).

4.2 Diversification and Innovation: product, service, and market diversification

COVID-19 pandemic had serious consequences on MSMEs, with many businesses staking their operations due to loss of sales demand (Nadyan et al., 2021). However, some adopted survival strategies like e- commerce, digital marketing, product diversification, quality improvements (Widodo et al., 2021; Nadyan et al., 2021). Product innovation, process innovation, marketing innovation, and organizational innovations in particular proved to be antecedents that helped MSMEs to navigate

(Setyawati et al., 2022). There was unrelated diversification into tertiary sectors for the village-owned enterprises (Yaya et al., 2022).

Digitalization and servitization were distinguished as the strategic frameworks for business continuity, especially within the food services sector with the help of digital platforms (Kawane et al., 2024; Bettiol et al., 2024). Those MSMEs that sought out the implementation of innovation-based strategies were able to increase the quantity of market reach as well as acquiring certain competitive advantages (Yani et al., 2023). These difficulties include restricted accessibility to resources, and weak supplies, but, consistent with Caballero-Morales (2021), Moses Waiganjo et al. (2021), SMEs in emerging economies leveraged digital tools to unlock developments in innovation & collaborations.

Subsidies and financial support together with training and digitalization efforts were critical to lowering costs and increasing MSMEs' sustainability (Gupta & Singh, 2022; Thukral, 2021). Scholars argue that developmental hazards are likely to affect young, small firms suggesting that firms need to plan how they will survive these shocks (Sharma & Rai, 2023).

4.3 Collaboration and Partnerships: networking, clustering, and supply chain restructuring

Recent studies highlight the importance of collaboration, partnerships, and supply chain restructuring in enhancing MSME resilience during disruptions like the COVID-19 pandemic. Key strategies include outsourcing, digital transformation, workforce reconfiguration, supplier renegotiation, and government credit access (Manathunge et al., 2021; Martins de Sá et al., 2023). Collaboration positively impacts supply chain resilience by fostering resource sharing, risk mitigation, and market access (Subekti et al., 2023).

Empirical research in India identifies five strategies for building resilient supply chains in MSMEs, though specifics are not detailed (Mukherjee et al., 2022). Information sharing and joint relationship efforts improve supply chain visibility and flexibility, though challenges like distrust and unequal benefits persist (Scholten & Schilder, 2015; Priyo Subekti et al., 2023). Digital technology helps address these barriers. SMEs supported by consortiums show stronger resilience and performance, emphasizing the importance of collaboration and adaptive strategies for post-pandemic recovery (Ali et al., 2017).

5. Conclusion and policy implications

The MSME's of India have been badly affected by the COVID-19 pandemic which is a critical sector for the growth of economy in terms of manufacturing, export and employment (P. Sahoo & Ashwani, 2020; Arundhathi 2020). Lockdowns disrupted supply chain, trade and production, which led to an economic slowdown and many MSMEs are close to operational shut down (Verma & Kumar 2021; Rathore & Khanna, 2020). Some of the challenges that hit the sector include; scarcity of resources, low technological advancement, and little government support during the pandemic (Haresh , 2020; Roy et al., 2020). A survey revealed that 70% of small firms were at the brink of shut down, massive loss of employment opportunities as well as reduced output (Rathore & Khanna, 2020).

Some of the policy suggestions towards the revival of the sector consist of Fiscal stimulus, Credit guarantee schemes, subsidies, and lastly promotion of digital uptake (Roy et al., 2020; Li Lu et al., 2021). Probably the government's interference is needed for the revival of msme because its problems can become a brake on the overall economic development (Siddiqua & Shreyas, 2020; sunilraj, 2020). Mainly, the government and businesses need to work together to create more resilience and pave the way to sustainable long-term recovery. To help Micro, Small, and Medium Enterprises (MSMEs)

recover and build resilience during the COVID-19 outbreak, policy makers, and business leaders need to take certain steps. To achieve certain objectives, policymakers can strengthen the conditions that affect the expansion and development of MSMEs through innovation and flexibility. These involve offering special fisc al incentives like tax exemption, subvention, and grant to counter balance the constraints of financial. Disbureaucratisation of regulations as well as de red tape will also enhance MSME operations. MSMEs recruitment of digital platforms and skills, development and training of tools and the provision of training programs will create opportunities for the growth of MSMEs.

Furthermore, in order to support the development of a culture of entrepreneurs, there is a need to advance policies to offer entrepreneurship as part of the syllabi in our learning institutions and part of vocational training. For finance is vital, and the authorities can develop and offer credit facilities, grants and venture capital programs as they would for MSME. Guarantees of loans, credit facilities and other instruments and equity investment from private sector financial institutions. There is a need to ensure MSMEs get financing in areas that are not sufficiently served with discrimination on region representing a significant challenge to economic development. This way, support measures will be carefully aimed and efficient and required frequency of assessment will be established.

The following are the key areas where entrepreneurs have a fundamental responsibility of facilitating the growth and development of the MSMEs. In the digital age, there is no choice but to adopt innovations aimed at popularizing e-commerce, online marketing, and electronic payments and at increasing the company's coverage. Flexible and expansion, trying new products, markets and services to avoid the risks of overly reliance on one source of income. The other union with other established MSMEs industries and organizations increases an opportunity to access new technologies, markets, and resources.

Finally, flexibility should be valued by entrepreneurs as specific markets should be constantly monitored and adapted to the new business models. To ensure adequate growth of the employee competencies, human resource should encourage and support training and development, which will further improve organization innovation and competitiveness. MSMEs should also take advantages of sustainable dimensions such as sustainability, environment, and social responsibility and fit them into United Nations Sustainable Development Goals of SDGs. Most of these strategies when implemented can help policymakers and entrepreneurs to enhance the sustainability and cohesiveness of MSMEs to economic development.

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Bakey's Edible Cutlery: A Journey of Innovation and Impact, Connecting the Dots

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Abstract

We talk about social and environmental challenges and also post in social media. But, are we playing our role in tackling these social and environmental challenges? Yes, this is about Mr. Narayana Peesapathy, a social entrepreneur and an environmental enthusiast who envisioned a plastic free environment and took forward it through initiating innovative edible cutlery, the first of its kind in the world.

This case study, titled "Bakey's Edible Cutlery - A Journey of Innovation and Impact, Connecting the Dots…", highlights the crucial role of market research and risk assessment in entrepreneurial ventures. It details the inspiring journey and hardship of Mr. Narayana Peesapaty, the visionary behind Bakey's Edible Cutlery. Inspired by a fellow passenger struggling with a broken plastic spoon, Mr. Peesapaty innovated an edible, biodegradable alternative cutlery crafted from millets. Despite innumerable challenges, including financial difficulties, consumer acceptance issues, and personal hardships, Mr. Peesapaty's unwavering determination led to the production of cost-competitive edible spoons. The case uses unstructured interview method with the founder Mr.Narayana Peesapathy to gain insights and present the facts and hardships in a lucid manner.

Market potential for edible cutlery propelled by environmental concerns, evolving consumer preferences, effectuation principles, turnaround strategies, employment opportunities for women, water conservation by promoting cultivation of millets and innovation are the key highlights of this socio entrepreneurial journey. However, Bakey's encountered significant setbacks, such as a factory fire and health crises, prompting critical discussions about planning, risk management, and strategic execution. This study invites analysis of Mr. Peesapaty's entrepreneurial qualities, strategies for business revival, and methods for market penetration, aiming to explore sustainable innovation and entrepreneurial resilience amidst adversity.

Key Words: Social Entrepreneurship, Edible cutlery, millets, effectuation, innovation, sustainability, turnaround strategy.

INTRODUCTION

One day Mr.Peesapaty was travelling from Ahmedabad to Hyderabad. He saw his fellow passenger eating srikhand with khakra after his plastic spoon broke. He got sparked with the idea of designing an edible spoon made of millets which is biodegradable.

In the year 2010, Mr.Peesapaty, a first generation entrepreneur showed courage to test the waters even without any prior experience in business, helping hand or a guiding force, which is highly commendable. Being an alumnus of Indian Institute of Forest Management and having worked in International Crops Research Institute. Mr. Peesapaty gathered all the requisite background knowledge which helped him in his innovation. Mr. Peesapaty was employed with International Water

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Management Institute. The India operations of which were housed in ICRISAT[20]. Mr. Peesapaty left his secured job at ICRISAT and went on a mission to find an alternative to plastic cutlery.

The journey just began, destination was still gloomy. Many hurdles, setbacks, sacrifices, obstacles, challenges were on the way of Mr.Peesapaty's journey. He realized that if the price of the product was not competitive with disposable spoons, then it would not penetrate into common man's life, losing the basic essence of his innovation. After spending sleepless nights, his persistent efforts paid off when he ultimately developed customized proprietary technology which can produce edible cutlery that is cost-comparable with its plastic counterpart. Customer acceptance is a litmus test to Bakey's edible spoons. Did Mr.Peesapaty succeed in passing this test? Bakey's Edible cutlery- The World's first edible cutlery is now struggling for survival and inviting solutions to revive and turnaround Bakey's. Let us explore his journey and be a part of this eco-friendly innovation.

Testing waters…..

Bakey's take the pride to be the first edible cutlery in the world. A new entrant into the market, where customer never thought of an edible cutlery, Bakey's have created a new product which is eco-friendly, bio-degradable and most importantly edible!

His invention and indeed the emergence of the whole Edible cutlery market owes its genesis to the plastic menace[21] which created a call for urgent action to promote sustainable and viable alternative solutions. The basic motive was to look out for alternatives which are environmental friendly and can help in creating a greener and more sustainable place for generations to come. The widespread and extensive scale of usage of single use plastic utensils which have inherent disposal challenges because of their low recyclability posed serious environmental challenges. It came to light that, having extended lifespan, loitered plastic utensils took hundreds of years to decompose. The improperly disposed utensils ended up in natural environments, including oceans and waterways, degraded into micro plastics which augmented the issues even further by disrupting ecosystems and threatening biodiversity. Even a shift in consumer attitudes towards eco-conscious choices was observed, creating demand for alternatives that minimize environmental harm which in turn was reflecting in their changes in demand patterns. All these circumstances led to the dawn of an era and the emergence of a new product market i.e. the Edible Cutlery Market.

This case is designed to understand the issues and challenges faced by social entrepreneurs in their entrepreneurial journey. Several literary works have been referred to draw insights for the case. Relevant theories and entrepreneurial experiences have been quoted below for better understanding of the case.

Relevant literature supporting the study

The Bakey's founder, Narayana Peesapaty's entrepreneurial journey connects with Schumpeter's (1934) theory of economic development, which proposes that innovation is a fundamental force driving entrepreneurial activities. Schumpeter argued that entrepreneurs, by creating new products, services, or processes, disrupt existing markets and drive economic growth. Peesapaty's invention of edible cutlery is fully consistent with this framework. His innovation, driven by environmental sustainability, challenged traditional plastic cutlery, marking an important disruption in the cutlery market.

Saras Sarasvathy's (2001) effectuation theory offers further insights into Peesapaty's decision-making

[20] ICRISAT is a research Institute dealing in semi-arid tropics

[21] According to United Nations: 300 million tons of plastic is produced world-wide each year half of which is single use plastic

process. The Effectuation highlights that, under uncertainty, how entrepreneurs make decisions based on the means at hand, and adapting to changing circumstances. Peesapaty's iterative product development, could not gain the market support initially, and personal struggles illustrate the risks faced by early-stage entrepreneurs.

Porter's (1985) competitive advantage model provides a framework for understanding how Bakey's could position itself within a market dominated by affordable, traditional plastic cutlery. According to Porter, cost leadership and innovation are competitive advantages in business. Bakey's edible cutlery, by being eco-friendly, biodegradable, and nutritious, pursued differentiation. However, Peesapaty faced significant challenges in reducing production costs to compete with plastic counterparts, reflecting the tension between differentiation and cost leadership.

Additionally, the blue ocean strategy by Kim and Mauborgne (2005) is highly relevant to Bakey's efforts. Bakey's innovative product offering positioned them outside the saturated market for plastic cutlery. By focusing on creating a new market for edible, sustainable utensils, Bakey's aimed to avoid head-to-head competition and capitalize on a unique opportunity. However, the company faced difficulties in generating customer demand and achieving long-term profitability.

The shift in consumer preferences toward eco-friendly products plays pivotal role in the success of Bakey's, as highlighted by Allied Market Research (2019). Their report underscores the growing demand for sustainable alternatives to plastic cutlery, citing increasing awareness of environmental hazards caused by plastic waste. Health concerns associated with plastic, such as prone to cancer and other diseases, have further accelerated the adoption of edible cutlery, making it a viable market avenue for entrepreneurs.

Resilience is the hallmark of entrepreneurs, as exemplified by Peesapaty's journey. Ries's (2011) lean startup methodology emphasizes the importance of adapting to feedback and changing products based on customer insights, a concept adopted by Peesapaty to refine design and construction of spoons. However, Bakey's journey was marked by serious personal and professional problems, including fire accident and Peesapaty's and his wife's health problems, which ultimately prevented progress.

Lumpkin and Dess (1996) focused on the importance of entrepreneurial orientation, specifically proactiveness, innovativeness, and risk-taking. Peesapaty demonstrated these traits by venturing into an untested market, despite limited resources and investor support. However, the lack of a strong support system, particularly in terms of financial backup and scalability, left Bakey's vulnerable, depicting how innovation alone is not sufficient without strategic partnerships and robust contingency planning.

Bakey's represents green entrepreneurship, where innovation targets environmental issues. Elkington's (1997) triple bottom line emphasizes balancing social, environmental, and financial sustainability. Peesapaty's edible cutlery fits this model by addressing environmental and social concerns. However, despite its clear eco-friendly benefits, scaling the product to compete with plastic cutlery posed significant challenges, highlighting the difficulties green entrepreneurs face in balancing sustainability and profitability.

Market potential for Edible Cutlery

Realizing the immense market potential and inherent sustainability aspects this market emerged as an extremely promising one for budding entrepreneurs trying to keep an eye on innovative product lines.

In India limited players are entering this market gauging the viability and success of the product. But,

in the global scenario, disposable cutlery has a great demand and it could reach US$ 2050 million by the year 2024. This indicates that the product is being accepted by the customer. This paves way for new manufacturing units which in turn promotes entrepreneurship.

Allied Market Research in its report 'Edible cutlery market-by product, raw material and application – Global opportunity analysis and industry forecast, 2019-2026, stated that global edible cutlery market size is valued at US$ 24,860 in 2018 and is expected to reach US$ 56,970 by 2026.[22]

Figure 1 – Global Edible Cutlery Market

Source-https://www.verifiedmarketresearch.com/product/edible-cutlery-market

Health concerns like kidney stones, breast cancer, etc., by use of plastic cutlery could be one of the reasons for shift towards edible cutlery. Vegan population, and increase in income levels have also paved the way for customer preferences towards edible cutlery. The Global Edible Cutlery Market report reveals that along with edible cutlery as a product, trends, drivers, restraints and competitive landscape should be critically evaluated for the success of edible cutlery.

Players in Indian edible cutlery market

Indian edible cutlery market at present has fewer players when compared to traditional sectors. But, given the market potential, changing demand patterns, government support towards sustainability and consumer pro environmental behaviour, it is surely going to be one of the booming upcoming sectors. The major players in this industry apart from Bakey's Foods Private Limited include: (i) Trishula, which manufactures edible cutlery made from wheat bran, free from artificial additives, (ii) Edible Pro Cutlery, which offers a range of edible spoons made from a mixture of rice, wheat, and tapioca flours, (iii) Eco Kaapi Solutions and (iv)Attaware Biodegradable Private Limited. Edible cutlery market in India still has a lot of untapped potential for entrepreneurs to venture in. The market as it stands today has a long dated history with Bakey's as the ice breaker.

[22] The data has been taken from the report: Global Edible Cutlery Market Size By Product (Spoon, Fork), By Raw Material (Corn Wheat, Bran), By Application (Commercial, Household), and By Geographic Scope And Forecast by Verified Market Research.

Bakey's Journey

Bakey's journey had never been a smooth one. It was a roller coaster ride but the determination and staunch belief of Mr. Peesapathy was even stronger. He had a strong belief that his idea will definitely work out and started head on heels. It took no time for Mr.Peesapaty to populate his idea among his known contacts, soon he started commercialization of the product by starting a small unit. Mr. Peesapaty was on cloud nine that his vision is not far away. Awards, accolades, appreciations, talks[23] came his way and further encouraged and motivated him towards his mission.

- With such noble thoughts in mind and the zeal to succeed was Mr. Peesapaty successful i n bringing his dreams into reality?

- Did he get the requisite support to further his venture with regards to technology and investment?

- Was he successful in making his venture viable despite of the sustainability aspect?

- Was he able to change the mindset of the price sensitive customers?

Mr.Peesapaty made a humble beginning with edible spoons by experimenting with different combinations of ingredients and spices that could not only make the spoons robust enough to not swell when served in hot liquids but even nutritious and tasty as well. The dual benefits of these edible spoons is that either they can be consumed or even if they are not consumed they are biodegradable within 3-4 days.

Challenges Encountered and Dilemma

Consumer adoption and acceptance of Bakey's was a major challenge in front of him, which was not segmented scientifically. Mr.Peesapaty was well aware that if he had to change the consumer's mindset and sustain in the market, he needs to reduce the price of his cutlery so that it can compete with cheaper plastic counterpart. Through his thorough research and dedicated efforts he was successful in bringing down the price to around Rs. 2.18 per piece. His strategy of sourcing raw materials directly from the farmers cultivating millets helped him further in bringing down the cost of production. But at the fag-end he ended up spending a noteworthy time of 9 months on R&D to get a cost effective product, meeting all the specifications. Mr.Peesapaty initiated to secure a patent for his innovation but did not take it forward. Early patenting of the intellectual property pertaining to the production process could have helped in protecting the R&D efforts of the entrepreneur.

He started getting initial acceptance by enquiries from across the world. His invention got a worldwide recognition and orders rained his way. He was fortunate enough to enjoy early success which is not common in business. Soon he saw himself being a part of enumerable Conferences and talks namely Tedex at Amsterdam and others. His promos went viral on YouTube within no time.

Mr.Peesapaty was joined by his wife in his inspiring entrepreneurial journey and the initial days were rosy. Although the results were encouraging but still he had to find ways to achieve the twin objectives of optimizing production processes and scaling up to achieve cost efficiencies and reaching every table. Having no backup support, achieving economies of scale was a tough nut to crack. He knocked every door for funding and technology support but all went in vain. Soon he realised that working as a one man army will be a difficult task and he needs to build a team of like-minded people. But as the market

[23] Mr. Peesapaty was a part of numerous Ted talks at Amsterdam in 2016 owing to his invention

was still at a nascent stage he could not get the conviction of visionaries into his team.

Though this innovation which is still at a naïve stage attracted customers, but it could not gain the confidence from the investors. The feasibility and market penetration was a cause of concern for majority of investors. Convinced by his own innovation Mr.Peesapaty still continued on his mission. But a major question – "Will the initial customer become a repeated customer?", still remained unanswered for Bakey's journey.

The time had come to answer all the unanswered questions and Bakey's was about to catapult in its growth trajectory. But uncertainties are certain in business and the unexpected series of tragedies took a toll on his life. He was bombarded with lot of unfortunate incidents in personal life and professional front too.

Helping his wife to recover from her terminal illness, Mr. Peesapaty's venture of Bakey's lost the growth trajectory. There was no one capable enough with the required expertise to continue Bakey's operations.

Added to this, a major fire accident in the factory gutted down not only the machinery but also the hard work and dreams of Mr. Peesapaty. Seeing his dreams shattering in front of him he broke and met with brain strokes thrice. Was it only the misfortunes that resulted in the downfall? Or was there a lack of proper planning at the end of Mr. Peesapaty and his over optimistic approach that led to the failure? Did he overlook the risk assessment and contingency planning of the venture?

Entrepreneurs dealing with innovative and novel concepts do come across several such situations. Risk is inherent in business. While running a business, future surely cannot be predicted.

Even when the future falls short of predictability still entrepreneurial response to challenges encountered can make a lot of difference. Strategic thinking and application of entrepreneurial principles can act as a savior while tackling a lot of expected and unexpected issues cropping while taking innovative products forward. Could the knowledge of Effectuation would have rescued Mr. Peesapaty? Mr. Peesapaty did not leverage on contingencies neither did he embrace the surprise factors, opportunities and crisis innovation. There was a lacunae in self-assessment, resource management, and gap identification on part of Mr. Peesapaty. No sincere attempts were made on building partnerships and co-creation of new markets. Scientific prediction was also a matter of concern with Mr. Peesapaty.

Call to Action

Entrepreneurship is the synergy created with the involvement of all the stakeholders. Demand conditions, factor conditions, firm's structure and strategy, related and supporting industry help in creating a competitive edge. Scientific approach has to be adopted to push the product into the market. Customer preference and adoption intention is one of the prominent deciding factors in determining the demand conditions of the product. Any lapse in segmentation of the market can have detrimental impact on the sustainability of the product.

Eagles really don't flock together. When the product and concept is relatively novel, trying to capture an existing market by competing with established players may not be a very good move. In order to ensure market penetration, the entrepreneur needs to follow blue ocean strategy by creating a relatively uncontested niche market for its products. When it comes to edible cutlery, the driving factor for increasing demand could be any: be it positioning the product as a differentiated one compared to the traditional alternatives or emphasizing on the biodegradability and environmental sustainability aspects. Edible cutlery business can focus on increasing market penetration via targeting new customer

segments or geographical markets, developing new flavors or variations of the cutlery (product development), or exploring diversification into related products such as eco-friendly packaging solutions. Through edible cutlery is still at nascent stage, taking the growth prospects and new entrants into consideration, a competitive landscape can be framed to attract investments. Innovative products need to capture acceptability from customers. Following an iterative production process can provide room for including customer feedback. Developing a minimum viable product and then going for iterations can prove to be helpful in this regard. For a product like Bakey's where product is totally new, and market has to be tested, ups and downs are common. As rightly said winning is not important, being in the race is the more important at times.

Entrepreneurship itself is a platform where entrepreneurs rise, fall, again rise and lead others. Challenges can bend a person but not break him. Especially in entrepreneurship where sometimes learning comes in disguise.

'Phoenix are meant to rise'. Mr.Peesapaty has inspired many entrepreneurs in the West to think on venturing into edible cutlery business. His inspiration has resulted in establishing several brands in the US catering to the edible cutlery market. Having inspired so many entrepreneurs and being the very originator of this innovative idea, should Mr. Peesapaty think on reviving his own venture of Bakey's?

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Assessing the Relationship between Service Capacity of Universal Health Coverage and Health Expenditure through Sustainable Development Goal3 in India

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Abstract

Purpose: In the Indian context, this study simultaneously examines dynamics of Universal health coverage through different issues. Universal health coverage is a crucial topic in World Health Organisation (WHO) and it is also considered in SDG 3. This study focuses on the relationship between health services capacity and government health expenditure.

Methodology: This study chooses the time series data from 2011-2020 for the analysis of regression model of the variables. Capacity of health services of UHC is a dependent variable and government of health expenditure (% of GDP) and out-of-pocket health expenditure are independent variables of the study.

Findings: This study depicts the strong positive relationship between the capacity and GHE and negative relationship between the capacity and OPE in India. GHE rises by 1 percent, the capacity of health services increases by 9.76 percent. Within regression analysis, there is a 0.03 percent increase in capacity as opposed to a 1 percent rise in OPE on health.

Practical Implications: According to this study India needs to fulfil the gap between public and private health sector for the better implementation of health policies. The policymakers should reinforce successful pathways, invest in infrastructure, and services to diverse segments.

Originality: This study contributes to the discourse on SDG 3 by providing a comprehensive map of pathways and emphasizing the need for holistic, context-specific approaches to achieve universal health coverage in India.

Keywords: Sustainable Development, Capacity services, Universal health coverage.

1 INTRODUCTION

In the economic development of any country, health is recognized as most important universal aspect. Uneven population density across the different low-level income and middle-income countries, creates different type of challenges about investment in health sector. More than 80 years, "right to health" is a most important topic for the international human rights (WHO, 1946)[1]. Universal health coverage is related to the major goal of SDG 3. Under SDG3, from 2000 to 2016, progress was noted in UHC in different nations (Barber et al., 2016). Universal health coverage (UHC) is also needed domestic action in every nation. Economic growth, reducing poverty, social protection, securing UHC etc, are those areas which is require for account the global health agenda (Kickbusch, 2014). Universal health coverage (UHC) (3.8)[2] is a sub-goal of SDG - Ensure healthy lives and promote well-being for all ages

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[1] World health organisation (1946), First international legal document which provide the right to health (WHO constitution 1946)

[2] Achieve universal health coverage, which will safeguard people from financial risk and provide access to high-quality healthcare services as well as safe, efficient, and affordable medications and vaccines.

(UN,2015). UHC has a two indicator (1) Coverage Essential Health services (3.8.1) and Catastrophic Health Expenditure (3.8.2) (World Health Organisation, the International Bank for Reconstruction and development,2022). Through the UHC it seems to greater access of healthcare services and minimise the cost of health spending for every nation of the world (WHO 2010). The main aim of UHC is to assess health services without any financial instability of every people. For strengthening the health system UHC need to collaborate with other SDGs goals like: No poverty, Quality Education, Gender Equality, Inclusive economic growth etc (Kieny et al. 2017). Quality of health services was needed to grab the desired outcome of UHC (Boerma et al. 2014). Every nation faces several challenges to achieving universal health coverage, including high healthcare costs, out-of-pocket expenses, the promotion of the private health sector, inefficiencies in subnational scheme implementation, an increase in communicable and noncommunicable diseases, inadequate access to health services, and more (Rao et al., 2014).

UHC is a dynamic concept, health sector are continuously increase with new technologies and innovations in medical products (Boerma et al. 2014). Health services are also increase over a time but quality of services is priority to achieve UHC of any nation. In India, progress towards the SDG3, especially for UHC (3.8) need to develop new paradigm of accessing the quality of health system. Financial protection and effective coverage are essential for the UHC (Boerma et al. 2014; Ng et al. 2014; Saksena et al. 2014). India has a shortage of 1.8 million health workforce (WHO 2020). Sufficient health workforce is required to fulfil the health goals and SDG3/UHC. India's target to spend 2.5% of GDP on health by 2025 (MoHFW, 2017). For the socio-economic development, health sector needs more investment to provide the essential health services to the poor people. It has direct link between the population health and economic growth because when labour productivity is increasing then it influences the growth of the nation (WHO 2016).

2. LITERATURE REVIEW

The evolution of current study concerning the relationship between health expenditure and service capacity of healthcare system in India. The following section provides an overview of some of the previously mentioned studies related to the aim of the study.

Table 1. Literature review

Author/ Study	Time-Period	Study Area	Objectives	Method	Findings
Rao (2014)	Mid 1990s to 2014	BRICS (Brazil, Russia, India. China. South Africa)	The role of government in financing health; motivation behind the reforms.	Comparative analysis, specific case studies	China, India, Russian Federation and South Africa were address the inequalities in assess of healthcare facilities. Brazil has a good state of level in health system.
Leegwater et al. (2015)	2000-2010	103 countries	To estimate the health service coverage index of UHC	Time series and cross-sectional capabilities	Health service index associate with health outcome indicators. strong correlation

					between the coverage index and measures like life expectancy and infant mortality.
Barasa et al. (2018)	2003-2013	Kenya	Assessing both service coverage (SC) and financial risk protection (FRP)	Geometric mean, Stochastic Frontier Analysis (SFA), Data Envelopment Analysis (DEA) Regression Analysis	SC increased significantly from 27.65% in 2003 to 41.73% in 2013. growing financial risks associated with healthcare expenditures. Inequities in both SC and FRP indicators
Behera & Dash, (2019)	1980-2014	21 Indian States	Relationship between government health expenditure and fiscal space	Panel data, Fixed Effects (FE), Fully Modified Ordinary Least Squares (FMOLS), VECM	Positive impact of Revenue Mobilization on healthcare. Borrowing Dependency increase long run high fiscal stress.
Taniguchi, et al., (2021)	2000-2018	Iraq	To analyse the disparities and factors influencing Iraq's advancement towards the UHC.	Bayesian hierarchical regression models, correlation, Deviance Information Criteria (DIC)	Education level, household wealth, and place of residence necessitate urgent health-system reforms, Inequities in health service indicators in Iraq are projected to decrease by 2030.
Nomura et al. (2021).	2011-2019	29 development assistance committee (DAC) member countries	To estimate the DAH and its essential flow, types of aid provided, the distributed channels	DAH (Development assistance for health)	60% of DAH allocated to primary healthcare by DAC countries. The overall proportion of ODA was 7.9 % in 2019. The total development assistance for health (DAH) amounted to 18.5 billion US$ in 2019.

Shabnam et al. (2022).	NFHS-4 (2015-16) and NFHS-5 (2019-21)	India	Analysed the health-related goals under SDG3 And the NHP-2017	Annual rate of progress and Required rate of progress	Both Neo-natal mortality and Maternal mortality ratio is 1.5 and 1.7 times higher than current yearly Progress rate. India will achieve the target of child immunization.
Zhou et al., (2022)	2003-2018	China	comprehensive assessment of Universal Health Coverage (UHC) in China.	Bayesian Regression Models, Multiple Regression,	UHC-Coverage, increased from 44.0% in 2003 to 79.8% in 2018, with a prediction to meet the 80% global target by 2030 and Need Financial Investment Efficiency.
Guerra et al. (2024).	1990-2017	96 low-income countries	To evaluate the relationship between service coverage and poverty.	Panel data: Fixed effect and random effect model, Hausman test	Poverty head count ratio decrease significantly. ARI treatment, full immunisation, and ANC have a substantial impact to overcome poverty.
Khan et al. (2024)	2000-2020	Pakistan	the impact of governmental efficacy, financial investment in healthcare, and the attainment of SDGs on life expectancy.	Time series data, cointegration, Granger causality	Long term cointegration between the variable and there is one-way causal relationship between health expenditure and government efficacy and life expectancy.

Source: Table Created by Author

3. OBJECTIVES

1. To develop understanding about the concept of universal health coverage in Sustainable Development Goal 3 in India.

2. To assess the relationship between service capacity of Universal Health Coverage and health expenditure in India.

3.1 Significance of the Study

Different type of studies was considered the relationship between UHC and other macro-economic variables like poverty (Guerra et al. 2024), financial stability (Kieny et al. 2017), financial protection (Boerma et al. 2014) and equity (Saksena et al. 2014). This study means sure the service capacity and access of universal health coverage in India under the SDG goal 3 and it is the first time when only capacity variable of UHC (3.8) consider to develop the relationship with government expenditure and out-of-pocket health expenditure by household. This study shows that capacity is highly correlated to government expenditure and it has impact on UHC service Index in India.

4. METHODOLOGY

The present study has used the secondary data to find the relationship between health service capacity and government health expenditure. The time series data cover 10 years, from 2011 to 2020 and further year are studied based on reports due to not availability of data after COVID-19 pandemic. UHC has a 14-tracer indicator of four major domains: Reproductive maternal, newborn and child health (RMNCH), infectious diseases, non-communicable diseases and services capacity and access. For compute the value of capacity (dependent variable) choose the Geometric mean of all these three variables (Equation 1). Health worker density also include medical doctor, Nursing and Midwifery personnel, Dentist and Pharmacist (10 000 population) (Figure 2).

Capacity = (Hospital bed density. Health worker density. IHR health capacity index)$^{1/3}$

…… . Equation (1)

4.1 Model Construction

The data was sourced from World health organisation India, World Bank, National institute of health and family welfare (NIHFW), Ministry of AYUSH etc.

$$capacity(C) = F(GHE, OPE)$$ ……. Equation (2)

Capacity (C) is the "Service Capacity and Access," GHE is "Government Health Expenditure as a share of GDP (in %)," OPE is "Out-of-pocket expenditure per capita on healthcare."

This study conducts the descriptive analysis, correlation, unit root and regression analysis of the variables. The empirical model of time series analysis is following as:

$$Cy_t = \beta_0 + \beta_1 GHE_t + \beta_2 OPE_t + \mu_t$$ ……. Equation (3)

β0 represent intercept and β1, and β2 represent slope coefficients of GHE and OPE respectively. Capacity (C) is the dependent variable," and "μt" is the normally distributed white noise residual term and "t" is the time-period (2011-2020).

4.2 Unit Root Test

For further statistical analysis, employed to examine the stationarity in a series called "Unit root test" (Shrestha & Bhatta 2018). There is different type of method for check the unit root, namely Augmented Dickey Fuller (ADF), Phillips Perron and KPSS tests (Herranz, E. 2017). This study considers the results of stationarity by ADF test. The unit root model of ADF (equation 4) as follow:

$$\Delta y_t = \alpha + \delta y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + \mu_t$$ …….. Equation (4)

Where $\delta = \alpha - 1$, α is a coefficient of y_{t-1}

and Δy_t is a first difference of y_t (which is $y_t - y_{t-1}$).

The null hypothesis (Ho) of ADF is δ=0 opposite to the alternative hypothsis (Ha) of δ< 0.

If study accept the null hypothesis, then series is non stationary whereas rejection means the series is stationary.

When the difference of a non-stationary time-series sequence is computed and ordinary least squares (OLS) regression is utilized after confirming the stationarity of all variables, it may seem to be a direct method for examining associations. However, it is important to note that the differenced series captures only short-run changes in the time series (Shrestha & Bhatta 2018).

Table 2. Variables and data source description

Context	Variable name/symbol	Source	Definitions
Dependent variable Service capacity and access	Hospital bed density (1,000 people (in %) (HB)	World Health Organization	hospital beds serve patients with acute and chronic illnesses. These beds are available in various settings, including public, private, general, and specialized hospitals.
	Health worker density per 10 000 population) (in %) (HWD)	Global Health Observatory (WHO, 2017, 2018, 2019, 2021)	Include Medical doctor, Nursing and Midwifery personnel, Dentist and Pharmacist
	IHR health capacity index (e-SPAR score based on 35 indicators for the 15 IHR capacities) (0-100) (E-SPAR)	World Health Organization	It consists 35 indicators for 15 IHR capacities improving the capacity through access, notify& respond to public health risks
Independent Variables	Government Health Expenditure as a share of GDP (in %) (GHE)	World development indicators (World Bank)	Government health spending means final consumption of healthcare goods and services which excluding the capital investment.
	Out-of-pocket expenditure per capita on healthcare (OPE)	WHO, Global Health Observatory (2022)	It is direct spendings by households to access the goods and services of healthcare

Source: Table created by author

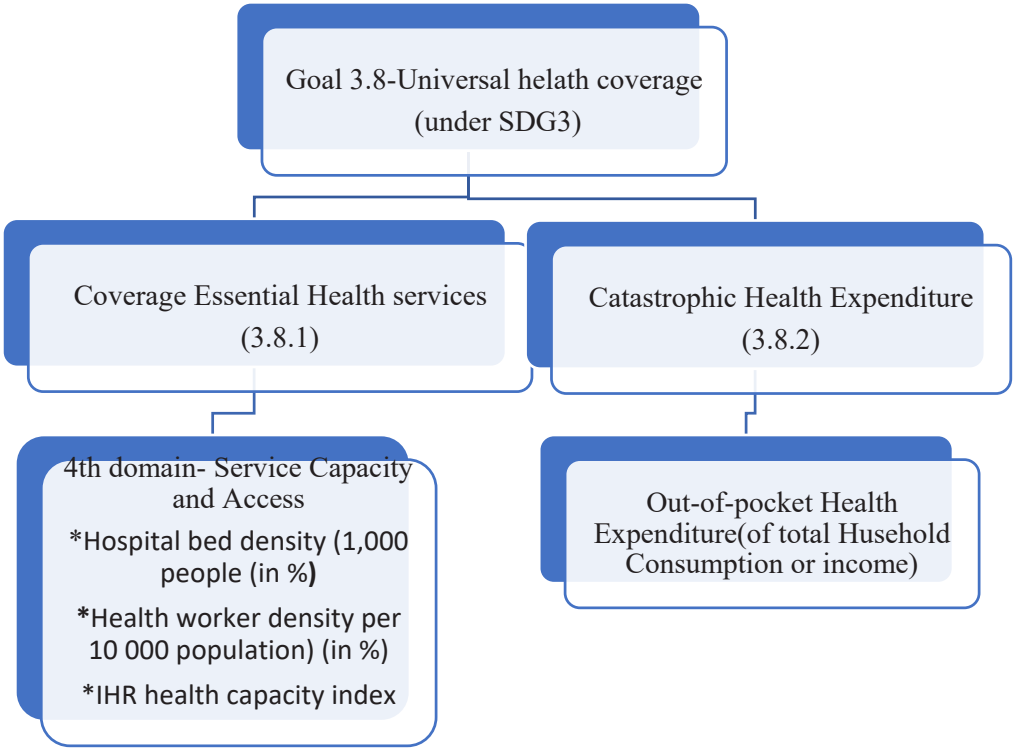

Figure 1. Computed Variables

Source: Author's own Compilation (World Health Organisation, the International Bank for Reconstruction and development, 2022).

This study has used the Service capacity and access (dependent Variable) and Government health expenditure (% of GDP) and Out-of-pocket Expenditure on health (independent variables) for the analysis (Table 2). In the services capacity and access has contain three more variables like: Hospital bed density**,** Health worker density, and IHR health capacity index (Figure 1).

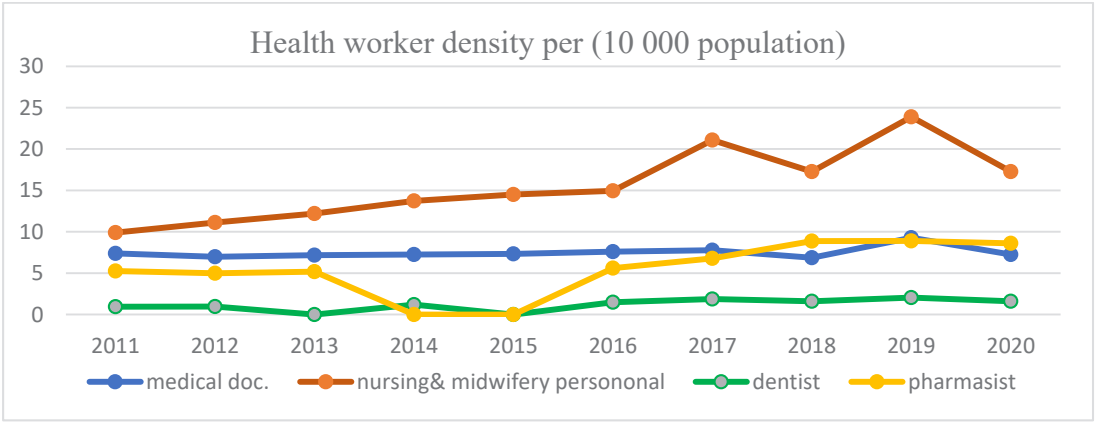

Figure 2. Health Worker Density per 10,000 Populatin In India

Source: Global Health Observatory (WHO 2021a, WHO 2021b, WHO 2021c, WHO 2021d)

Total stock of health professionals is 34.72 percent per 10000 population of India in 2020. Health worker density include medical doctor, Nursing and Midwifery personnel, Dentist and Pharmacist (10 000 population). Projections indicate that by 2030, approximately 2.06 million doctors will be trained, with over half of this cohort (around 1.1 million) anticipated to practice within the healthcare sector (Karan et al. 2023). Ensuring an adequate supply of healthcare professionals is crucial for meeting the growing demands of India's population and achieving universal health coverage. In case of AYUSH, share of health professional is lower than the private sector. Most of practitioner is engaged with the private sector. States like GOA and Kerala has a highest density of health worker than Orissa and Chhattisgarh. To develop a health structure and density of health worker will be needed for improving the rank of India in SDG 3.

5. EMPIRICAL RESULTS

Table 3 indicates the overall descriptive analysis which is showing maximum, minimum, skewness, kurtosis, and normality results. It has also a corresponding mean and median value of given statistics. In the case of skewness, GHE and OPE are found to be negatively skewed. In the kurtosis, all values have a platykurtic pattern. For the normality of all the variables have found significant values through Jarque-Bera normality Test.

Table 3. Descriptive analysis

Variable	Capacity	Government Health Expenditure	Out-of-pocket health Expenditure
Mean	10.08	0.93	61.47
Median	9.86	0.94	63.10
Maximum	11.32	1.01	69.07
Minimum	9.24	0.83	52.00
Std. Dev.	0.68	0.06	5.93
skewness	0.7	-0.47	-0.54
Kurtosis	2.30	2.08	1.88
Jarque-Bera	1.01	0.72	1.00
Probability	0.60	0.69	0.60
sum	100.75	9.30	614.69
Sum Sq. Dev.	1.140	0.0370	316.35
Observation	10	10	10

Source: Author's calculation

From the correlation analysis of the variables are, indicates that the service capacity is positively related to government health expenditure **(Table 4).** It has a direct relation between the capacity and government health expenditure, if GHE increase then capacity of health services is also increase and if GHE decrease then service capacity is also decrease. Capacity of health services and out-of-pocket health expenditure is negatively related with the -0.368 value of correlation **(Table 4)**.

Table 4. Correlation analysis

	Capacity	GHE	OPE
Capacity	1	0.697	-0.368
GHE	0.697	1	-0.733
OPE	-0.368	-0.733	1

Source: Author's calculation

From the unit root analysis of the variables, all are showing the stationarity at first difference I (1). The stationarity of the variables is signifying through the ADF test **(see Table 5)**. The dependent variable (Capacity) and both independent variables (GHE & OPE) of the study are significant at 5% (p-value = 0.05).

Table 5. Unit Root Test Results

Variable	ADF test Statistics	Order of Integration	Remarks
Capacity	-3.3209* (0.004)	I (1)	Stationary
Government Health Expenditure (GHE)	-3.4033* (0.043)	I (1)	Stationary
Out-of-pocket health Expenditure (OPE)	-1.9958* (0.035)	I (1)	Stationary

Source: Author's calculation

Service capacity and access is an important aspect of UHC with in the SDG3. In this study short run equilibrium establish in service capacity and government health expenditure through the regression analysis. When government health expenditure (GHE) increases by 1 percent then capacity of health services is increased by 9.76 percent which is help to promote the healthcare access.

In regression analysis, capacity rises by 0.03 percent in contrast to 1 percent increase in out-of-pocket expenditure (OPE) on health (Table 6). R^2 value is 0.53 percent which shows the goodness of fit of the model, and Durbin-Watson statistics value is 2.56 which is highest then R^2 which shows impact and association are accurately define by the selected regression model

Table 6. Regression analysis

Variables	Coefficient	Std. Error	t-statistic	Prob
GHE	9.761	4.0293	2.422	0.0459
OPE	0.035	0.0436	0.809	0.444
C	-1.1773	6.001	-0.196	0.850
R-squared	0.5301	Mean dependent var		10.0775
Adjusted R-squared	0.3958	S.D. dependent var		0.6782
S.E. of regression	0.5272	Akaike info criterion		1.8008
Sum squared resid	1.9456	Schwarz criterion		1.8916
Log likelihood	-6.0044	Hannan-Quinn criteria.		1.7013
F-statistic	3.9487	Durbin-Watson stat		2.5684

Source: Author's calculation

.COVID-19 pandemic has suggested the new framework for improving the health sector and UHC. Across the globe, the vulnerable segments of society encountered challenges when attempting to obtain essential healthcare services (Nomura et al. (2021). India's hybrid public-private healthcare system has experienced a steady decrease in the quality of public services, attributable to the unregulated expansion of both formal and informal private healthcare providers (Mir & Singh 2022). Considering India's significant cost advantages in terms of labor and other sectors, it is reasonable to suggest that $2000 per capita (adjusted for inflation in 2018) would be sufficient to cover the costs related to achieving universal health coverage (UHC) (Mor & Shukla 2023). By contrast, the projected pool of available nurses and midwives is expected to reach 2.74 million by 2030, of which only about half, or 1.4 million, are expected to be actively employed in the health sector (Karan et al. 2023).

For achieving the universal health coverage, the government of India launched a great scheme named as "Ayushman Bharat" (long live India) in 2018. This scheme has two components: Pradhan Mantri Jan Arogya Yojana (PMJAY) and Health and Wellness Centers (HWCs) (GOI 2019). This scheme covers the approximately 40 % of the total population of the nation. Health is a state subject in India. Due to different political economy of every state has create heterogeneity in health spendings. The overall health spendings in India was 3.6 % of total GDP in 2015 and 3.3 % in 2020[3]. The out-of-pocket expenditure by household to assess the healthcare facilities was around 60.5% of the total spendings. For the effective development of UHC, efficient funding is required to strengthen the healthcare sector. The National Rural Health Mission promote the primary care, which was funded by the government to strengthened the public health sector (Rao 2014). India has also developed a National Health policy-2017 for addressing the healthcare system.

[3] The health expenditure estimates have been prepared by the World Health Organization under the framework of the System of Health Accounts 2011 (SHA 2011).

6. CONCLUSION

This study explores the relationship between government health expenditure and check its impact on services capacity and access through different parameters. After proving the stationarity of variable, linear regression model has been used for the analysis. The variable demonstrates that the strong positive association between the GHE and capacity. There is negative association between the out-of-pocket health expenditure and capacity of health services. These three variables of this study are interlinked with each other because if government increase the expenditure on health, then services are rises in healthcare sector and people must pay less for grab the public healthcare facilities and its out-of-pocket expenditure on health is decrease. The implications of these findings for policymakers in India are indeed significant. The empirical results shed light on several key insights related to UHC and sustainable development goal 3.

The analysis shows that the government health expenditure is leading factor for the development of the healthcare sector. WHO suggested that India has need to more spending after COVID-19 in their health sector. Due to large population, the vulnerable section of the society is lagging for accessing the healthcare facilities. To sustain growth in health sector, it is essential to progressively involve in healthcare service capacity and access in India. This study suggested the need to overcome the gap between health worker density which is divided in private or public sector because the poor people use public sector only that is why there is need to create well-structured health sector which will help the vulnerable section of the society. Improving care quality becomes essential to ensure that patients' safety and clinical outcomes are prioritized along with appropriate prescriptions for their individual clinical circumstances. The private healthcare industry, which is primarily profit-driven and is typified by high levels of commercialization and inadequate standardized regulations regarding quality and cost, requires effective regulation.

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A Multidimensional Analysis of Interstate Disparities in Health in India

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Abstract:

By utilizing the most recent cross section data on various health indicators, the paper primarily deals with interstate disparities in health status and heath care services across the states in India. For this purpose the study uses cluster analysis and regression analysis. It is found that four states viz. Bihar, Jharkhand, Madhya Pradesh, and Uttar Pradesh are reported as worst performing states in terms of each and every aspect of health care. All of the five dimensions of health (viz., health status, child healthcare, maternal healthcare, human resource, and infrastructure) considered in this paper are significantly responsible for interstate heath disparities in India. It is also found that increase in per capita health expenditure, per capita income, and literacy rate plays a positive role in reducing overall health disparities; whereas prevalence of poverty is significantly responsible for widening the gaps in overall health performance of Indian states.

Key words: Health disparities, Health status, health care services, and cluster analysis.

1. INTRODUCTION

It is widely acknowledged that health is an important component of human development and high level of per capita income is expected for improving the physical quality of life. Since its independence, India has made remarkable growth in its per capita income. However, the story of India's economic growth loses its luster when we consider the rising income inequalities. This indicates that the benefits of economic growth are not evenly distributed across states or the population. These widespread economic disparities further exacerbate other socio-economic disparities, such as those in health, education, and infrastructure. Among these, disparity in health remains a major challenge in achieving overall human development and gross happiness.

Despite rapid economic growth, the country still lags behind in many human development indicators (Sagar and Najam, 1998). The performance of a country or a state depends heavily on the health of its populace. It also improves the efficiency of human resources and reflects the overall performance of a nation. In India, the population averages of many health status indicators, such as infant mortality rate (IMR), maternal mortality rate (MMR), and prevalence of anemia among women and children, remain unacceptably high compared to countries in South and East Asian regions with similar income levels and rates of economic growth. Underlying these low levels, worrisome inequities coincide with multiple axes of caste, gender, and regional disparities (Baru et al. 2010). Among these, the present paper deals with the regional aspect of health inequities/disparities.

Given the crucial importance of health for the economic growth and well-being of the population of a country, it is important to understand the structure of health inequities. The importance of health is multifaceted, as it affects every aspect of one's life. Poor health not only reduces a person's productive capacity but also limits their ability to enjoy a variety of goods. The present study is an attempt to

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analyze the multi-faceted aspects of India's health sector disparities both in terms of health inputs and outcomes. By this way, we try to understand the extent to which the misallocation of resources among states contributes to interstate disparities in health outcomes. Apart from this, the study also tries to understand the extent to which inequality in economic growth and government policy contributes to these disparities. Thus, the present study may serve as an important document for policy formulation to reduce interstate health disparities.

In India, the issue of inequalities in health and healthcare has not received sufficient attention from scholars. Consequently, only a few empirical studies have been conducted on this issue, and these often consider just one or two dimensions (e.g., health status, health expenditure, and infrastructure) of health inequalities. This study seeks to measure interstate disparities in the health sector by focusing on five major dimensions: health status, maternal healthcare services, child healthcare services, health infrastructure, and human resources employed in the health sector. Apart from this, the study analyzes the interconnections among these various dimensions of the health. In this respect, the present study makes significant departures from the existing literature on this issue.

2. REVIEW OF LITERATURE

A large volume of literature is available to analyze economic disparity in India. As far as inequality in health care is concerned, there is a paucity of empirical literature in this regard. Here, an attempt has been made to review the existing empirical literature on health care disparities in India.

Several studies paint a concerning picture of healthcare disparities in India. Joe et al. (2008) present evidence of significant health inequalities across various Indian states, with poorer sections of the population bearing a disproportionate burden of ill health. The rising average income levels, when accompanied by increasing income inequality, exacerbate health inequalities, which that economic growth alone is insufficient to improve health outcomes equitably; instead, the distribution of income plays a crucial role in determining health disparities. Focusing on a broader scale, Goli and Arokiasamy (2014) investigate the convergence hypothesis for health and health inequalities across major Indian states, employing both traditional and advanced convergence metrics. The findings support the idea of convergence in average health status among the states and various socioeconomic groups in India, as indicated by selected health metrics. Since the late 1990s, the trend of convergence in reducing health inequalities has shifted towards emerging divergence. Ghosh (2014) investigates horizontal inequities in healthcare utilization, focusing on outpatient and inpatient care across 15 major states and the northeastern region of India using cross-sectional data from the 60th round of NSSO conducted in 2004. The findings reveal significant absolute inequalities in healthcare utilization, with disparities in outpatient visits ranging from 4.42 to 21.72 percent and inpatient care from 1 to 10 percent. Inequities were found to be pro-rich, especially in rural areas compared to urban areas. Higher per capita government health spending was associated with lower inequity in inpatient care utilization.

The above studies focus only on disparities in health outcomes and ignore regional disparities in health infrastructure. In this direction, Further, Anand (2014) measures the extent of inequality in health status and healthcare services in Uttar Pradesh and Bihar, the two most populous states. The results reveal a generally low health status and substantial disparities within both states, with Uttar Pradesh exhibiting lower disparities in health status but higher disparities in health infrastructure compared to Bihar. Notably, there is a weak correlation between healthcare infrastructure and health outcomes. The health status inequality is influenced by factors beyond healthcare facilities, primarily reflecting the government's commitment and policy effectiveness. Taking the sample of North-Eastern states, Lyngdoh (2015) examines the rural public healthcare infrastructure by constructing an index applying principal component analysis. The author finds significant disparities in the healthcare infrastructure among the North-Eastern states. Assam, despite being the largest state, shows better infrastructure

development compared to others. States like Manipur and Sikkim, however, display stagnation in the growth of healthcare facilities, particularly in establishing Sub Centres and Primary Health Centres (PHCs). Further, severe shortage of healthcare personnel, particularly specialists, intensifies the healthcare challenges in rural regions. Similarly, Taqi et al. (2017) found that some states have a surplus of physical infrastructure like Sub-Centers (SCs), Primary Health Centers (PHCs), and Community Health Centers (CHCs), compared to the national level. Similarly, the availability of human resources is equally concerning, with notable shortages of doctors and paramedical staff in many regions. Accessibility to healthcare is also inadequate, particularly in northern, central, and eastern states, where population-to-doctor ratios are alarmingly high. They also found that the healthcare system in rural areas remains inefficient and suboptimal, despite decades of planned development.

Further, Dwivedi and Pradhan (2017) find the greatest disparity in average healthcare spending between the richest and poorest households in the major states of India. Lower healthcare spending was geographically concentrated in states like Odisha, Chhattisgarh, and the northeastern region. It is also revealed that individuals in urban areas, with higher economic status, non-Muslim communities, non-Scheduled Tribes (STs), and non-poor households spend more on healthcare. Despite government efforts to mitigate healthcare spending burdens, significant inequalities persist, particularly affecting SCs/STs and poorer households. Recently, Ud Din et al. (2023) confirm the hypothesis of β- and σ-convergence in public health expenditure for the selected states during the specified period. The coefficient of variation across states shows a declining trend, further supporting the robustness of the σ-convergence. The authors claim that it is the first study to examine the convergence of public health expenditure, specifically within the framework of the National Rural Health Mission, across Indian states using β- and σ-convergence techniques. Similarly, Gumber et al. (2023) demonstrate substantial disparities between states in healthcare costs, insurance coverage, and financial protection. These disparities are evident in the percentage of households that paid premiums, had insurance, and the financial protection received by insured households. The high level of out-of-pocket (OOP) expenditure on healthcare is identified as a major factor pushing people into poverty.

All the studies discussed above address only one or two dimensions of healthcare disparities, neglecting inequities in other crucial aspects. For instance, Joe et al. (2008), Ghosh (2014), and Anand (2014) examine disparities in child and maternal healthcare services, while Goli and Arokiasamy (2014) focus on health status indicators like life expectancy and mortality rates. Lyngdoh (2016) and Taqi et al. (2017) analyze interstate inequality in health infrastructure, while Dwivedi and Pradhan (2017), Ud Din et al. (2023), and Gumber (2023) examine disparities in health expenditure and healthcare costs. **Therefore, to bridge this gap in existing literature, the present study aims to analyze interstate disparities across the entire public healthcare system. By utilizing 24 variables encompassing five broad dimensions, this study offers a more comprehensive picture of healthcare inequalities compared to previous research.**

3. DATA AND METHODOLOGY

At present, India is a union 28 states and 8 union territories. The sample of the study includes 22 states and one union territory on the basis of the availability of data on key indicators related to health. The study considers Jammu & Kashmir and Ladhak as one entity and includes it among the 22 states considered in this paper. It is basically a cross section study based on latest available data which collected from various sources like National Rural Health Mission (NRHM), Census of India, SRS Bulletin (2009 – 13), Indiastat, and Census of India.

In order to analyze the data descriptive statistics like mean, coefficient of range, and Gini coefficient is used. Apart from this, K-means cluster analysis is also employed in this study which is a popular technique used to classify data points into distinct clusters based on their similarities. It is an iterative

algorithm that aims to minimize the within-cluster sum of squares, also known as inertia. Further, correlation analysis is used to analyze the interdependence of various health indicators and regression analysis is used to explain the factors contributing to interstate health disparities

4. INTERSTATE HEALTH DISPARITIES IN INDIA

In Table 1, we have measured interstate health disparities across the five broad dimensions of health—health status, maternal health care, child health care, human resources, and health infrastructure—using the Coefficient of Range (CR), Coefficient of Variation (CV), and Gini Coefficient (GC).

Table 1: Interstate health disparities in India: An overview

	Variables	MEAN	CR (%)	CV (%)	GC (%)
Health status	Life expectancy (years)	69	80	4.5	2
	DALYs (per person)	0.25	21	12	6
	Death rates due to diseases (per 100000)	**588**	30	13	7
	MMR (per 100000 live births)	163	66	**44**	**24**
	IMR (per 1000 live births)	30	71	**38**	**21**
Maternal health care	Anemic Pregnant women (%)	47	47	19	10
	Institutional births (%)	83	23	14	8
	Home delivery conducted by SHP (%)	4	**98**	**57**	**30**
	Mothers having full antenatal care (%)	28	**90**	**59**	**33**
	Mothers receiving postnatal care (%)	67	37	20	11
Child health care	Anemic children of age 6-59 months (%)	56	34	18	10
	Children of age 12-23 months fully immunized (%)	79	27	12	7
	Children of age 6-23 months receiving an adequate diet (%)	10	**80**	**65**	**30**
	Children of age 9-59 months receiving vitamin A (%)	64	42	20	11
Human resource	Average population served by a Govt. Allopathic Doctor (1000)	11	86	55	29
	Average population served by an Ayush doctor (1000)	6	98	257	68
	Average population served by a pharmacist (1000)	4	96	140	58

	Average population served by a Nurse (1000)	1	96	134	59
Infra-structure	Average population covered per AYUSH hospital (1000)	3027	100	106	54
	Average population covered per AYUSH dispensaries (1000)	59	95	83	37
	Average population covered per CHC (1000)	243	79	54	26
	Average population covered per PHC (1000)	225	99	367	79
	Average population covered per Sub Centre (1000)	95	100	441	89
	Average population covered per bed in Govt. Hospital (1000)	5	80	70	34

Source: Author' calculation

The first dimension is characterized as health status, which includes health outcome variables such as life expectancy (LE), maternal mortality rate (MMR), infant mortality rate (IMR), death rate (DR) due to communicable and non-communicable diseases, and disability-adjusted life years (DALY) rate. LE measures health achievement, while the other four variables measure deprivation from good health. From Table 1, it is evident that interstate health inequality is highest in terms of MMR and IMR, as indicated by the relatively high values of CR, CV, and GC. Both of these variables are associated with the health of mothers and children, the most vulnerable sections of society. Moreover, many empirical studies have raised concerns that poor health status of children may result in lower life expectancy for the population in the future (De Beer, 2006), which will not only reduce the quality and productivity of the future labor force but also overburden the country with increased health expenditures that could otherwise be productively invested (Dormont et al., 2008). In this way, poor health status among children can hinder future economic growth. In underdeveloped countries like India, where per capita investment is very low due to the paucity of economic resources, the magnitude of this adverse effect will undoubtedly be very high and exacerbating. Therefore, the prevalence of high interstate disparities in these two variables poses a serious challenge in ensuring health equity in India. LE, followed by DALY rate and DR, is reported with the minimum interstate inequality in terms of both CV and GC among all health outcome variables. All of these variables measure the health status of the entire population in general. It is interesting to note that LE shows a higher value of CR (80 percent) than that of CV and GC among all outcome variables. This means that the gap between rich and poor states is highest concerning LE, while the average interstate disparities are minimal as measured by CV and GC. In this case, the results of CV and GC are more reliable since they utilize all the information contained in the sample, compared to CR, which is based solely on the difference between two extreme values in the sample. Therefore, in order to reduce interstate disparities in health status, the inequality in child and maternal health care needs to be addressed through appropriate policy measures by both the central and state governments in India.

The second dimension of health, classified as maternal health care services, includes the prevalence of anemia among pregnant women, institutional deliveries, deliveries conducted at home by skilled health personnel (SHP), and antenatal and postnatal care services. The table reveals that 47 percent of pregnant women in India suffer from anemia, which is very alarming, as poor maternal health may lead to both high maternal mortality rates and high infant mortality rates. The CV and GC values indicate that there are 10 and 19 percent inequalities in the incidence of anemia among mothers, respectively. The table

also shows that delivery care services are considerably better than other maternal care services, with a high rate of institutional deliveries (88 percent) and relatively low interstate disparity (CV = 14 percent and GC = 8 percent). However, antenatal care services show a significant degree of variation, as indicated by very high CV (59 percent) and GC (33 percent) values. Alarmingly, 72 percent of mothers do not have access to antenatal care services. For postnatal care services, 67 percent of mothers have access, with relatively low interstate variations.

The third dimension of health encompasses child healthcare services, including the percentage of anemic children, children receiving adequate diet, fully immunized children, and those receiving vitamin A. Malnutrition, as evidenced by the low percentages of children receiving adequate diet (10 percent) and vitamin A (64 percent), is a primary contributor to these disparities. Moreover, Table 1 reveals that a staggering 10 percent of Indian children receive an adequate diet, while 56 percent are anemic. This high prevalence of malnutrition and anemia among children, coupled with poor maternal care services, results in India's high infant mortality rate of 30 per thousand. Although child immunization services are relatively satisfactory compared to other child healthcare services, they still fall short of the 100 percent target. The poor state of maternal and child healthcare is a significant challenge hindering India's overall human development. Therefore, the government must prioritize the formulation and effective implementation of appropriate policies to ensure the delivery of these services to every mother and child.

The availability of sufficient and competent human resources and appropriate physical infrastructure are two essential prerequisites for effective healthcare service delivery. Consequently, human resources and physical infrastructure are identified as the fourth and fifth pillars of the health sector. This study categorizes government allopathic doctors, AYUSH doctors, nurses, and pharmacists under the fourth pillar. Disappointingly, India's healthcare system faces a severe and alarming shortage of human resources. For instance, there is only one government allopathic doctor for every 11,000 persons, compared to one AYUSH doctor for every 6,000 persons. Similarly, each nurse and pharmacist serves an average of 1,000 and 4,000 persons, respectively. Beyond the mere scarcity, significant inter-state disparities in the distribution of human resources, as indicated by high CV and GC values, are evident in India's health sector. The fifth pillar, physical infrastructure, encompasses the number of AYUSH hospitals, AYUSH dispensaries, sub-centers (SCs), primary health centers (PHCs), community health centers (CHCs), and beds in government and semi-government medical colleges and universities. Like human resources, there is a critical shortage and wide-ranging inter-state disparity in physical infrastructure. Table 1 reveals that an average of 802,700 and 59,000 persons are served by an AYUSH hospital and dispensary, respectively, with substantial inter-state variations. The average population covered by a CHC, PHC, and SC is 24,300, 225,000, and 95,000 persons, with inter-state variations of 54 percent, 367 percent, and 441 percent, respectively. The average population per bed in government-aided hospitals is 5,000, with a 70 percent inter-state variation. Similar disparities are reflected by the GC for various infrastructure indicators. Therefore, it can be argued that the insufficient availability of human resources and physical infrastructure, coupled with pronounced inter-state disparities in their distribution, is a primary factor contributing to the nation's poor health outcomes (Bajar and Rajeev, 2015).

5. EXPLAINING INTERSTATE HEALTH DISPARITIES: CLUSTER ANALYSIS

In this section, we have used the cluster analysis to explain the inter-state variations present in the different dimensions of health care sector. Cluster analysis efficiently categorizes the states in our sample on multi-dimensional scale as ‘best’, ‘average’ and ‘poor’ performing states and in this way it provides a simple method to explain and understand the dynamics interstate health disparities in India. The clusters are formed by minimizing the within cluster distance and maximizing the between cluster

distances in a way that the states falling within the same cluster have the minimum interstate variations. Table 2 explains the interstate disparities in health status. The results of ANOVA clearly demonstrate that each of health outcome variables significantly contributes in interstate disparities in health status in India. ANOVA results confirm the significant contribution of each health outcome variable to overall interstate health differences.Cluster-1 states (Delhi, Goa, Himachal Pradesh, Jammu & Kashmir, and Kerala) outperform cluster-2 and cluster-3 states across all health status indicators. For instance, cluster-1's average life expectancy of 72 years surpasses cluster-2's 69 years and cluster-3's 66 years. Similarly, cluster-1 states exhibit lower maternal and infant mortality rates. DALY rate, measuring the average burden of disability and premature death, is 0.20 years (or 2.5 months) for cluster-1, significantly lower than cluster-2 and cluster-3. This implies a cluster-1 resident loses 2.5 months of healthy life annually due to illness-related disability or premature death. Notably, even these top-performing states carry a substantial disease burden. Cluster-3 states represent the lowest performers across all health indices.

Table 2: Interstate disparities in Health status: Cluster analysis

Variable	Final Cluster centers			ANOVA	
	Cluster 1	Cluster 2	Cluster 3	F	P
Life expectancy (years)	72	69	66	9	.001
Disability adjusted life years (DALY)	0.20	0.25	0.27	91	.000
Death rate due to diseases (per 100000)	478	608	631	16	.000
Maternal mortality rate (per 100000 live births)	113	145	218	5	.015
Infant mortality rate (per 1000 live births)	17	28	39	13	.000
No of states in each cluster	5	10	8		

Cluster 1: Delhi, Goa, HP, J&K, Kerala

Cluster 2: AP, Chhattisgarh, Gujarat, Jharkhand, Maharashtra, Punjab, TN, Telangana, UK, WB

Cluster 3: Assam, Bihar, Haryana, Karnataka, MP, Odisha, Rajasthan, UP

Table 3: Interstate disparities in child health care: Cluster analysis

Variable	Cluster centers			ANOVA	
	Cluster 1	Cluster 2	Cluster 3	F	P
Anaemic children (%)	50	56	62	4	0.035
Fully immunized children (%)	87	68	**74**	20	0.000
Children receiving adequate diet (%)	15	8	7	5	0.014
Children receiving vitamin A (%)	70	**77**	52	19	0.000
No of states in each cluster	10	4	9		

Cluster 1: AP, Chhatisgarh, HP, J&K, Kerala, Odisha, Punjab, TN, Telangana, and WB

Cluster 2: Goa, Gujarat, Karnataka, and Maharashtra

Cluster 3: Assam, Bihar, Delhi, Haryana, Jharkhand, MP, Rajasthan, UP, and UK

Table 3 explains the interstate disparities in child healthcare services. The prevalence of anemia among children and malnutrition are significant at the 5 percent level, while child immunization and vitamin A intake are significant at the 1 percent level in distinguishing the states into three clusters. Cluster-1 states have relatively higher levels of child healthcare services compared to clusters 2 and 3. The inadequacy of child care services is underscored by the fact that even in best-performing cluster-1 states, 50 percent of children are anemic, 85 percent are undernourished, 30 percent of newborns lack vitamin A supplementation, and 13 percent of infants remain unvaccinated. When we look at the worst-performing states (i.e., cluster-3 states), the deficiency in child health care services increases drastically. In these states, 62 percent of children are anemic, 93 percent of infants do not receive an adequate diet, and 48 percent of children do not receive the vitamin A dose. Surprisingly, a poor level of child immunizations (68 percent) is reported in the states belonging to cluster-2 instead of cluster-3 (74 percent). Therefore, it can be said that the level of child healthcare services is not only inadequate in India but also unevenly distributed across the states (Ghosh, 2014).

Table 4 demonstrates that all of the maternal health care variables significantly contribute to the interstate disparities in maternal health care services. Only two states, viz. Goa and Kerala, are classified as having a high level of maternal health care services compared to the other states in our sample. The level of anemia among pregnant women is very low (25 percent) in these two states relative to the states belonging to cluster-2 and cluster-3. In cluster-1 states, 99 percent of institutional deliveries are conducted either by a doctor or other skilled health personnel. Apart from this, 62 and 90 percent of mothers receive antenatal and postnatal care services, respectively. It is interesting to note that Kerala appears in the category of best-performing states in terms of both maternal and child healthcare indicators (Iyengar and Dholakia, 2016). Consequently, Kerala has lower levels of infant and maternal mortality rates compared to other states. Further, the cluster analysis classified 11 states as average-performing states, and the remaining 10 states are categorized as poor-performing states in providing maternal health care services. In poor-performing states, 51 percent of pregnant women are anemic, only 72 percent of women benefit from institutional deliveries, only 13 percent of mothers receive antenatal care services, and only 56 percent of women have access to postnatal care services compared to the states belonging to cluster-1. Therefore, the comparison of cluster-1 and cluster-3 states depicts a clear picture of widespread disparities in maternal health care services across the states in India.

Table 4: Interstate disparities in maternal health care: Cluster analysis

Variable	Cluster centers			ANOVA	
	Cluster 1	Cluster 2	Cluster 3	F	P
Anaemic Pregnant women (%)	25	47	51	20	0.000
Institutional births (%)	98	89	72	23	0.000
Home delivery conducted by SHP (%)	0.95	3	6	9	0.002
Mothers having full antenatal care (%)	62	35	13	56	0.000
Mothers receiving postnatal care (%)	90	74	56	23	0.000
No of states in each cluster	2	11	10		

Cluster 1: Goa, Kerala

Cluster 2: AP, Delhi, Gujarat, HP, J&K, Karnataka, Maharashtra, Odisha, Punjab, TN, Telangana

Cluster 3: Assam, Bihar, Chattisgarh, Haryana, Jharkhand, MP, Rajasthan, UP, UK, WB

Table 5: Interstate disparities in human resources in health sector: Cluster analysis

Variable	Cluster centers			ANOVA	
	Cluster 1	Cluster 2	Cluster 3	F	P
Average population per allopathic doctor	10110	18520	28390	8	0.003
Average population per AYUSH doctor	2800	71870	750	250	0.000
Average population per pharmacist	2470	14210	24390	58	0.000
Average population per nurse	920	4050	5470	8	0.002
No of states in each cluster	21	1	1		

Cluster 1: Assam, AP, Chattisgarh , Delhi, Goa, Gujarat, Haryana, HP, J&K, Karnataka, Kerala, MP, Maharashtra, Odisha, Punjab, Rajasthan, TN, Telangana , UP, UK, WB

Cluster 2: Jharkhand

Cluster 3: Bihar

As far as human and physical capitals are concerned, substantial interstate disparities exist in India. This highlights a critical issue within the Indian healthcare system: the significantly low availability of human resources and physical infrastructure, coupled with substantial interstate variations. Tables 5 and 6 clearly illustrate this situation. Table 5 reveals that all human resource variables contribute significantly to interstate inequalities in human resource availability. Out of 23 states, 21 states fall into cluster-1, indicating that these 21 states have almost the same level of human resources. The remaining two states, Jharkhand and Bihar, are categorized in cluster-2 and cluster-3 respectively. On average, the cluster-1 states have one doctor per 1,000 persons, one AYUSH doctor per 2,800 persons, one pharmacist per 2,470 persons, and one nurse per 920 persons. This signifies that even in the best-performing states, the availability of human resources is insufficient and unsatisfactory. The situation is worst in the case of Bihar, where only one allopathic doctor is available for 28,390 persons. However, Bihar has the highest availability of AYUSH doctors, with one doctor per 750 persons, among all three clusters, while it has the lowest availability of other human resources. On the other hand, cluster-2, which includes only Jharkhand, performs well in terms of the availability of allopathic doctors, pharmacists, and nurses relative to cluster-3. However, in the case of the availability of AYUSH doctors, it is in a ten times worse situation compared to cluster-3. Based on this fact, it can be said that the availability of human resources is not only considerably low but also misallocated across various states in India (Taqi et al., 2017). Thus, India faces the challenge of maintaining adequate levels, skill mix, quality, and distribution of human resources for health across states, especially in poorer rural areas (Dussault and Franceschini, 2006). Over a million rural practitioners serve these areas, many of whom are not formally trained or licensed**.** Since the most disadvantaged are more likely to receive treatment from less qualified providers, the poor quality of India's health human resources poses an additional obstacle to ensuring equity in the healthcare sector (Reddy et al., 2011).

Table 6: Interstate disparities in health infrastructure: Cluster analysis

Variable	Cluster centers			ANOVA	
	Cluster 1	Cluster 2	Cluster 3	F	P
Average population per AYUSH hospital	1323560	5960380	12691000	55	0.000
Average population per AYUSH dispensary	55730	69930	46680	0.202	0.818
Average population per CHC	226440	213650	676840	11	0.001
Average population per PHC	49940	721340	53460	2	0.241
Average population per sub-centre	7680	340830	10200	1	0.253
Average population per bed in Govt. Hospital	4130	4990	14170	6	0.008
No of states in each cluster	16	6	1		

Cluster 1: Chhattisgarh, Goa, Gujarat, Haryana, HP, Karnataka, Kerala, MP, Maharashtra, Odisha, Punjab, Rajasthan, TN, Telangana, UP, UK

Cluster 2: AP, Assam, Delhi, J&K, Jharkhand, WB

Cluster 3: Bihar

Table 7: Interstate health disparities in India based on un-weighted health indices: Cluster analysis

Variable	Cluster centers			ANOVA	
	Cluster 1	Cluster 2	Cluster 3	F	P
Health status index	0.76	0.38	0.21	17.162	0.000
Child health care index	0.57	0.47	0.28	4.189	0.030
Maternal health care index	0.61	0.47	0.24	12.091	0.000
Human resource index	0.94	0.85	0.51	15.268	0.000
Infrastructure index	0.84	0.84	0.65	4.247	0.029
Health expenditure index	0.61	0.23	0.07	21.591	0.000
No of states in each cluster	5	14	4		

Cluster 1: Delhi, Goa, HP, J&K, Kerala

Cluster 2: AP, Assam, Chhattisgarh, Gujarat, Haryana, Karnataka, Maharashtra, Odisha, Punjab, Rajasthan, TN, Telangana, UK, WB

Cluster 3: Bihar, Jharkhand, MP, UP

From Table 6, it is evident that health infrastructure variables such as AYUSH hospitals, beds in government and government-aided medical colleges, and community health centers (CHCs) significantly contribute to inter-state disparities in health infrastructure, as indicated by statistically significant F-values. On the other hand, AYUSH dispensaries, primary health centers (PHCs), and sub-centers (SCs) play a statistically insignificant role in inter-state health inequality. Health infrastructure not only displays substantial interstate disparities but also indicates a poor level of availability across the country. Even in the cluster-1 states, which are characterized as the best-performing states, the availability of health infrastructure falls far below international standards. As per WHO norms CHCs, PHCs, and SCs should cater to populations of 80-120 thousand, 20-30 thousand, and 3-5 thousand respectively in geographically plain areas (different norms apply for mountainous terrain and tribal areas). Against this, even in the best performing states of India (e.g. cluster 1 states) 1,323 thousand persons are covered by one AYUSH hospital. The average populations per bed and per CHC are 4 thousand and 226 thousand persons, respectively. Bihar is reported as the poorest state in India in terms of health infrastructure. The low level of health infrastructure, accompanied by low quality and inadequate availability of human resources (Sharma et al., 2016), constrains the efficient and adequate delivery of healthcare services, resulting in low health status for the masses in India.

Table 7 categorizes Indian states into best, average, and poor performing groups based on five dimensions of health status, providing an overview of interstate health disparities. Delhi, Goa, Himachal Pradesh, Jammu and Kashmir, and Kerala constitute the best-performing group across all five indices. These states exhibit significantly higher health index values compared to clusters 2 and 3, suggesting relatively greater human and physical capital investment in the health sector. This translates to more efficient child and maternal healthcare delivery, thereby improving overall health status. For instance, the health status index for this group is 0.76, substantially higher than cluster 2 (0.38) and cluster 3 (0.21).The lower health status indices of clusters 2 and 3 can be attributed to poor physical infrastructure, human resource availability, and healthcare service delivery, as reflected by lower CI, MI, HI, and II index values. Notably, Bihar, Jharkhand, Madhya Pradesh, and Uttar Pradesh are consistently ranked as the worst performers across all health care aspects (Anand, 2014). Furthermore, all five health dimensions analyzed in this study significantly contribute to interstate disparities in both health outcomes and inputs.

6. DETERMINANTS OF INTERSTATE HEALTH DISPARITIES

Table 8 shows the correlation between various health indices taken in this study. The correlations of HSI with CHI (0.47) and MHI (0.705) are found to be statistically significant. However, the associations of the HRI and II with the health status index are found to be statistically insignificant. HSI includes IMR and MMR, which directly depend on the availability of child and maternal health care services. The improvement in these services significantly reduces the magnitude of IMR and MMR, which consequently increases the health status. Therefore, the positive correlation of HSI with CHI and MHI may be established through IMR and MMR. Further, it is also found that CHI is positively and significantly associated with MHI; however, the correlation of CHI with other health indices is found to be statistically insignificant. The strong and positive correlation between CHI and MHI may be due to the fact that most child and maternal health care services are complementary goods in nature. For instance, an increase in institutional delivery implies that all infants born through institutional deliveries receive proper child care services immediately after birth. Moreover, an increase in pre- and post-natal care services also reduces the risk and magnitude of infant mortality. Further, MHI is strongly and positively correlated with HRI, which implies that a relatively higher availability of human resources engaged in health services results in the effective delivery of maternal care services.

Table 8 also shows that HRI and II are significantly and positively correlated. Since HRI is based on human inputs and II is based on physical infrastructure, a proportionate supply of human resources is required to fully utilize the available physical infrastructure. In other words, a relatively high level of physical infrastructure requires a proportionately large volume of human resources for proper utilization. Therefore, an increase or decrease in human resources with an increase or decrease in physical infrastructure is natural.

Table 8: Inter-relationship between health indices: Correlation analysis

Variables	HSI	CHI	MHI	HRI	II
Health Status Index (HSI)	1	0.469*	0.705***	0.384	-0.023
Child health Index (CHI)		1	0.652***	0.358	0.360
Maternal health Index (MHI)			1	0.593**	0.365
Human resource index (HRI)				1	0.524*
Infrastructure index (II)					1

* p < .05, ** p < .01, *** p < .001

Table 9 explores the determinants of various health indices using regression analysis. The findings indicate that per capita health expenditure (PCHE) by the government positively and significantly impacts the Health Status Index (HSI), Maternal Health Index (MHI), Human Resource Index (HRI), and the overall health index (Dwivedi and Pradhan, 2017). This suggests that states investing more in health services tend to achieve higher health indices, reflecting better health outcomes and performance (Gumber, 2023). Additionally, the disparity in per capita income has emerged as a crucial determinant of interstate health disparities. States with higher per capita incomes generally show significant improvements in overall health performance (Gupta and Mitra, 2004), highlighting the importance of economic well-being in enhancing public health. The analysis also reveals that the prevalence of poverty exacerbates the disparities in health performance across Indian states (Balarajan et al. 2011). Poorer states face greater challenges in achieving higher health indices, indicating that poverty is a significant barrier to health equity. Furthermore, increases in the literacy rate contribute positively to reducing overall health disparities. Higher literacy rates are associated with better health outcomes, as educated populations are more likely to engage in health-promoting behaviors and access health services effectively (Bayati et al 2018). Therefore, it can be said that to achieve overall health equity across the Indian states, policymakers should focus on reducing disparities in government health expenditure, per capita income, and education. Investing in these areas can lead to more equitable and improved health outcomes across regions.

Table 9: Determinants of inter-state health disparities: Regression Analysis

	Independent variables			
Dependent variables	PCHE by Govt.	Per capita GSDP	Poverty ratio	Literacy rate
Health Status Index (HSI)	0.551***	0.683***	-0.722	0.705***

Child health Index (CHI)	0.192	0.030	0.227	0.347
Maternal health Index (MHI)	0.503**	0.636***	-0.658***	0.631***
Human resource index (HRI)	0.421**	0.457**	-0.606***	0.583***
Infrastructure index (II)	0.270	-0.008	-0.321	0.219
Overall heath Index	0.540***	0.532***	-0.709***	0.702***

* $p < .05$, ** $p < .01$, *** $p < .001$

7. POLICY IMPLICATIONS

From the findings of this study, the following policy implications can be drawn: First, it has emerged that disparities in health outcomes across states are the result of inadequate availability of human resources and physical infrastructure in India's health sector. These resources are not only insufficient but also misallocated across various states. For example, Bihar and Jharkhand have the highest availability of allopathic and AYUSH doctors, respectively, but suffer from poor physical infrastructure. Therefore, a policy is required that increases the availability of human and physical capital in optimal combinations, best suited to the specific requirements of each state. Second, the study also indicates that widespread disparities in child health care services pose a serious threat to India's future growth potential. Poor child health not only reduces the quality and productivity of the future labor force but also burdens the country with increased health expenditures that could otherwise be invested productively. Therefore, disparities in child health care services require the immediate attention of the government, to be addressed with appropriate policy interventions. To a great extent, the health of children depends on the health of mothers; thus, increasing the quantity and improving the quality of maternal health care services can significantly enhance children's health. Third, Goa and Kerala have emerged as the best-performing states across all five dimensions of health examined in this study. The governments of average- and poor-performing states can learn many lessons from these two states when designing policies aimed at improving the health status of their populations. Fourth, by increasing levels of per capita income and education, states can improve their health indices, as both of these variables have a positive impact on overall health performance. Increased per capita income facilitates direct access to private healthcare services and reduces dependence on government services. A policy measure targeted at reducing poverty by increasing the productivity of the population is an appropriate intervention for achieving high-quality health outcomes. Similarly, a high prevalence of education among the population encourages health-promoting behaviors and effective access to health services. Finally, the study finds that increased government expenditure on health is positively associated with health status, and health status is positively associated with productivity. Increased public expenditure may help reduce interstate health disparities without hampering productivity.

8. CONCLUSION

The existence of widespread economic disparities gives rise to socio-economic disparities, including those in health, education, and infrastructure. Among these, health disparity is one of the biggest challenges in achieving overall human development and happiness. Utilizing the most recent cross-sectional data on various health indicators, this paper addresses interstate health disparities across five dimensions: health status, child health care, maternal health care, physical infrastructure, and human resources. Cluster analysis reveals that four states—Bihar, Jharkhand, Madhya Pradesh, and Uttar Pradesh—perform poorly in terms of health outcomes and health inputs, which emphasizes the need for targeted interventions in these states. The analysis also indicates that all five dimensions of health

(i.e., the health status index, child healthcare index, maternal healthcare index, human resource index, and infrastructure index) significantly contribute to interstate disparities in health outcomes and inputs. It implies that addressing health disparities demands a holistic strategy that considers various interconnected determinants. Additionally, the results of regression analysis suggest that increasing per capita health expenditure, per capita income, and literacy rates can significantly reduce overall disparities in health across states. These factors play a crucial role in enhancing health outcomes and promoting health equity. Conversely, states with high poverty rates tend to have significantly lower levels of health indicators. This relationship between poverty and poor health outcomes indicates that poverty alleviation should be a central component of strategies aimed at reducing health disparities. Policymakers should focus on these areas to foster more equitable and improved health outcomes across regions.

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A Fuzzy Transportation Model for Cost-Effective Inventory Management Using Trapezoidal Fuzzy Numbers

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ABSTRACT

Uncertainty of demand, supply, and production costs is a major challenge in the efficient management of inventory in a dynamic business environment. Traditional approaches do not consider the imprecise nature of those variables and lead to suboptimal decisions. In this research paper, a new approach to optimization under uncertainty, using trapezoidal fuzzy numbers, has been developed within a framework of a fuzzy transportation problem. The study focuses on reducing production and inventory costs across multiple periods, incorporating both regular and overtime production capacities.

It then presents the application of a fuzzy number to define the trapezoidal members of the fuzzy sets to obtain fuzzified demand, production capacities, and costs because this captures their inherent vagueness. Defuzzification uses the centroid method again to convert these fuzzy parameters into crisp values to be used for actual decision-making purposes. Finally, the model emphasizes applying the transportation model regarding the efficient allocation of production in order to meet the demand at the lowest possible cost.

To illustrate this proposed model, a case study of a retail chain that faces uncertain demand for electronic gadgets is performed. The results are shown in which it proves how the company can reduce their cost with fuzzy optimization techniques much more than that of a traditional crisp model, thus proving the efficacy of the fuzzy transportation problem in handling uncertainty. This research therefore supports the fact that fuzzy logic can indeed provide better decision-making for the complexity of inventory management and comes with a scalable solution for business running under uncertain conditions.

KEYWORDS

Fuzzy Transportation Problem, Trapezoidal Fuzzy Numbers, Inventory Management, Defuzzification, Cost Minimization

INTRODUCTION

Successful operations in today's competitive markets require effective management of inventory. Indeterminate demand, supply, and cost of production are only a few examples that confuse managers or put them at unknown waters when it comes to predicting which parameter will show its impact when other parameters are kept constant. With classic models for inventory being based on the assumption that parameters have fixed values, often unreal in real scenarios in which data is often imprecise or vague, it becomes a test of time for managers to dare determine the uncertainty. Fuzzy logic, especially trapezoidal fuzzy numbers, gives the challenge a stronger tool to deal with the uncertainty. The paper discusses the applicability of a fuzzy transportation model that could be applied to optimize the management of inventories under uncertain conditions. Trapezoidal fuzzy numbers in the framework of the transportation problem may help reduce inventory costs according to vague production capabilities and demand fluctuations.

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Thus, it means that fuzzy logic might be useful in optimal models of inventory control so that businesses may make better decisions when considering a range of possible outcomes rather than fixed data points. Some parameters, for example, demand, production capacity, and cost, representing uncertain ones, are applied with the help of trapezoidal fuzzy numbers to make the decisions more flexible in this paper. This paper presents a fuzzy transportation model in the context of inventory management and demonstrates the effectiveness of the model through a simulated case study, comparing the results with the usual crisp models.

LITERATURE REVIEW

Concepts of inventory management have undergone several changes over the years, along with models and techniques developed to combat various problems. One of the early approaches to managing inventories was an application of the EOQ model, emphasizing the minimization of total costs associated with ordering and holding inventory. But the model, like many other classical ones, assumed ideal conditions of data, consequently leaving real-life uncertainties unaccounted for.

In 1965, Zadeh introduced fuzzy set theory, which enabled a practical way of dealing with such imprecisions. Since then, applications of fuzzy logic and fuzzy numbers have been applied in many problems-from inventory control. Fuzzy numbers in particular have gained popularity in decision-making models because they can represent data that are not crisp. Hsieh (2002) also optimized fuzzy production inventory models as approaches for minimizing uncertainties within the productions as well as the demands, thereby introducing new feasibility of enhancing more effective and efficient inventory management tools. The study also emphasized integration of fuzzy logic with inventory decision-making along with ways on how to better enhance the overall efficiency and effectiveness. Fuzzy transportation problems, started in logistics and distribution, since have been developed into numerous other more optimization problems. Chanas and Kuchta (1996) were among the first authors to apply fuzzy logic to the transportation problem, showing how fuzzy numbers may be used in order to model uncertain transportation costs. Later research also included Singh et al. and Tang et al. (1999). The latter treated the problems and uncertainties which occur in production and inventory management by introducing a fuzzy approach for modeling such phenomena. They concentrated their methodology on the betterment of planning precision and elasticity to boost efficiency in general production. The new approach postulated by Kaur and Kumar (2012) resolves the fuzzy transportation problem through generalized trapezoidal fuzzy numbers. In this regard, uncertainty within traditional transportation models will be better represented, thereby being an extension of it in terms of the generalization of supply chain decision-making processes. Diaz et al. (2014) brought forward the idea of merging fuzzy transportation methods into inventory and supply chain management methods; this provides a more robust methodology for solving uncertain cost and demand conditions.

There are very limited numbers of research focused on the optimization using trapezoidal fuzzy numbers. As an example, Kumar and Kaur applied trapezoidal fuzzy numbers to production planning to exemplify how they may be useful when incorporating multi-period fluctuations in demand. There is a vast amount of research on fuzzy logic and inventory management however the existence of research specifically applying fuzzy transportation models to optimize inventory is relatively scarce. This study contributes to the literature by incorporating trapezoidal fuzzy numbers into a transportation problem framework for inventory management, which presents a new methodology in cost minimization in uncertain environments. This paper by Singh and Sharma uses fuzzy AHP and extent analysis to select competitive supply chains, which further enhanced the decision-making paradigm. Their approach has illustrated how fuzzy logic can be utilized in prioritizing criteria as well as alternatives with sound implications on supply chain performance.

He devised an easy approach for solving a fuzzy transportation problem using a generalized trapezoidal fuzzy number. His concept goes toward the simplification of transport decision-making by streamlining the process with proper management of uncertainty on both the cost and supply side. Chandran and Kandaswamy (2016) presented a fuzzy approach to optimize transportation network problems in which the transportation costs were also uncertain along with the demand. Their approach included fuzzy logic to enable enhanced decision-making in the supply chain management. Applying the fuzzy logic made the transportation problems more flexible and manageable by giving a more robust framework. It also pointed out the potential as portrayed by fuzzy models in optimization outcomes relative to traditional models. Muruganandam and Srinivasan (2016) propose a novel algorithm for solving fuzzy transportation problems with trapezoidal fuzzy numbers. They aimed at applying the methodology to computationally assist decision making in transportation logistics under uncertainty. Shekarian et al. (2017) conducted an in-depth review of fuzzy inventory models, discussing their applications and methodologies for dealing with uncertainties in inventory systems. A case emerged wherein fuzzy logic is particularly crucial for optimizing inventory stock levels for maximized optimization.

Das, Bera, and Maiti (2018) discussed the defuzzification methods of trapezoidal type-2 fuzzy numbers in transportation problems relating to green solid transportation. One of the significant points of their research is that environmental concerns should be bound up with transportation planning, and uncertainty cannot be avoided. The article by Guo et al. (2018) presented a review of the process of inventory management for mass customization activities. The issue of variability in demand and production was highlighted while discussing business challenges. The study also brought out the fact that there was a need to have adaptive strategies and advanced techniques to get the optimum level of inventory while fulfilling all customer-specific requirements. Deb, Kaur, and Sarma developed a fuzzy approach for designing decision support systems for control and management of inventory in 2019. Their contribution emphasized the utility of fuzzy logic to improve accuracy and effectiveness under uncertainty in decision-making involving inventory management. Kamal et al. (2021) addressed a multi-objective transportation problem with type-2 trapezoidal fuzzy numbers and parameter estimation with goodness of fit.

Using the proposed technique, the investigators demonstrated that this method optimizes transportation decisions effectively, apart from managing the uncertain cost and demand parameters. The authors, Chakraborty et al. (2021), presented a new approach for representation, ranking, and defuzzification specifically designed for applications in the context of inventory management under a new scenario of hexagonal fuzzy numbers. The results highlighted the effectiveness of hexagonal fuzzy models in optimizing production inventory decisions in uncertain conditions. Kané et al. have proposed a new algorithm for solving fuzzy transportation problems, which utilized the trapezoidal fuzzy numbers, as adapted in their proposed mechanism for solving fuzzy transportation problems under uncertainty. Their approach was to enhance the effectiveness of transporting decisions by utilizing the strategy of fuzzy logic in the ability to tackle variability in costs and demand conditions. Actually, Akila and Raveena proved toward solutions for fuzzy transportation problems using trapezoidal fuzzy number, upgrading the basic models in transporting with respect to uncertain transportation cost.

Improvements that can be made towards the decision issues of logistics and supply chains were confirmed through the use of trapezoidal fuzzy numbers. Prabhavati and Ravindranath (2022) proposed a straightforward and time-effective procedure for solving fully interval and fuzzy transportation problems. Their approach sought to exploit the accuracy and effectiveness of transport logistics using interval and fuzzy techniques in handling uncertainties of supply and demand. The introduction of fuzzy logic as well as trapezoidal fuzzy numbers has greatly enhanced the evolution of inventory management by handling uncertainty inherent in decisions of supply chain and transportation.

Many of these methods have been proven to optimize the level of inventory and transportation cost as well as account for real-world variability. With the vast growth that the field is experiencing, further research on fuzzy models may improve the operational efficiency and adaptability, which will further respond to the complex nature of their environment. This paper will contribute to this body of knowledge by developing innovative approaches in inventory optimization based on fuzzy transportation frameworks.

Numerical Simulation

EcoMart is a large retail chain that sells electronic gadgets. They face uncertain demand due to changing customer preferences, technological advancements, and competition. EcoMart divides the year into four quarters and must decide how many units of a specific gadget to produce or order for each quarter to minimize costs. Both regular production and overtime production options are available, but regular production is cheaper. Overtime production incurs additional costs due to overtime wages and machine wear. Due to uncertainty in demand, production capacity, and costs, all data is represented using trapezoidal fuzzy numbers.

The goal is to determine the optimal number of gadgets to produce in each quarter while minimizing total production and inventory costs.

Data (in trapezoidal fuzzy numbers):

1. Fuzzy demand (in units) for each quarter:

Q1: D1=(900,1000,1100,1200); Q2: D2=(850,950,1050,1150);

Q3: D3=(1000,1100,1200,1300) ; Q4: D4=(950,1050,1150,1250)

2. Fuzzy regular production capacity (in units per quarter):

Q1: Preg1=(800,850,900,950) ; Q2: Preg2=(750,800,850,900)

Q3: Preg3=(900,950,1000,1050) ; Q4: Preg4=(850,900,950,1000)

3. Fuzzy overtime production capacity (in units per quarter):

Q1: Pot1=(100,150,200,250); Q2: Pot2=(100,150,200,250)

Q3: Pot3=(150,200,250,300); Q4: Pot4=(150,200,250,300)

4. Fuzzy regular production cost (in dollars per unit):

Q1: Creg1=(20,22,24,26) ; Q2: Creg2=(21,23,25,27)

Q3: Creg3=(19,21,23,25); Q4: Creg4=(22,24,26,28)

5. Fuzzy overtime production cost (in dollars per unit):

Q1: Cot1=(30,32,34,36) ; Q2: Cot2=(31,33,35,37)

Q3: Cot3=(29,31,33,35); Q4: Cot4=(32,34,36,38)

Objective:

EcoMart needs to minimize the total production costs (regular and overtime) while meeting the fuzzy demand in each quarter. The company should decide how many gadgets to produce under regular production and how many under overtime production, considering the uncertain demand, production capacity, and costs.

Solution to Inventory Management Problem Using a Fuzzy Transportation Table

To solve this inventory management problem using a fuzzy transportation approach, this study follow the steps of defuzzification, applying fuzzy transportation principles to allocate production based on demand, and finally forming the transportation table.

Step 1: Defuzzification of Trapezoidal Fuzzy Numbers

This study used the centroid method to convert the trapezoidal fuzzy numbers into crisp values by averaging the four points of each trapezoidal number.

1. **Defuzzify the demand in each quarter:**

Q1 Demand: D1= (900,1000,1100,1200) = 1050 units

Q2 Demand: D2= (850,950,1050,1150) = 1000 units

Q3 Demand: D3= (1000,1100,1200,1300) = 1150 units

Q4 Demand: D4= (950,1050,1150,1250) = 1100 units

2. **Defuzzify regular and overtime production capacities:**

Regular Production (Q1): Preg1=(800,850,900,950) =875 units

Overtime Production (Q1): Pot1=(100,150,200,250)= 175 units

Similarly,

Quarter	Regular Production Capacity (Units)	Overtime Production Capacity (Units)
Q1	875	175
Q2	800	175
Q3	950	225
Q4	900	225

3. Defuzzify the costs:

Regular Production Cost (Q1): Creg1= (20,22,24,26) = 23 dollars/unit

Overtime Production Cost (Q1): Cot1=(30,32,34,36) = 33 dollars/unit

Similarly,

Quarter	Regular Production Costs(dollars/Unit)	Overtime Production Costs(dollars/Unit)
Q1	23	33
Q2	24	34
Q3	22	32
Q4	25	36

Decision Variables

Let:

- Xq,r: Number of units produced using **regular production** in quarter q
- Xq,o: Number of units produced using **overtime production** in quarter q

Where q=1,2,3,4 represents each quarter.

Objective Function

The goal is to minimize total production costs:

$$\text{Minimize } Z = \sum_{q=1}^{4} (C_{regq} \cdot X_{q,r} + C_{otq} \cdot X_{q,o})$$

Constraints

Demand Satisfaction:

For each quarter, ensure that the total production (regular + overtime) meets or exceeds demand:

$$X_{q,r} + X_{q,o} \geq D_q, \quad \forall q \in \{1, 2, 3, 4\}$$

This can be broken down into:

$$\text{For Quarter 1: } X_{1,r} + X_{1,o} \geq 1050$$

$$\text{For Quarter 2: } X_{2,r} + X_{2,o} \geq 1000$$

$$\text{For Quarter 3: } X_{3,r} + X_{3,o} \geq 1150$$

$$\text{For Quarter 4: } X_{4,r} + X_{4,o} \geq 1100$$

Production Capacity:

The total production (regular + overtime) should not exceed the available capacity:

$$X_{q,r} \leq P_{regq}, \quad \forall q \in \{1, 2, 3, 4\}$$

$$X_{q,o} \leq P_{otq}, \quad \forall q \in \{1, 2, 3, 4\}$$

Non-negativity Constraints:

All decision variables must be non-negative:

$$X_{q,r} \geq 0, \quad X_{q,o} \geq 0, \quad \forall q$$

Corresponding Transportation Table for Production and Demand Fulfilment

	Manufacturing / Supply	Q1	Q2	Q3	Q4	Total Supply
Q1	R1	23	23	23	23	**875**
	O1	33	33	33	33	**175**
Q2	R2	M	**24**	**24**	**24**	**800**
	O2	M	**34**	**34**	**34**	**175**
Q3	R3	M	M	**22**	**22**	**950**
	O3	M	M	**32**	**32**	**225**
Q4	R4	M	M	M	**25**	**900**
	O4	M	M	M	**36**	**225**
Demand		1050	1000	1150	1100	

Balanced **Transportation Table for Production and Demand Fulfilment**

	Manufacturing / Supply	Q1	Q2	Q3	Q4	Dummy	Total Supply
Q1	R1	23	23	23	23	0	**875**
	O1	33	33	33	33	0	**175**
Q2	R2	M	**24**	**24**	**24**	0	**800**
	O2	M	**34**	**34**	**34**	0	**175**
Q3	R3	M	M	**22**	**22**	0	**950**
	O3	M	M	**32**	**32**	0	**225**
Q4	R4	M	M	M	**25**	0	**900**
	O4	M	M	M	**36**	0	**225**
Demand		1050	1000	1150	1100	25	

Solution Table Using Excel Solver

	Manufacturing / Supply	Q1	Q2	Q3	Q4	Dummy	Total Supply
Q1	R1	850	25	0	0	0	875
	O1	175	0	0	0	0	175
Q2	R2	0	800	0	0	0	800
	O2	0	175	0	0	0	175
Q3	R3	0	0	950	0	0	950
	O3	0	0	200	25	0	225
Q4	R4	0	0	0	900	0	900
	O4	25	0	0	175	25	225
Demand		1050	1000	1150	1100	25	Min cost= $1,32,950

Corresponding Fuzzy Solution

	Manufacturing / Supply	Q1	Q2	Q3	Q4	Dummy	Total Supply
Q1	R1	**(825, 837.5, 862.5, 875)**	**(0, 12.5, 25, 37.5)**	(0,0,0,0)	(0,0,0,0)	(0,0,0,0)	**(825, 837.5, 862.5, 875)**
	O1	**(150, 162.5, 187.5, 200)**	(0,0,0,0)	(0,0,0,0)	(0,0,0,0)	(0,0,0,0)	**(150, 162.5, 187.5, 200)**
Q2	R2	(0,0,0,0)	**(775, 787.5, 800, 825)**	(0,0,0,0)	(0,0,0,0)	(0,0,0,0)	**(775, 787.5, 800, 825)**
	O2	(0,0,0,0)	**(150, 162.5, 175, 200)**	(0,0,0,0)	(0,0,0,0)	(0,0,0,0)	**(150, 162.5, 175, 200)**
Q3	R3	(0,0,0,0)	(0,0,0,0)	**(925, 937.5, 962.5, 975)**	(0,0,0,0)	(0,0,0,0)	**(925, 937.5, 962.5, 975)**
	O3	(0,0,0,0)	(0,0,0,0)	**(175, 187.5, 212.5, 225)**	**(0, 12.5, 37.5, 50)**	(0,0,0,0)	**(200,212.5,237.5,250)**
Q4	R4	(0,0,0,0)	(0,0,0,0)	(0,0,0,0)	**(875, 887.5, 912.5, 925)**	(0,0,0,0)	**(875, 887.5, 912.5, 925)**
	O4	25	(0,0,0,0)	(0,0,0,0)	**(150, 162.5, 187.5, 200)**	**(0, 12.5, 37.5, 50)**	**(200,212.5,237.5,250)**
Demand		**(900, 950, 1000, 1200)**	**(850, 950, 1050, 1150)**	**(1000, 1100, 1200, 1300)**	**(950, 1050, 1150, 1250)**	**(0, 12.5, 37.5, 50)**	Min cost= **$(132,000,132,400,132,800,133,200)**

Fuzzy Interpretation of the Final Table and Allocations

The allocations from the fuzzy transportation table can be interpreted with trapezoidal fuzzy numbers, which account for uncertainty in production capacities, costs, and demands. Below are the fuzzy allocations and the corresponding costs:

Fuzzy Allocations from the Transportation Table:

1. From Regular Production:

Q1:

From R1: (825, 837.5, 850, 875) to Q1 (Defuzzified to 850 units)

From O1: (150, 175, 200, 250) to Q1 (Defuzzified to 175 units)

Q2:

From R2: (750, 775, 800, 825) to Q2 (Defuzzified to 800 units)

From O2: (150, 175, 200, 250) to Q2 (Defuzzified to 175 units)

Q3:

From R3: (900, 925, 950, 975) to Q3 (Defuzzified to 950 units)

From O3: (200, 225, 250, 275) to Q3 (Defuzzified to 200 units) and (25, 50, 75, 100) to Q4 (Defuzzified to 25 units)

Q4:

From R4: (850, 875, 900, 925) to Q4 (Defuzzified to 900 units)

From O4: (0, 25, 50, 75) to Q1 (Defuzzified to 25 units) and (150, 175, 200, 225) to Q4 (Defuzzified to 175 units)

Fuzzy cost: $ (132,000,132,400,132,800,133,200)

Total Cost Across All Quarters

Total Cost in crisp environment=25,325+25,150+27,300+28,800= $106,575

LIMITATIONS

The use of fuzzy trapezoidal numbers is quite beneficial but there are several limitations related to them. The computation for results is pretty complex as fuzzy logic is a concept that one has to explore more about and may even complicate the decision by users who do not have a good hold on the concept. There is also subjectivity related to the method used in defuzzification, as different methods might give different crisp values. Moreover, fuzzy models are not useful for every situation especially for sectors where data are precise and straightforward. Fuzzy analysis's reliance on the accuracy of input data is very high, and so poor estimates can potentially damage the reliability of the results.

SUGGESTIONS

Implementation of robust data collection systems will thus enhance the accuracy and relevance of parameters. Continuous validation of the parameters will ensure them to be in line with the change in the market scenario. Pilot studies, therefore, can be done before the massive implementation of fuzzy methods to validate them against the traditional methods regarding practical applicability.

CONCLUSION

In conclusion, although the fuzzy cost is more than the crisp cost, it better represents uncertainty and variability in the retail environment. The fuzzy approach enhances decision-making by preparing EcoMart for different demand scenarios, which may result in better overall business performance in the long run. Therefore, even though the on-the-spot costs appear to be higher, the benefits related to flexibility, risk management, and strategic production planning may balance out these and result in a more sustainable and responsive business model. This methodology, therefore, enables better decision-making based on sound judgments and yields better efficiency and reduced cost in production planning. Fuzzy trapezoidal numbers give strength to the organization in dealing with dynamic market conditions and customer preferences, which may not be covered by crisp models because of their failure in incorporating uncertainties.

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Growth Maximising External Debt and Sustainable Development Goals: A Special Case of India

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Abstract

In today's era of economic competition, most economies are impatient to achieve higher economic growth, leaving behind the concern of sustainable development goals adopted by the UN (United Nations). Out of 17 goals, goal No.8 is about decent work and economic growth, and its target is to achieve a 7 per cent annual growth rate of Gross Domestic Product. One of the main factors in achieving this objective is the amount of debt an economy exhibits. The present paper is concerned with the debt growth relation, which primarily signifies the level of external debt with particular reference to the Indian economy. A non-linear regression analysis has been carried out to determine theof debt impacting economic growth positively and a turning point after which it will negatively affect economic growth. The findings indicate that about 23.9 per cent of the external debt to GDP ratio is manageable to sustain a strong pace of economic growth. The results are in line with the hypothesis of the Debt-Laffer curve, which is an inverted U-shaped curve. The curve shows that debt is good up to a certain level. After that, it will adversely affect the growth of the economy.

Keywords: Economic Growth, External Debt, Non-linear, Sustainable Development Goals.

1. INTRODUCTION

Sustainable Development Goal 8 - 'Decent Work and Economic Growth' is emphasized in Indicator 8.1: 'Annual growth of real GDP per capita.' This indicator is a fundamental measure of economic health and prosperity, reflecting how well an economy performs in terms of growth relative to its population size. However, achieving sustained economic growth is not always straightforward. External debt plays a substantial part in this dynamic. When countries face high levels of external debt, a substantial portion of their national revenue is often diverted to debt servicing. This financial strain can undermine their ability to invest in critical areas such as infrastructure, education, and healthcare, all essential for fostering economic growth.

In essence, while Indicator 8.1 measures the per capita GDP growth rate, foreign debt can impact this growth rate by limiting the resources available for development and economic expansion. Addressing and managing external debt effectively is therefore vital for ensuring that economies can achieve sustainable growth and advance the livelihoods of their population. To some extent, external debt is considered beneficial for economic growth and development, as supported by several studies (Bal & Rath, 2014; Fincke & Greiner, 2015; Siddiqui & Malik, 2001; Zuhroh & Pristiva, 2022; Dawood et al., 2020). However, after a threshold point, it can harm economic growth. Several studies found only an adverse relation between foreign debt and economic growth (Barik & Sahu, 2022; Manik & Khan, 2018; Quddus & Hameed, 2020; AL-Tamimi & Jaradat, 2019; Adhikari, 2023; Ale et al.,2022; Aloulou et al.,2023). Hence, it is crucial in the instance of the Indian economy to examine this relationship to find the expanse of debt that is beneficial for the economic prosperity of the Indian economy. The problem of external debt must be managed to moderate its harmful economic effects. It can be challenging for the Indian economy as well; India also takes a massive amount of loans from external sources. "External debt in India in South Asia is highest among other countries" (Zuhroh & Pristiva, 2022).

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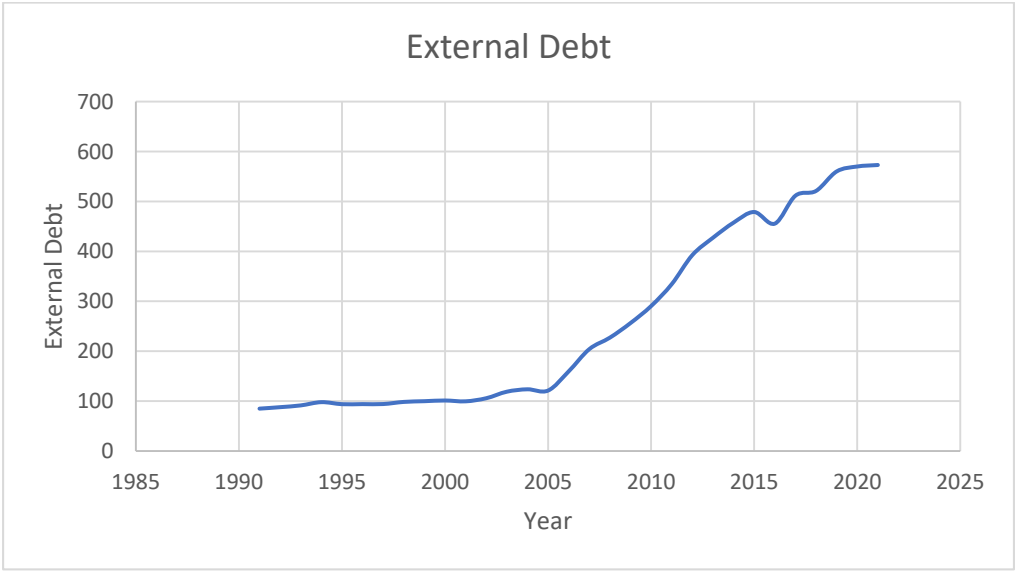
Nevertheless, the threshold point depends on country-specific financial, political, geographical, and economic conditions. It is likewise necessary to analyze the trends of external debt in India. The trends and their ratio to GDP can provide valuable and necessary insights:

Table 1 Trends and External Debt - GDP Ratio

(In US Billion Dollars & Percentage)

Sr. No.	Year	External debt	External Debt - GDP ratio
1.	1991	84.85	28.7
2.	1995	93.80	30.9
3.	2000	101.13	22
4.	2005	121.10	18.5
5.	2010	290.40	18.5
6.	2015	478.80	23.8
7.	2020	570.00	20.9
8.	2021	573. 00	21.2

Source: RBI Handbook on Indian Economy.



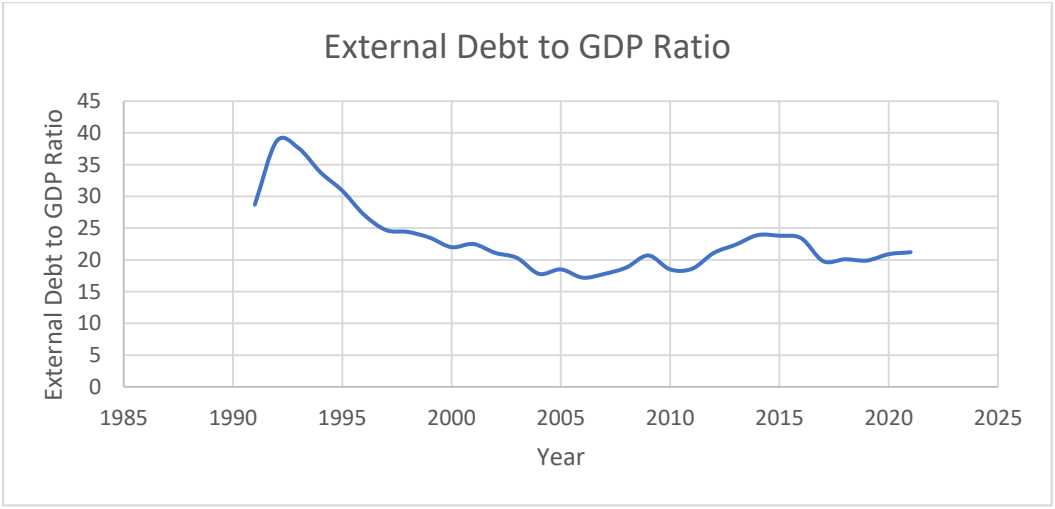


Figure-1 Trends and External Debt to GDP Ratio

Source: Table-1

Table 1 and Figure 1 show how external debt and its ratio to GDP have evolved in the country over three decades. Policymakers, economists, and analysts must monitor these metrics closely to ensure sustainable economic growth without excessive debt burden.

Over this period, the country's external debt has steadily increased, rising from approximately 84.85 billion to 573 billion (units are in billions of dollars). This upward trend indicates a growing reliance on borrowing from external sources to finance various economic activities and infrastructure projects. Simultaneously, the external debt to GDP ratio, which measures the country's debt relative to its economic output, fluctuated over the years. It peaked in the early 1990s and again in the mid-2000s, reflecting periods of higher indebtedness compared to the size of the economy. In recent years, from around 2017 onwards, while the absolute external debt continued to rise, the ratio has stabilized somewhat, suggesting potential improvements in economic management or GDP growth that have kept pace with debt accumulation. Monitoring these metrics is crucial to ensure sustainable economic development and to manage the country's debt levels effectively without jeopardizing long-term economic stability.

This paper focuses more on the non-linear relationship between external debt and economic growth, as there is little evidence of the threshold estimation in India. The paper is divided into the following different sections. Section A is introductory whereas Section B elaborates on the existing literature about external debt and economic growth. Section C is about the data and methodology section. D and E sections particularize results, discussion, and policy implications.

2. REVIEW OF LITERATURE

2.1. Theoretical review

Chenery & Strout (1966) augmented the Harrod -Domar model of the financing gap with an understanding of the need to have savings funds internally as there are resource bottlenecks for a developing economy. The study found that the growth rate of the underdeveloped nation would be about 3 to 4 per cent and less than 1 per cent per capita without foreign assistance. With foreign aid,

economies can grow at a healthy rate of up to 6 to 7 per cent. A negative relation is characterized by a "debt overhang," according to Krugman (1998), in which the capacity for repayment of outstanding facilities is less than the signed value. Debt overhang is regarded as a major contributor to distortion and deceleration of economic growth in highly indebted economies. Debt overhang can also result from other events, such as unfavourable economic shocks or weak economic activity, in addition to a nation's excessive debt accumulation. Romer (2012) explained that the probability of debt default arises when taxes are less than debt obligations.

2.2. Empirical Review

Zaghdoudi (2019) examined the non-linear effects of external debt on economic growth in middle- and low-income countries. The study identified a threshold of 15.28 per cent of GDP for external debt, beyond which external debt negatively influences economic growth. This threshold highlights that while lower levels of external debt might not be detrimental, exceeding this level can adversely affect economic performance.

Aloulou et al. (2023) applied a non-linear approach to explore the relationship between external debt and economic growth. The findings indicated a negative relationship between external debt and economic growth, with the negative effect being more distinct in the short run compared to the long run. This study underscores the complexities of the relationship, showing that the impact of external debt can vary over different time horizons. Bese and Friday (2022) analyzed the association between foreign debt and economic growth in Turkey. The study found a long-run relationship between external debt and economic growth but did not find evidence of a non–linear relationship. The study proposes that even though external debt has a long-term impact on growth, it may not follow the expected non-linear pattern seen in other contexts. Checherita and Rother (2010) explored the non-linear relationship between public debt and economic growth using panel data regression across 12 euro countries. The study identified a threshold for the debt-to-GDP ratio between 90 per cent and 100 per cent, below which public debt positively affects economic growth and above which it negatively impacts growth. The finding suggests that the effect of public debt on economic growth changes direction depending on the debt relative to GDP. Egert (2014) employed a debt threshold model to analyze the relationship between public debt and economic growth within the EU. The study examined the widely cited 90 per cent debt-to-GDP ratio proposed by Reinhart and Rogoff (2010) and found that this threshold might not be universally applicable, indicating that the influence of public debt on economic growth can vary and does not strictly adhere to the 90 per cent threshold. Law, Mohd, and Sulaiman (2021) investigated the relationship between external debt and economic growth, emphasizing the threshold effect and the inverted U-shape hypothesis. The study identified a threshold value of 51.65 per cent for public debt, beyond which economic growth is harmed. The study also provided evidence supporting the inverted U-shaped relationship, where the impact of debt on growth is positive up to a certain point and becomes harmful beyond it. Ale et al. (2022) used a cross-sectional dependent Autoregressive distributed lagged technique to analyze the association between external debt and economic growth. The study found a noteworthy adverse relationship between external debt and economic growth in the short and long run. The findings suggested that South Asian nations should not depend upon external debt for economic growth and look for other ways to reduce the negative effect of external debt on economic growth. Using a structural vector autoregressive method, Mohanty and Panda (2020) examined the impact of public debt on the macroeconomic variables of the Indian economy, such as interest rate, GDP growth rate, and investment. The findings discovered that debt harms economic growth and positively impacts interest rates and that domestic debt has a more significant negative impact on growth than external debt. Mariano and Villanueva (2005) used the extended version of the neoclassical growth model to analyze the upper limit of external debt, beyond which its accumulation adversely impacts Asian economies. The study found that when external borrowing costs increase, sustainable external debt

decreases, and vice versa. Llorca (1993) analyzed the sustainability of external debt through the present value criteria of twenty-four developing Asian countries. The study revealed that Asia's external debt is within sustainable limits in the long run. Sucharita (2014) analyzed India's external debt sustainability. The study concluded that external debt is sustainable but still has high ratios, such as debt to GDP and the ratio of the present value of debt to export, etc.

In light of the above literature review, very few studies emphasize external debt sustainability in India, specifically in the context of threshold estimation. There is comprehensive literature on panel studies in such a context, but no particular attention has been given to the Indian economy. The current study focuses on external debt sustainability in the Indian economy by estimating a debt Laffer curve or the threshold point.

3. DATA AND METHODOLOGY

The study used the following data sources, along with their unit of measurement for the analysis.

Table2 Data Sources

Variable	Data Source	Unit of Measurement
External Debt	RBI Handbook on Indian Economy	Percentage of GDP
Real GDP	Economic Survey Statistical Appendix	Crore
Gross Capital Formation	Economic Survey Statistical Appendix	Crore
FDI	Economic Survey Statistical Appendix	US Billion Dollar
Research and Development Expenditure (R&D)	Department of Science and Technology (DST)	Percentage of GDP
Education Expenditure	World Bank Development Indicators	Percentage of GDP
Population growth rate	World Bank Development Indicators	Percentage Annual Change
Trade Openness Index	Department of Economic Affairs	Percentage of GDP
Labour Force Participation Rate	World Bank Development Indicators	Percentage of Labour Force

Source: Author's compilation.

The data on external debt has been extracted from the RBI Handbook on Indian Statistics, Real GDP, Gross Capital Formation, and FDI data from the Economic Survey Statistical Appendix, Research and Development (R&D) expenditures from the Department of Science and Technology (DST), Education expenditure and annual Population growth data from World Bank Development Indicators, and Trade Openness Index from the Department of Economic Affairs.

The statistical analysis is based on the non-linear least square multivariate regression analysis used by RBI (2022). Different statistical tools for robustness analysis have been used. The Breusch–Pagan–

Godfrey test (Breusch & Pagan, 1979) of heteroskedasticity and Bruch – Godfrey Test of Autocorrelation (Bruch & Godfrey, 1979) and the Jarque—Bera Test of Probability Distribution (Jarque & Bera, 1980) have been applied to identify the method's robustness.

3.1. Model Specification and Variables

$$Y_i = \beta_0 X_i + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + \beta_n X_n \ldots\ldots\ldots\ldots \quad \textbf{(Equation 1)}$$

The model can be rewritten in its original form as

$$Y_i = \beta_0 X_1 + \beta_1 X^2 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \mu_i \ldots\ldots\ldots\ldots \quad \textbf{(Equation 2)}$$

Here

Y_i = Real GDP annual growth rate. (Gross Domestic Product).

X_1 = External Debt Percentage of GDP.

X_2 = Debt Service Payment.

X_3= Annual growth of Capital Formation.

X_4= Growth rate of Foreign Direct Investment.

X_5 = Human Skills.

X_6 = Growth rate of Population.

X_7 = Labour Force Participation rate.

μ_i = Error – Term.

β_S= Parameters to be estimated.

4. RESULT AND DISCUSSION

The following results have been derived from the data analysis

Table 3 Results of Non-Linear Regression Analysis

Variable	Co-efficient	T - Statistics	P- Value
X_1	0.0207	2.030*	0.05*
X_1^2	-0.0004	-2.164*	0.04*
X_2	-0.0040	-1.589	0.12
X_3	0.05623	27.23*	0.00*
X_4	0.02090	1.647	0.10*
X_5	0.00066	1.135	0.26

X_6	0.14792	1.817	0.08**
X_7	-0.0068	-1.737	0.09**
R- Square		0.98	
Adjusted R- Square		0.98	
D -W Statistics		1.8	
F – Statistics		76.2	
Turning Point		23.9 Percent	

Source: Author's Calculations.

Indicates significance at a 5 percent level.

Indicates significance at 10 percent level.

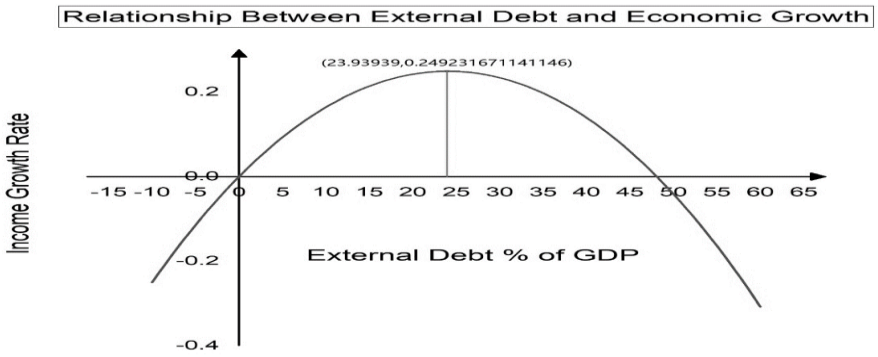


Figure 2 External Debt Laffer Curve

Source: Table-3

The table and figure represent the outcomes of non–linear regression analysis employed to determine the relationship between external debt and economic growth in India.

- The external debt to GDP ratio has a coefficient of 0.0207, a t-statistic of 2.030, and a p-value of 0.05, signifying that it is statistically significant at the 5 percent level. This suggests a positive effect of external debt on the growth rate.

- The square term of the external debt to GDP ratio shows a coefficient of -0.0004, a t-statistic of -2.164, and a p-value of 0.04, indicating significance at the 5 percent level as well. This suggests a negative impact of external debt on economic growth.

- Debt service payment has a coefficient of -0.0040, a t-statistic of -1.589, and a p-value of 0.12, which is not statistically significant at the 5 percent level but is significant at the 10 percent level.

- Capital formation exhibits a strong positive coefficient of 0.05623, a very high t-statistic of 27.23,

and a p-value of 0.00, making it highly significant and indicating a substantial positive effect on the dependent variable.

- FDI has a coefficient of 0.02090, a t-statistic of 1.647, and a p-value of 0.10, suggesting significance at the 10 percent level but not at the 5 percent level.

- Human skills show a coefficient of 0.00066, a t-statistic of 1.135, and a p-value of 0.26, indicating that it is not statistically significant.

- Population growth has a coefficient of 0.14792, a t-statistic of 1.817, and a p-value of 0.08, suggesting significance at the 10 percent level.

- Labour Force participation displays a coefficient of -0.0068, a t-statistic of -1.737, and a p-value of 0.09, indicating significance at the 10 percent level.

- The non-linear analysis shows that the turning point for the external debt-to-GDP ratio to real GDP is Twenty-three-point nine percent, after which it will deteriorate economic growth.

- The model's overall fit is also significant, with an R-Square value of 0.98 and an Adjusted R-Square of 0.98, suggesting that the independent variables in the model explain 98 percent of the variation in the dependent variable. The Durbin-Watson statistic of 1.8 suggests no significant autocorrelation in the residuals. The F-statistic of 76.2 indicates that the model is statistically significant overall.

4.1. Robustness analysis

4.1.1 Heteroskedasticity test – Breusch – Pagan-Godfrey

H_o = There is Homoskedasticity.

Table 4 Result of Heteroskedasticity Test

F-Statistics	**2.38***
P-Value	0.06*
Observed R-Square	14.3

Author's calculations.

Indicates significance at a 5 percent level.

The results from the Breusch-Pagan-Godfrey heteroskedasticity test are as follows:

The F-statistic is 2.38, with a p-value of 0.06, and the Observed R-squared value is 14.3. In this context, the null hypothesis (H_o) posits that there is homoskedasticity, meaning that the variance of the error terms is constant across observations. The F-statistic and p-value are used to assess this hypothesis. Here, the p-value of 0.06 is slightly above the conventional 5 percent significance level, indicating that the evidence against rejecting the null hypothesis is weak. it does not provide strong enough evidence to conclusively reject the null hypothesis at the 5 percent significance level. However, the null hypothesis is accepted, suggesting that the variance of the error term is constant.

4.1.2 Breusch - Godfrey Serial Correlation Test

H_o = No serial Correlation

Table 5 Result of Autocorrelation Test

F-Statistics	**0.50***
P-Value	0.60*
Obs R-Squared	1.43

Author's calculations.

* Indicates significance at a 5 percent level.

The Breusch-Godfrey serial correlation test results are as follows: The F-statistic is 0.50, the p-value is 0.60, and the Observed R-squared value is 1.43. This test is designed to evaluate the presence of serial correlation in the residuals of a regression model, with the null hypothesis (Ho) asserting that there is no serial correlation. The F-statistic of 0.50 and the high p-value of 0.60 suggest that the test does not find evidence against the null hypothesis, indicating no significant serial correlation in the residuals at the 5 percent significance level. The Observed R-squared value of 1.43, which is relatively low, supports the conclusion that the model does not show substantial serial correlation. In summary, the results imply that the model's residuals are likely independent and not influenced by past values, aligning with the assumption of no serial correlation.

4.1.3 Normality Test (Jarque – Bera test)

H_o = The probability distribution is normal.

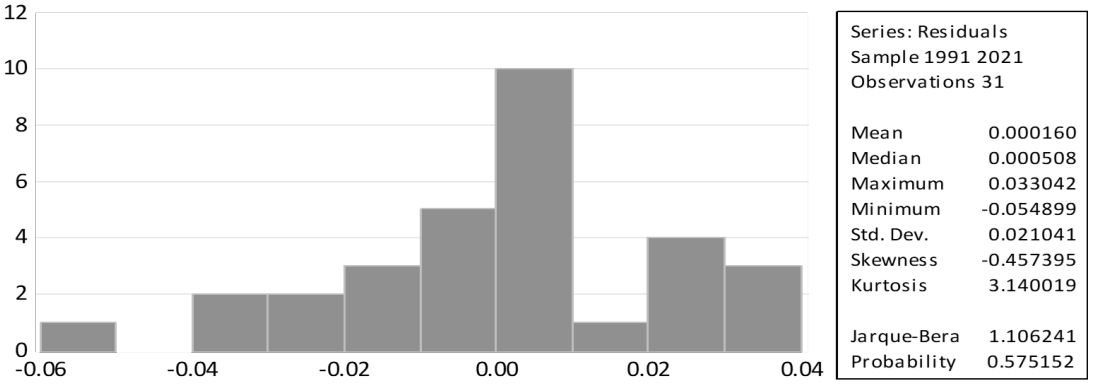


Figure – 3 Result of Normality Test

Source: Author's Calculations.

Figure 3 represents the result of the Normality test of the Jarque—Bera test of probability distribution. A P value greater than 5 signifies the acceptance of the null hypothesis. It indicates that the probability distribution of residuals is normal.

5. CONCLUSION AND POLICY IMPLICATIONS

The non-linear regression analysis conducted to examine the relationship between external debt and economic growth in India reveals several vital insights. It shows that while the external debt-to-GDP ratio positively affects economic growth, this impact is tempered by a negative squared term, indicating diminishing returns after a turning point of 23.9 percent. At lower levels, external debt can support growth by providing essential resources. However, excessive debt may hinder economic performance due to increased servicing costs and financial instability, as debt service payment has a negative coefficient. Additionally, capital formation significantly boosts growth, highlighting the critical role of investments in physical assets, while debt service payments and human skills are less impactful. Other factors, such as Foreign Direct Investment (FDI) and population growth, contribute moderately to growth, but labour force participation negatively affects it, suggesting inefficiencies in the labour market. The model's high R-squared value of 0.98 confirms its robustness, indicating it explains a substantial portion of growth variability. Thus, it is essential for policymakers to manage external debt prudently, ensuring it remains below the critical threshold and is directed toward productive investments to maximize its benefits while minimizing potential drawbacks.

To effectively foster economic growth, policymakers should focus on three key strategies. First, managing external debt is essential; they must closely monitor the external debt-to-GDP ratio, as moderate levels can stimulate growth, but exceeding the 23.9 percent threshold may lead to negative consequences. Ensuring that external debt is allocated to productive investments is critical. Second, promoting capital formation is vital, given its strong positive impact on economic growth. This can be achieved by prioritizing investments in infrastructure, technology, and other capital assets, enhancing both public and private sector investment and improving the overall business environment to attract and retain investment. Finally, addressing labour market issues is crucial, as the negative effect of labour force participation indicates inefficiencies. Policymakers should implement initiatives to enhance job training programs, improve labour market regulations, and tackle structural challenges that may impede effective employment. By focusing on these areas, policymakers can create a more robust framework for sustainable economic growth rather than depending on external debt.

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Contribution of Migrant Workers in the Economic Development of Haryana

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Abstract

Migrant workers contribute a lot towards development of any region as human capital. The study attempts to analyse the contribution of migrant workers in the economic development of Haryana. Herein, a well-designed schedule has been used to gather information from 600 unorganized migrant workers working in the manufacturing and construction sectors. This study observed that the incremental changes in per capita income, expenditure, savings, remittance, health, and education of migrant workers after migration has resulted in increased level of consumption, improved residential conditions, and augmented spending on children's education, thereby enhancing their living standards at both native and migrated places. Income, savings, expenditure, education, health, and socio-economic status are important indicators of economic development. The study found that migrant workers contribute significantly to the economic development of their migratory and native places.

Keywords: - Migrant workers, development, per capita income, health, education, Haryana.

1.0 INTRODUCTION

The term informal sector gained importance in 1972 while analysing economic activities in Kenya for an employment mission by International Labour Organization (ILO), and recognising informal economic activities as unrecognized, unrecorded, unprotected, and unregulated.

Informality attained the interest of economists in the unorganized sector after the 1990s, especially in developing and transition economies. The ILO developed a theoretical framework for data collection in the unorganized sector, and this framework was circulated in resolution form at the 15th International Conference of Labour Statisticians (ICLS) held in 1993. Only at the 15th conference of ICLS, the informal economy was adequately defined for the first time, both in concept and statistical terms. The unorganized sector, which constitutes the majority of economic activities in developing and transition economies, holds immense potential (Srivastava & Sasikumar, 2023; Madan & Goyal, 2018). Reports and censuses in India show that agriculture and construction are significant sources of survival for large sections of unorganized workers. In India, the organized sector has grinds for employment opportunities for unskilled, semi-skilled, and skilled workers. As a result, it has provoked the migration of workers to pursue work in the unorganized sector. Simultaneously, the unorganized sector is seen as absorbing labour (Mitra et al., 2013). Migrant workers have played an enormous role in sustaining and building the Indian economy, but their contribution has not been recorded, highlighted, or recognized due to the dearth of data. The Lewis model of development shows that the surplus of labour from the agricultural sector to the urban manufacturing sector creates a surplus in the sector to which they migrate. This surplus aids in developing an economy and capital formation through reinvestment. While this result has theoretical implications, identifying surplus labour in the existing sector is challenging. The Harris-Todaro development model (Harris-Todaro, 1970) also suggests that labour migration from rural-urban areas catalyses development. In this model, the envisioned earnings of migrant labour in the urban area are at least as high as those in the rural area, a condition that drives migration. An important implication of these theoretical results is the potential of migration to be a

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significant driver of development in the sector where labour migrates (Sathaya, 2014). Migrant workers contribution to any economy is a much-discussed issue (Srivastava et al., 2020).

However, in 1991, India launched a new economic policy known as Liberalization, Privatization, and Globalization (LPG); and as a result, the competition intensified for employment, and the importance of cities and urban centres grew in developing the Indian economy. As a result, more job opportunities emerged in the unorganized sector; workers have migrated from rural areas to urban areas for livelihood. Apart from this, India's GDP increased from 29 % to 47 % from 1950 to 1980, which further increased to 63 % in 2007 and 75 % in 2021, sparking anticipation and interest. (Misra & Alam, 2014). The increasing contribution of urban areas to India's GDP has been possible because of the rising migrated population in urban areas. The positive and strong correlation between human capital and economic development is evident in the significant role play of migrant workers in the development dynamism of any economy. Their contribution is integral to the economic development of countries (Sathaya, 2014). However, the evidence on migration's impact on destination areas must be more easily defined. Migrant workers contribute a lot to develop any region as human capital. Income, savings, expenditure, education, health, and socio-economic status are important parameters for understanding the economic development of an economy. Each parameter plays a significant role in driving sustainable development and improving societal welfare. The expenditure of migrant workers on consumption, residential housing, children's education, and other assets is higher than that of non-migrants. Migrant workers have managed to save a good portion of their salary, which they remit or take back to their native place and is used to boost consumption; improve the condition of residential housing; rise spending on children's education, and to invest in other assets. Migration has a better effect on both the native and the migrated places; as a result, it has helped to reduce rural poverty (Pandey, 2013).

2.0 REVIEW OF LITERATURE

Some of the popular models of economic development to explain migration in economic development were proposed by Lewis in 1954, Harris in 1963, and Todaro in 1970. These models emphasized on the main reasons for migration such as wage differences, uneven income distribution, and the low efficiency of factor production. The growth level of any region is affected by the extent of labour migration. It has been recorded that the numbers of workers in the agricultural sector have decreased, with a corresponding increase in the unorganized non-agricultural sector (Bhattacharya, 1996). Low labour productivity in the agriculture sector is another factor affecting rural-to-urban migration. In economic development, a structural transformation occurs from the primary sector to the secondary sectors in terms of value-added and workforce structure (Pandey, 2013).

Moreover, it was expected that labour migrants would reinvest substantially in enterprises in their origin after their widely expected return. The migrant workforce is a key factor in urbanization and contributes to urban development (Sanyal & Maity, 2018). Hereby, the impact of liberalization, privatization, and globalization, particularly since 1991, has significantly increased the internal migration of skilled, semi-skilled, and unskilled workers from rural to urban areas, shaping the urban landscape. On the other hand, the unorganized sector has absorbed a large section of the migrant workers (Mor, Madan, Chhikara, 2020). The reason behind this is that most of the economic activities in developing and transitioning economies constitute an unorganized sector. Reports and censuses in India have shown that agriculture, manufacturing, and construction are significant sources of survival for large sections of unorganized workers (Bhattacharya, 1996) revealing the role of migrant workers in the development dynamism of any economy.

However, the evidence that exists on migration’s impact on economic development cannot be easily defined. States are different in terms of their geography, language, demography, and social norms, and

have different prospects of economic development. Individual analysis of each state conveys this anomaly. Migrant workers contribute to the nation's GDP (Gross domestic product). They may also affect the wages and job opportunities in migrated places, alter the country's income distribution, and change the incentives to invest in schooling and companies (Keely & Tran, 1989). Further, migrant workers have directly or indirectly affected social, economic, and political life of their native and migrative places. So far, remittances sent by migrant workers at their native place is concerned, it has helped in enhanced consumption, improved housing conditions, raised spending on children's education, and invest in other assets at their native place (Keely & Tran, 1989). Moreover, it has been observed that migrant workers are relatively better placed than non-migrant workers regarding access to education, consistency in employment, and higher monthly per capita consumption expenditure. As a result, migration's impact on development was positive (Srivastava & Sutradhar, 2016; Srivastava et al., 2020). On the other hand, migrant workers still have low economic status and are low-paid, with temporary or seasonal jobs. Workers also migrate from a region with a lower wage rate to a higher one. This kind of continued migration creates worker competition, which lowers the wage rate. This process continues until the wage gap between the two regions is eliminated (Sanyal & Marity, 2018; Srivastava et al., 2020).

Some studies confirm that in areas like agriculture, industry, and construction, where fewer skills are required, primarily poor migrant workers are preferred. It has been observed that the construction and manufacturing sectors have vital importance to the Indian economy and employ the highest numbers of migrant workers. Further, the construction sector contributes 7.7 %, and the manufacturing sector contributes 17.42 % to India's GDP. The manufacturing sector, the second largest employer outside agriculture, and the construction sector, the third largest, employ a workforce of 46 million annually (Turrey, 2016; 2020; Tipayalai, 2020). The research also highlighted the crucial role of migrant workers in urban development, fostering a sense of appreciation for their contribution. Moreover, labour unavailability is the main hindrance factor to the growth or development of an economy. The urban sector offers higher wages than rural or backward areas. As a result of the wage differential, workers have migrated from the primary sector to the modern sector. The modern sector will continuously reinvest to keep the demand for cheap labour present, and as a result, migrants contribute to economic development directly and indirectly (Srivastava et al., 2020).

3.0 OBJECTIVES OF THE STUDY:

This paper attempts to analyse the contribution of migrant workers in the economic development of Haryana viz change in the level of their per capita income, per capita expenditure, expenditure pattern, savings, the status of indebtedness, levels of education, health conditions, and living standards.

4.0 RESEARCH METHODOLOGY:

4.1 Data collection tools and Sampling technique:

The present study has utilised primary data obtained from 600 unorganized migrant workers engaged in construction and manufacturing industries with the help of a well-designed schedule. The required information was obtained with the help of systematic random sampling technique. For the purpose, the information is collected from six administrative divisions of Haryana state, i.e., Ambala, Rohtak, Karnal, Hisar, Faridabad, and Gurugram (Statistical Abstract of Haryana, 2021-22). Table 1 provides detail of sampling units from six administrative divisions of Haryana.

Table 1: Sample Size of Migrant Workers from Haryana

Divisions	Districts	Blocks	Manufacturing Sector	Construction Sector	Total
Ambala	Kurushetra	Thanesar	25	25	100
		Shahabad	25	25	
Rohtak	Rohtak	Rohtak	25	25	100
		Meham	25	25	
Karnal	Panipat	Israna	25	25	100
		Panipat	25	25	
Hisar	Hisar	Hansi	25	25	100
		Hisar	25	25	
Faridabad	Palwal	Hodal	25	25	100
		Palwal	25	25	
Gurugram	Rewari	Dharuhera	25	25	100
		Rewari	25	25	

As shown in table 1, one district from each of the administrative divisions is selected. Two blocks are chosen from each of the selected district. In this way, Thanesar and Shahabad blocks are selected from Kurukshetra district; Rohtak and Meham blocks are selected from Rohtak district; Israna and Panipat blocks are from Panipat district; Hisar and Hansi blocks are chosen from Hisar district; Hodal and Palwal blocks are selected from Palwal district; Dharuhera and Rewari blocks are selected from Rewari district. Herein, an attempt is made to select equal number of migrants from each block for better precision and to make the data representative. i.e., 50 migrant workers have been chosen from each of the selected block comprising 25 migrant workers from construction and manufacturing sector separately. In this way, a total of 100 migrant workers are selected from each of the chosen district, to collect desired information from 600 migrant workers.

4.2 Sample Size Determination

The sample size is determined on the basis of Cochran's equation to obtain a representative sample. Since, the variability in the population is not known; assuming p=0.5 (maximum variability equal to 50%) at a 95% confidence level with ±5% precision" (Malhotra & Dash, 2010), following method is utilised to determine the sample size:

i.e. n= z2 p.q / e2

n= (1.96) 2 0.5 * 0.5 / (0.05) 2

n = 384.16

A sample of 600 migrant workers is taken, which is more than the minimum benchmark of 384.16, as in the case of an infinite population.

5.0 JUSTIFICATION OF THE STUDY

In recent years, workers have migrated from neighbouring states to selected districts of Haryana due to the rapid expansion of manufacturing and construction activities and broadening service sectors. A

targeted sample from selected districts can comprehensively outline Haryana's economic landscape (Aggarwal et al., 2020). The selected districts have specific economic features such as Kurukshetra district is known for its predominantly agricultural features and a concentration of agro-based industries i.e rice milling, milk processing, wooden industries, hosiery, readymade garments, and chemicals are the leading industrial groups in the district. Similarly, Rohtak district have potential to generate employment opportunities for migrants as the Haryana State Industrial and Infrastructure Development Corporation (HSIIDC) has developed an Industrial Model Township (IMT), and MNCs like Maruti Suzuki, Asian Paints, Suzuki Motorcycle, Amul, Lakshmi Precision Screws (LPS) and Aisin Automotive launched work on projects in Rohtak (Aggarwal et al., 2020). Panipat district is known for its small-scale textile industries that provide informal employment. Panipat is called the city of weavers and produces textiles and carpets. The Hisar district has a large steel industry called the 'City of Steel' and Hisar, India's largest manufacturer of galvanized iron, textiles, and automobile parts, which provides better employment opportunities for labourers. Faridabad is another big industrial part of Haryana. Faridabad has large-scale companies, i.e., Yamaha Motor Pvt. Ltd., Havells India Limited, Indian Oil, Whirlpool India Ltd., Bata India Ltd and Lakhani Armaan Group, which employ to labour (Aggarwal et al., 2020). Lastly, Gurgaon has appeared as a vibrant hotspot with excellent connectivity and a series of developments in the infrastructural sector that created employment. Thus, the increasing labour force in these districts is due to better job opportunities and development in Haryana.

5.1 Results and Discussion:

This study intends to examine a change in the per capita income, per capita expenditure, savings, the status of indebtedness, levels of education, health conditions, and living standards of migrants before and after migration to have a significant insight on their contribution for economic development of Haryana. The detailed analysis is provided in the subsequent headings.

5.1.1 Per Capita Income of Migrant Workers:

Per capita income is a significant measurement of economic development. In recent years, a faster pace of economic growth has been placed Haryana in a competitive stance with other states (Aggarwal et al., 2020). Table 2 presents average per capita income of migrant workers before and after migration. It makes clear that the average income of migrants has increased from Rs. 3119.58 to 6113.01 after migration, which indicates a significant improvement in their income and corresponding living standard.

Table 2- Average per capita income of migrant workers

Average per capita income of migrant workers before migration	Average per capita income of migrant workers after migration	Difference in the average per capita income of migrant workers after and before migration	**T-statistic**
3119.58 (2552.163)	6113.01 (4474.012)	2993.428 (3052.800)	24.019*

Note: Figures in the parenthesis indicate standard deviation

Significant at 1 percent level of significance

5.1.2 Per Capita Expenditure and Average Expenditure Pattern of Migrant Workers:

Per capita expenditure is a measure of the living standards of a person (Sathaya, 2014). Herein, per capita expenditure includes expenditure on consumption i.e. food, victuals, apparel and expenditure on basic facilities such as education, medical, accommodation and entertainment. Table 3 demonstrates the per capita expenditure of migrant workers before and after migration. It makes clear that the per capita expenditure has increased from Rs. 795.83 to 2409.11 after migration. Further, the average expenditure difference indicates that the average per capita expenditure has drastically increased by Rs. 1613.278 after migration, which reveals a substantial increase in their per capita expenditure correspondingly increasing the probability of their improved living standard. Apart from this, table 4 sheds light on the changing expenditure pattern of migrant workers; it clarifies that the average expenditure of migrants has increased from Rs. 3298.31 to Rs. 7521.67 after migration. Along with increasing expenditures on cereals and pulses, procurement of additional goods and services has also increased, resulting in an overall increase in their expenditures after migration. Earlier, they used to spend primarily on cereals, pulses, intoxicants, and social and religious rituals only. In contrast, after migration, they had to additionally spend on LPG, paying rent, services and perishable goods (veg. fruits, milk, and meat), cookies, fast-food, thus resulting in high expenditure comparatively.

Table 3- Average per capita expenditure of migrant workers

Average Per Capita Expenditure of Migrant Workers before migration	Average Per Capita Expenditure of Migrant Workers after migration	Difference in the average per capita expenditure of migrant workers after and before migration	**T- statistic**
795.83 (439.19)	2409.11 (1793.66)	1613.278 (1723.766)	22.925

Note: Figures in the parenthesis indicate standard deviation

Significant at 1 percent level of significance

Table 4 Changing expenditure pattern of migrant workers

Status of Average Expenditure of migrant workers	**Average Expenditure on Household Items (Rs.)**	**Household Items**	**Frequency 600 (Per cent)**
Household Expenditure on items before Migration (Monthly)	**3298.31**	Cereals, Pulses	365 (60.8)
		Intoxicants	**428 (71.3)**
		Others (social & religious ritual)	**600 (100.0)**
Household Expenditure on items after Migration (Monthly)	7521.67	Cereals, Pulses	**528 (87.9)**
		Perishable goods (veg. fruits, milk, meat), Cookies, Fast-food	**416 (69.4)**
		Intoxicants	**479 (79.8)**
		Fuel for cooking (LPG,	396 (66.0)

		wood)	
		Rent	341 (56.8)
		Services	298 (49.7)
		Other expenditure – (Occasionally clothing, religious fest & social rituals)	**600 (100.0)**

Note: Figures in the parenthesis indicate percentage

Source: Compiled from filed survey

5.1.3 Saving of Migrant Workers:

Saving is an essential element of economic development. Many studies related to migrant workers are evident that migrant workers managed to save money after migration. Besides, these individuals amass savings and income by remitting funds to their families (Srivastava et al., 2020). Herein, the study highlights the status of savings before and after migration. Table 5 presents the savings of migrant workers before and after migration. It clarifies that their savings have increased from 1.53 to 1.83 after migration, which indicates a significant improvement in their savings and corresponding living standards.

Table 5- Saving of migrant workers

Saving of Migrant Workers before migration	Saving of Migrant Workers after migration	Difference in the saving of migrant workers after and before migration	**T- statistic**
1.53 (0.845)	1.83 (0.462)	0.3 (1.022)	7.188

Note: Figures in the parenthesis indicate standard deviation

Significant at 1 percent level of significance

5.1.4 Status of Remittances of Migrant Workers:

Remittances augment the financial resources of the households of migrant workers residing at their native place (Keely & Tran, 1989). Further, to study the contribution of migrant workers to economic development, it is necessary to know the status of remittances of migrant workers. Table 6 makes it clear that 77.7 % of migrant workers send remittances to their native place which is spent by their households on consumption, healthcare, education, and social and religious rituals, whereas the remaining 22.3 % migrant workers indicating no need of remittance because all the family reside at their destination place.

Table 6 Status of remittance of migrant workers (000s per month)

Amount of Remittance of Migrant Workers	Frequency	Per cant
1000-2000	307	51.2
2000-5000	111	18.5
5000-10000	48	8.0
No Remittance	134	22.3
Purpose of Remittance		
Consumption, Education, Health, Social & Religion causes	466	77.7
No Remittance	134	22.3
Total	600	100.0

Source: Compiled from filed survey

5.1.5 Status of Indebtedness of Migrant Workers after Migration:

The households of migrant workers often take loans from banks and money landers for a better standard of living and life events such as social rituals, household items and education (Santhya, 2022). Table 7 reveals that 56.3 % of migrant workers have repaid their loans after migration whereas 23.3 % of migrant workers have not borrowed money from any source. Further, it also reveals that a small fraction of migrant workers, i.e., only 20.4 % of migrants, have borrowed money from banks and money lenders. Herein, 5.0 % of migrant workers have borrowed for marriage, only 3.5 % have borrowed for social rituals, and the remaining 11.8 % have borrowed money for purchasing household assets. Thus, a remarkable decline is evident in the status of indebtedness of migrant workers after migration.

Table 7 Status of indebtedness of migrant workers after migration

Status of Loan/Indebtedness	Frequency	Per cent
Public or Private Bank	60	10.0
Money Lender at Destination or origin place	62	10.4
Repayment	338	56.3
No Borrowing	140	23.3
Purpose of Loan		
Marriage	30	5.0

Social Rituals	21	3.5
Households assets	71	11.8
Total	600	100.0

Source: Compiled from filed survey

5.1.6 Status of Education, Health and Living Standard:

Education, health, and living standards are the key parameters of economic development (Satyarthi, 2022). Herein, table 8 demonstrates that 19.5 % of migrant workers are those whose children are illiterate, whereas the children of 55.5 % migrant workers study in primary- up to the middle. Moreover, it also shows that the children of 15.8 % migrant workers study in high school up to Sr. Sec. School whereas the children of remaining 9.2 % migrant workers has access to higher education after the migration.

Table 8 Status of education, health and living standard after migration

Status of Education of migrant worker's children	Frequency	Per cent
Illiterate	117	19.5
Primary - upto Middle	333	55.5
High School- upto Sr. Sec. School	95	15.8
Higher Education	55	9.2
Mode of Education		
Not going to school /No child	116	19.5
Govt. Institution	97	16.2
Private Institution	387	64.5
Accessibility to better Health Facilities		
Yes	554	92.3
No	46	7.7
Preference of Hospitals		
Public hospital/ clinics	294	49
Private hospital/ clinics	169	28.2
Both	137	22.8

Improvement in Living Standard		
Good	420	70.0
Very good	180	30.0
Total	600	100.0

Source: Compiled from filed survey

Further, table 8 clarifies that 64.5 % of migrant workers prefer private schools for their children's, underscoring the high value placed on education in migrant families. At the same time, it presents that 92.0 % of migrant workers agree with the accessibility to medical facilities, a reassuring sign of the healthcare situation for migrant workers. They express their preference for both private and public hospitals, indicating a diverse and accessible healthcare system. Further, the study also observes that all the migrant workers have answered positively about the improvement in their socio-economic status after migration.

6. Conclusion

The study observes that migration has a mixed but predominantly positive impact on the economic development of migrant workers. After analysing various parameter of economic development the study reports incremental change in per capita income, per capita expenditure and savings of migrant workers. Besides, the change in the pattern of expenditure is also found after migration. Further the study finds better access to health facilities, spending on education for their children, and majority of migrant workers answered in positive about the improvement in their living standard after migration. Furthermore, there has been a notable change in their indebtedness, the majority of migrants, earlier indebted, have repaid their borrowings after migrating to Haryana. The remittances migrant workers send to their families enhance consumption power in their native places. Moreover, the study concludes that migrant workers contribute to the economic development of and migrated and native places, thereby improving the overall quality of their life. The through expenditure of migrant workers incur in Haryana state for purchasing various goods and services. On the other hand this process of procurement functions as sources of income for the goods and services provider of the state. Moreover, economic development and growth depends on human capital for a region. In this context, migrant workers constitute a significant portion of this capital, i.e., approximately 5 % of the total population of Haryana (Minister of State for Labour & Employment (2021). This inflow of migrant workers helps expanding the manufacturing capabilities that are continuously fuelling the economic growth of the state through establishing industrial hubs and improving infrastructure. Haryana is experiencing rapid economic growth through industrialization and urban development (Aggarwal et al., 2020). Future policies and support mechanisms should ensure the economic development of the state as well as the welfare of migrant workers, like subsidized health services, and implementation of educational initiatives to improve the skill levels of migrant workers, focusing on adult education and vocational training.

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Towards A Greener Future: Sustainable Practices For Indian Public Sector Thermal Power Plants

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Abstract

In order to better use resources and address the country's growing energy demands, the Indian power industry is concentrating on efficiency studies. Fossil fuel combustion results in greenhouse gas emissions, such as carbon dioxide, which exacerbate climate change. Enhancing effectiveness and switching to sustainable energy sources can advance sustainability. As the Indian power industry focusses on efficiency studies to meet growing energy demands, the shift towards sustainable energy sources becomes crucial to combat greenhouse gas emissions. This study employs an undesirable slack-based data envelopment analysis model to assess the efficiency of public sector thermal power plants in India from 2016–17 to 2021–22, aiming to enhance effectiveness and promote sustainability in the industry. When CO_2 is taken into account as an undesirable output, the public sector thermal power plant's average technical efficiency score is 57.90 percent, indicating a need for considerable improvement. The study's findings showed that most Indian public sector thermal power plants have not been using their full potential when it comes to cutting CO_2 emissions. These plants must prioritise sustainability initiatives and put plans in place to lessen their negative environmental effects. Implementing strategies like increasing the use of renewable energy sources, improving operational procedures, and updating technology into practise can help achieve the necessary CO_2 emission reductions. Investing in research and development for greener energy production techniques can also help thermal power plants operate more efficiently. The Indian public sector thermal power plants can work towards a more sustainable and ecologically friendly future with coordinated efforts and strategic planning.

Keywords: Efficiency, DEA, Sustainable Performance, Power, Undesirable Output

JEL Classification: Q42, P48, C67, L32

1. Introduction

Recently, there has been a significant focus on efficiency studies in the Indian power sector due to the country's growing energy consumption and the need to optimise resource usage (Bazmi & Zahedi, 2011). An essential aspect of Indian thermal power plants is doing efficiency analysis to identify areas of energy wastage and apply solutions for enhancement (Luthra et al., 2015). Through comprehensive efficiency analysis, operators may enhance the performance of their power plants, save operational expenses, and mitigate environmental consequences (Leach et al., 2020). This not only guarantees a more enduring and dependable energy supply for the nation, but also aids in fulfilling the escalating energy requirements of a swiftly progressing country such as India (Elavarasan et al., 2020).

Consequently, there is a growing demand for energy sources that are sustainable and ecologically conscious, along with an emphasis on enhancing the efficiency of current power plants and infrastructure (Jaiswal et al., 2022; Lu et al., 2020; Strielkowski et al., 2021). Given the government's

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ambitious objectives for increasing renewable energy generation and decreasing carbon emissions, there is an increasing demand for thorough efficiency analysis to pinpoint areas that may be enhanced and optimised within the power industry (He et al., 2021; Narciso & Martins, 2020).

As India continues to progress rapidly, the need for sustainable energy sources has become more critical than ever (Kumar & Majid, 2020). The government's push towards increasing renewable energy generation and reducing carbon emissions highlights the importance of efficiency in the power industry (Tanaka, 2011). This surge in demand for energy that is both eco-friendly and efficient underscores the need for thorough analysis and optimization of current power plants and infrastructure to meet the nation's escalating energy requirements (Omer, 2008). Yet, power plants and infrastructure encounter numerous obstacles on the path to peak efficiency, such as antiquated technology, inadequate financing for improvements, and the hefty price tags attached to environmentally friendly solutions (Shabalov et al., 2021). Despite these obstacles, investments in research and development for new energy technologies are crucial in order to transition towards a more sustainable energy future (Kabeyi & Olanrewaju, 2022). It is essential for power plants and infrastructure to adapt and evolve in order to meet the growing energy demands while also reducing their environmental impact (Ghoniem, 2011). By incorporating innovative and efficient energy solutions, the power industry can play a key role in combating climate change and ensuring a cleaner, greener future for generations to come (Mohideen et al., 2021). However, despite the importance of investing in research and development for sustainable energy technologies, there is a significant research gap in understanding the most effective and cost-efficient ways to implement these solutions. More studies are needed to analyse the long-term effectiveness and economic feasibility of various sustainable energy technologies in different contexts. Therefore, the present study aims to analyse the efficiency analysis of thermal power plants using undesirable output in order to determine the most sustainable and economically viable options for energy production. By incorporating the concept of undesirable output into the efficiency analysis of thermal power plants, this study seeks to provide valuable insights into the environmental impact and cost-effectiveness of different energy generation methods. Ultimately, the findings from this research will help policymakers and industry leaders make informed decisions about investing in sustainable energy technologies that will benefit both the planet and future generations.

2. Review of Literature

Multiple international studies have been conducted to evaluate the efficiency levels of different types of thermal power plants. For instance, Lam & Shiu, (2001) used data envelopment analysis to estimate the efficiency of thermal power generation in China between the years 1995 and 1996. The survey revealed that provinces and municipalities situated near the eastern coast and those abundant in coal exhibited the highest levels of technical efficiency. Fuel economy and capacity issues had an impact on technical efficiency, but workforce redundancy posed a significant challenge. The state power corporation (SPC) had lower efficiency levels in comparison to provinces and autonomous organisations external to it. Foreign investment had no impact on efficiency. Furthermore, Shanmugam & Kulshreshtha, (2005) utilised a stochastic frontier production function to assess the technical efficiency of fifty-nine thermal power plants located in India. The results indicated a large variation in technical efficiency among the power plants, with values ranging from 30% to 90%. Azadeh et al., (2007) conducted a comprehensive assessment and enhancement of forty thermal power plants in Iran from 1997 to 2000. Their investigation's findings indicated that mixed cycle plants had superior performance compared to steam or gas-based plants. In addition, Chen et al., (2013) examined the efficiency of resource utilisation in power plants across 73 nations between 2006 and 2008. The findings indicated that Europe exhibited comparatively lower levels of technical efficiency in contrast to Asia, which demonstrated much higher levels. In addition, the study conducted by Singh et al., (2013) found that out of the 25 Indian coal-fired power plants (CFPPs), seven were operating at the

largest capacity. The study analysed the operational and environmental performance of these CFPPs over the period of 2009-10.

There has been numerous research into how environmental issues are addressed, including an effort by Bi et al., (2014) to explore how thermal power generation in China is regulated in terms of fossil fuel use and environmental concerns. The study's findings indicate that environmental efficiency has a substantial impact on the sector's energy performance. Reducing key pollutants can lead to more efficient energy use and reduced pollution. Between 2007 and 2009, energy and environmental efficiency were rather low, with significant variations within provinces. According to the study, thermal power plants should prioritise minimising their environmental effect while maintaining the social and economic benefits they deliver. Fang et al. (2022) used a super efficiency slack-based model with undesirable outputs to determine the carbon emissions efficiency (CEE) of 42 thermal power producing units in China in 2020. According to the findings, the majority of power plants show increasing scale, while the remaining plants show constant returns to scale. CEE from power plants is distributed in two clusters: low-CEE and high-CEE groups. Furthermore, CEE is highest in South China and lowest in Central China. The low CEE is mostly due to the high input redundancy, heat supply, and power supply carbon emission intensity. The input-output structure and resource allocation must be changed to reflect the rates of deficiency and redundancy. This research can provide managers with targeted policy recommendations to help power corporations develop sustainably. In spite of the knowledge acquired from prior research, the Indian thermal power plant remains unexplored in terms of the impact of carbon emission efficiency. This gap in research presents an opportunity for further exploration and analysis of the carbon emission efficiency of Indian thermal power plants. As a result, the study's primary goal is to evaluate an Indian thermal power plant's efficiency using carbon emissions—an undesirable output—as a crucial metric. The study intends to close this vacuum in the literature by shedding light on the present situation of carbon emissions from Indian thermal power plants and pointing out areas in need of development.

3. Methodology

There are two primary types of DEA models: radial and non-radial. Based on the current input or output levels, radial models concentrate on either decreasing all inputs proportionately (input efficiency) or raising all outputs proportionately (output efficiency) (Fried et al., 2008). The only goal of radial input (output) orientated models is to maximise input (output) efficiency; non-radial slacks are not taken into consideration during the estimate process (Apergis et al., 2015). A non-radial subset of the DEA model called the Slack-Based Model (SBM) is utilised to calculate efficiency. Because SBM takes into account both input excesses and output shortfalls, it is more discriminating than the radial model. Moreover, it is unaffected by the statistical properties of the entire dataset, declines steadily with rising input and decreasing output, and is independent of the unit of measurement (Tone, 2001). According to Apergis et al., (2015), the models that are non-radial and non-oriented have the best success rate in capturing all efficiency metrics associated with undesired outputs. The goal of the non-radial, non-oriented notion is to reduce inputs and undesirable outputs in order to improve sound output. To create the SBM for the technology set T, which consists of n DMUs (j : 1,..., n), the study used Tone's methodology. It was assumed that the DMUs generate s1 acceptable outputs (r : 1,..., s_1) and s_2 disagreeable outputs (r : 1,..., s_2) using m common inputs. In the event of undesirable results, the non-oriented SBM model is constructed as follows:

$$p^* = min\left[\frac{1-\frac{1}{m}\sum_{i=1}^{m}\frac{s_i^-}{X_{io}}}{1+\frac{1}{s_1+s_2}\left(\sum_{r=1}^{s_1}\frac{s_r^g}{y_{r_0}^g}+\sum_{r=1}^{s_2}\frac{s_r^b}{y_{r_0}^b}\right)}\right] \qquad (i)$$

Subject to:

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{io};\ \ i = 1,2,\dots,m, \qquad (ii)$$

$$\sum_{j=1}^{n} \lambda_j y_{rj}^g - s_r^g = y_{ro}:\ r = 1,2,\dots,s_1, \qquad (iii)$$

$$\sum_{j=1}^{n} \lambda_j y_{rj}^b + s_r^b = y_{ro};\ \ r = 1,2,\dots,s_2, \qquad (iv)$$

$$\lambda_j \geq 0, (\forall j); s_i^- \geq 0, (\forall i);\ s_r^g \geq 0, (\forall r), j = 1,2,\dots n \qquad (v)$$

In this context s_i^- and s_r^b represent an excess of inputs and undesirable outputs, respectively; s_r^g represents a deficiency of desirable outputs; and λ_j are intensity variables produced by the best linear programming solution. For all s_i^-, s_r^g and s_r^b,, the objective function, Eq. (vi), is a constant decreasing function, and p^* is in the range of$0 \leq p^* \leq 1$. The efficiency of a DMU is dependent on $p^* = 1$, at which point all the input and output slacks are equal to zero, because the optimal solution dominates $\lambda^*, s_i^{-*}, s_r^{g^*},\ and\ s_r^{b^*}$.

According to Charnes & Cooper (1962), equation (i) can be converted into a linear programming problem in the following way:

$$\tau^* = min\left(t - \frac{1}{m}\sum_{i=1}^{m}\frac{s_i^-}{x_{io}}\right) \qquad (vi)$$

Subject to:

$$t + \frac{1}{s_1 + s_2}\left(\sum_{r=1}^{s_1}\frac{s_r^g}{y_{r_0}^g} + \sum_{r=1}^{s_2}\frac{s_r^b}{y_{r_0}^b}\right) = 1 \qquad (vii)$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{io}t;\quad i = 1,2,\dots,m, \qquad (viii)$$

$$\sum_{j=1}^{n} \lambda_j y_{rj}^g - s_r^g = y_{ro}t:\quad r = 1,2,\dots,s_1, \qquad (ix)$$

$$\sum_{j=1}^{n} \lambda_j y_{rj}^b + s_r^b = y_{\mathrm{r}o}t;\quad r = 1,2,\dots,s_2, \qquad (x)$$

$$\lambda_j \geq 0, (\forall j); s_i^- \geq 0, (\forall i);\ s_r^g \geq 0, (\forall r); t > 0; j = 1,2,\dots,n \qquad (xi)$$

Further, following Banker et al.(1984); convexity constraint that is, $e\lambda = 1$ added for the Variable returns to scale (VRS).

Additionally, the convexity constraint, denoted as eλ=1, has been introduced to the variable returns to scale (VRS) in accordance with Banker et al. (1984). It is important to mention that τ^* demonstrates technical efficiency, which aims to reduce inputs while producing both desirable and undesirable outputs.

4. Data and Variables

The study used 'CDM-CO2 Baseline Data' from the Central Electricity Authority, Government of India, for various years. A single performance indicator cannot evaluate Indian thermal power plants. This study measures energy generation, installed capacity, coal and oil use, and auxiliary power consumption as input and output variables. Gigawatt hours of electricity generation and metric tonnes of CO2 emissions are taken as desirable and undesirable output variables, respectively. Power plants have a long gestation period, making capital cost data unavailable. Therefore, installed capacity is employed as a surrogate for capital in the input variables. Specific coal consumption (SPCC) in metric tonnes and specific oil consumption (SPOC) in litres are input variables. Additionally, power plants also uses some of the electricity they create in the form of auxiliary power consumption which is estimated by subtracting electricity used from total generation. The efficiency analysis for 2017-18 to 2021-22 evaluates thermal power generation trends and CO2 emissions. The study seeks to understand the sector's efficiency and sustainability by examining input factors and output indicators across five years.

5. Results and Discussions

The average efficiency scores of different Indian thermal power plants from 2017–18 to 2021–22 is shown in Table 1. Since there was a considerable probability of excessive variation in efficiency scores in cross-sectional tests for each year, the efficiency scores were pooled rather than estimated on a frontier particular to each year. This approach allowed for a more accurate representation of the overall efficiency trends across the years. By pooling the efficiency scores, it was easier to identify any consistent patterns or improvements in performance over time. Additionally, this method helped to mitigate the potential impact of outliers or anomalies in individual year data on the overall analysis of efficiency in Indian thermal power plants. This methodology allowed for a more thorough examination of the general efficiency trends in the Indian thermal power plants. The most efficient thermal power plant out of all of them is one that has an efficiency score of one on the efficiency frontier. This indicates that the fuel can be converted into electricity with the maximum percentage of useful energy and the least amount of wasted energy. It is a remarkable accomplishment to get an efficiency score of one, which represents the pinnacle of thermal power generating technology. Because of their high efficiency, these power plants not only have fewer negative environmental effects, but they also save money by producing more electricity from the same fuel.

Table 1: Efficiency Scores of Indian Thermal Power Plants

DMU	2017-18	2018-19	2019-20	2020-21	2021-22	Average	Rank
AMAR KANTAK	1.000	1.000	0.966	0.911	0.791	**0.934**	6
ANPARA	0.621	0.789	0.698	0.642	0.661	**0.682**	18
BAKRESWAR	0.663	0.643	0.569	1.000	0.769	**0.729**	13
BANDEL	0.428	0.360	0.344	0.386	0.431	**0.390**	58
BARH STPP II	0.855	1.000	1.000	1.000	0.741	**0.919**	7
BELLARY TPS	0.478	0.498	0.378	0.420	0.458	**0.446**	48
BHILAI TPP	1.000	0.824	0.710	1.000	0.766	**0.860**	10
BHUSAWAL	0.532	0.585	0.455	0.455	0.484	**0.502**	32

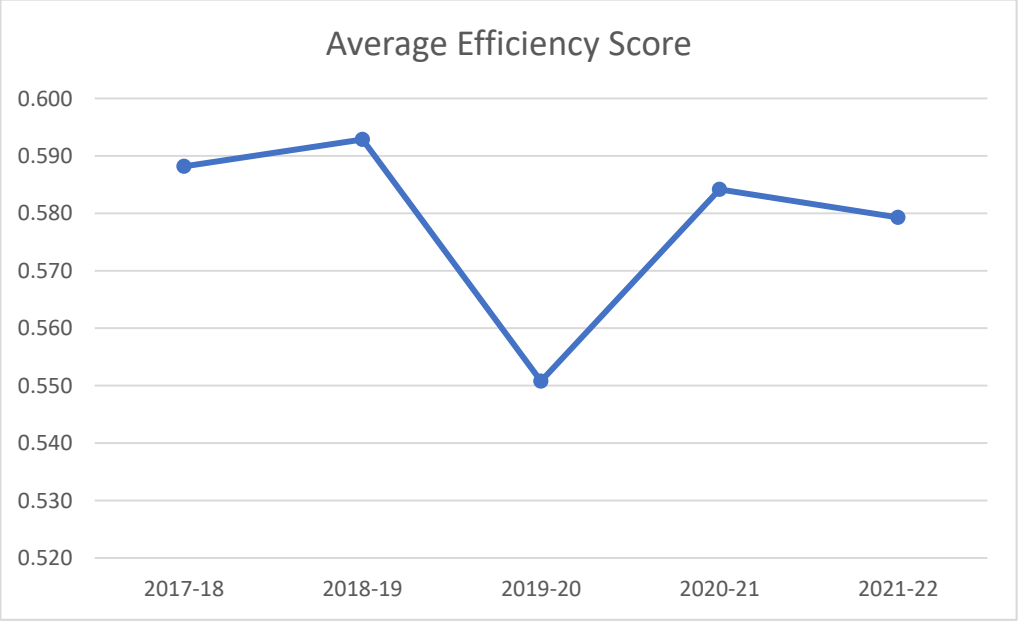
CHANDRAPUR_Coal	0.544	0.567	0.485	0.546	0.471	**0.522**	27
CHANDRAPURA	0.721	0.768	0.685	0.817	0.651	**0.728**	14
CHHABRA TPS	1.000	0.682	0.588	0.737	0.543	**0.710**	16
D.P.L.	0.437	0.432	0.451	0.506	0.469	**0.459**	46
DADRI (NCTPP)	0.663	0.659	0.438	0.387	0.443	**0.518**	30
DURGAPUR	0.480	0.459	0.470	1.000	0.655	**0.613**	22
FARAKKA STPS	0.582	0.676	0.561	0.543	0.530	**0.578**	25
GANDHI NAGAR	0.515	0.534	0.403	0.443	0.469	**0.473**	39
GHTP (LEH.MOH.)	0.433	0.380	0.378	0.400	0.377	**0.394**	57
H_GANJ B	0.584	0.548	0.525	0.402	0.369	**0.486**	37
I.B.VALLEY	0.363	0.405	0.388	0.523	0.636	**0.463**	45
INDRA GANDHI STPP	0.570	0.526	0.372	0.449	0.565	**0.497**	33
K_GUDEM NEW	0.430	0.563	0.633	1.000	1.000	**0.725**	15
K_KHEDA II	0.361	0.389	0.403	0.421	0.373	**0.389**	59
KAHALGAON	0.695	0.675	0.698	0.578	0.682	**0.666**	19
KAKATIYA TPP	0.864	1.000	1.000	1.000	0.847	**0.942**	5
KODERMA	0.872	1.000	0.786	1.000	0.906	**0.913**	9
KOLAGHAT	0.334	0.307	0.268	0.308	0.330	**0.309**	64
KORADI	0.509	0.333	0.411	0.403	0.473	**0.426**	52
KORBA STPS	0.941	0.918	0.867	1.000	1.000	**0.945**	3
KORBA-WEST	0.631	0.680	0.531	0.546	0.506	**0.579**	24
KOTA	0.490	0.545	0.428	0.411	0.466	**0.468**	40
MEJIA	0.474	0.475	0.473	0.557	0.474	**0.490**	34
METTUR	0.552	0.638	0.532	0.465	0.514	**0.540**	26
MOUDA STPS	0.431	0.607	0.555	0.425	0.584	**0.520**	28
NORTH CHENNAI	0.542	0.549	0.475	0.387	0.385	**0.468**	41
OBRA-A	0.382	0.420	0.349	0.382	0.369	**0.380**	63
PANIPAT	0.421	0.508	0.524	0.450	0.509	**0.482**	38
PARAS	0.571	0.483	0.456	0.482	0.444	**0.487**	35
PARICHA	0.548	0.468	0.423	0.420	0.463	**0.464**	43
PARLI	0.378	0.410	0.373	0.404	0.429	**0.399**	56
R_GUNDEM – B	1.000	1.000	1.000	1.000	1.000	**1.000**	1
R_GUNDEM STPS	0.826	0.786	0.771	0.743	0.792	**0.784**	11
RAICHUR	0.538	0.457	0.475	0.378	0.383	**0.446**	49
RAJIV GANDHI_TPS HISAR	0.491	0.499	0.447	0.480	0.638	**0.511**	31
RIHAND	1.000	1.000	1.000	0.911	0.861	**0.955**	2
ROPAR	0.394	0.394	0.381	0.381	0.365	**0.383**	61
SAGARDIGHI TPP	0.388	0.411	0.447	0.626	0.728	**0.520**	29
SANJAY GANDHI	0.468	0.568	0.440	0.549	0.405	**0.486**	36
SANTALDIH	0.696	0.526	0.570	0.674	0.716	**0.637**	21
SATPURA	0.390	0.413	0.390	0.399	0.672	**0.453**	47
Shri Singaji MALWA TPP	0.351	0.358	0.407	0.370	0.431	**0.383**	60
SIKKA REP.	0.866	0.885	1.000	0.836	1.000	**0.918**	8
SIMHADRI	0.649	0.684	0.585	0.522	0.605	**0.609**	23
SINGRAULI STPS	0.746	0.765	0.780	0.740	0.694	**0.745**	12
SIPAT STPS	1.000	1.000	0.929	0.911	0.873	**0.943**	4
SURATGARH	0.351	0.416	0.357	0.387	0.398	**0.382**	62
TALCHER STPS	0.728	0.692	0.620	0.696	0.731	**0.693**	17
TANDA	0.466	0.347	0.329	0.421	0.498	**0.412**	55
TENUGHAT	0.397	0.402	0.467	0.467	0.471	**0.441**	50
TUTICORIN	0.431	0.539	0.428	0.353	0.347	**0.420**	53
UKAI_Coal	0.516	0.537	0.482	0.412	0.391	**0.467**	42
UNCHAHAR	0.566	0.441	0.450	0.416	0.448	**0.464**	44
VIJAYWADA	0.442	0.450	0.425	0.385	0.497	**0.440**	51
WANAKBORI	0.389	0.421	0.348	0.433	0.472	**0.413**	54
YAMUNANAGAR TPP	0.659	0.649	0.672	0.690	0.625	**0.659**	20
Average	0.588	0.593	0.551	0.584	0.579	**0.579**	
Source: Author's Calculations							

The thermal power plant R_GUNDEM-B has been found to run at the highest level of efficiency, as indicated by its average score of one for this specific DMU. R_GUNDEM-B exemplifies exceptional efficiency, establishing a benchmark for other thermal power plants to aspire to. This guarantees a future of energy production that is more sustainable and environmentally conscious. The KOLAGHAT thermal power plant has been determined to be the least efficient, with an average efficiency score of 0.309. This indicates that there is a substantial potential for enhancement, estimated at around 69.1 percent on an annual basis.

Enhancing the efficiency of the KOLAGHAT thermal power plant has the capacity to significantly diminish its environmental footprint and enhance its overall operational effectiveness. With a low efficiency score of 0.309, it is evident that there are areas in which the plant may be optimised to enhance its operational effectiveness.

Furthermore, it has been shown that the majority of the DMUs, approximately 32, exhibit low efficiency, with efficiency scores below 0.5. This indicates a significant opportunity for improvement across multiple areas within the plant. By targeting these underperforming DMUs and implementing targeted efficiency improvements, the plant can make significant strides towards reducing its environmental impact and improving overall operational effectiveness. Through the implementation of strategic measures and advanced technology, the plant will effectively enhance its operational efficiency, resulting in substantial reductions in input consumption and emissions.

Fig1: Intertemporal Efficiency Score



Source: Author's Compilation

As far as intertemporal efficiency is concerned, it has been found that there is a slight decrease in efficiency from 2017-18 to 2019-20, but then a slight increase in efficiency from 2019-20 to 2021-22 (fig 1). This suggests that there may have been fluctuations in performance over the years, but on average, the thermal power facilities in India have maintained relatively consistent efficiency levels.

The results indicate that thermal power plants must enhance their efficiency score, which is currently at an average of 0.579, in order to align with sustainable practices. It is crucial for thermal power facilities in India to prioritise the enhancement of their efficiency in order to comply with sustainable practices. Improving efficiency not only benefit the environment by reducing emissions and conserving resources, but it also leads to cost savings for the facilities themselves.

6. Conclusion and Policy Implications

Efficiency ratings for thermal power plants in India were examined for the years 2017–18 through 2021–22. With an efficiency score of one, R GUNDEM-B proved to be the most cost-effective and environmentally friendly plant. A score of 0.309 indicated that KOLAGHAT was the least efficient plant. Efficiency in relation to the environment was assessed using the slack-based undesired DEA model.

This model takes into account not only the input and output measures of the power plants, but also the undesirable outputs such as carbon dioxide emissions. The results of the analysis revealed that while R GUNDEM-B excelled in terms of efficiency and environmental impact, KOLAGHAT lagged behind in both areas. Overall, the slack-based undesired DEA model provided a comprehensive evaluation of the power plants, highlighting the importance of considering not only the desired outputs but also the negative impacts on the environment. The results clearly demonstrated the significant difference in performance between R GUNDEM-B and KOLAGHAT, emphasizing the need for the latter to improve its efficiency and reduce its environmental footprint. Moving forward, these findings can inform decision-making processes and drive initiatives towards more sustainable and eco-friendly operations in the power generation industry. It suggests that investing in more environmentally friendly technology and practices could lead to improved efficiency and reduced negative impact on the environment. For example, by investing in newer, more efficient technologies, such as supercritical and ultra-supercritical boilers, thermal power facilities can significantly reduce their carbon footprint and increase their overall efficiency. Additionally, implementing energy-saving practices like regular maintenance and operational optimization can further enhance the efficiency of these facilities. By adopting these strategies, thermal power facilities in India can not only meet sustainable practices but also improve their bottom line through reduced operational costs. To further enhance energy-saving practices in thermal power facilities, it is recommended to regularly monitor and analyse energy consumption data to identify areas for improvement. Implementing strategies such as retrofitting older equipment with energy-efficient models can also result in significant energy savings. Additionally, conducting regular energy audits and training staff on best practices for energy conservation can help ensure that these plants operate at peak efficiency levels. By taking these actionable steps, thermal power facilities can continue to reduce their environmental impact and save on operational costs.

Therefore, it is crucial for the power generation industry to prioritize sustainability and environmental responsibility in order to meet the growing demands for clean energy. With advancements in technology and a shift towards renewable energy sources, the industry has the opportunity to make a significant impact on both the environment and future generations. By taking proactive steps now, power plants can pave the way for a more sustainable and environmentally conscious future. The policy implications of technological breakthroughs and the transition to renewable energy indicate that government laws have to promote and incentivise thermal power plants to implement sustainable practices. Policymakers may advance the industry towards a more sustainable future by enacting laws that encourage renewable energy utilisation and enforce stronger environmental regulations. Moreover, investing in research and development for clean energy technology might enhance the transition to a more sustainable power producing sector. Prioritising sustainability in policy decisions would help the environment and yield long-term cost savings for power plants and consumers both.

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Impact of Socio-Economic Factors in Decision Making Skill of Women Engaged in Agriculture as Cultivators and Agricultural Labours: A Comparative Analysis

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Abstract

This study examines how socio-economic factors (SE) affect the decision-making skills of women engaged in agricultural activities in Kerala, a state in India with a substantially higher percentage of literacy, especially for women, and places the greatest emphasis on women's empowerment. Using a multi-stage stratified random sampling technique, 360 women agriculturalists throughout the state's three regions where women's involvement in agriculture is higher were selected for the study. The structural equation model (SEM) used for analysis in this study described the influence of socio-economic features of women agriculturalists on their ability to make decisions. All of the socio-economic constructs such as “Access to Land and Property Rights", “Access to Financial Resources”, “Market Access and Pricing”, “Education and Training,” and “Cultural and Gender Norms” were found to have statistically significant coefficients, which indicated that the SE of the women agriculturalists analyzed in this study has a substantial impact on their capacity to solve problems effectively and to make decisions. It is further identified that there is a significant difference in the influence of socio-economic factors on decision-making ability between women cultivators and women agricultural laborers using one-way ANOVA. And using MANOVA, it was found that there is significant variation in the access to various socio-economic factors according to the categories of women agriculturalists. Based on the coefficient value, “Access to Financial Resources” impacts the decision-making capability of women the most, with an unstandardized coefficient value of 0.53. Results from this research will also assist administrators in the agricultural industry in laying the groundwork for efficient formulation of policies pertaining to women's empowerment in agriculture.

Keywords: decision-making skill; women; agricultural labor; cultivators; socio-economic factors

1. INTRODUCTION

Women have long had a multifaceted and important role in society, contributing significantly to domestic, commercial, and agricultural fields when labour needs were taken into account. Up to 60% of farmers are considered to be female, and they are believed to do 70% of the real farm labour (Choudhary and Singh 2003). This has been further stated by FAO (2017). According to FAO (2017), rural women make up one-quarter of the global population and nearly half of the agricultural work force in developing countries. Women have important roles in contributing towards food security, including cultivation, processing, marketing activities, and consumption in households and nutrition (FAO, 2011). Traditionally, women have been integral to the agricultural industry as wage workers, family laborers, co-farmers, farmers, and farm managers. Women have always been responsible for the selection, preservation, growth and development, and distribution of seed stock. They have worked in related fields including horticulture, cattle, and fisheries in addition to agricultural agriculture (Rao, 2021). According to Manda et al. (2015), women contribute more labour to agricultural output than men do, and they also work four hours longer on productive farms (Ladusingh, 2017). Although women make up the majority of the agricultural workforce globally, their labour is mostly underpaid.

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Nonetheless, they experience prejudice and are often in a poor negotiating position. Furthermore, other types of unfair treatment (based on race, class, caste, or religion) frequently compound gender inequalities (UN Women, 2014). The diminishing involvement of the state in the farming sector in the late 1980s and 1990s exacerbated female farmers' marginalization by limiting their access to supplies, resources, and services (UN Women, 2014). Rural women endure uneven power dynamics throughout both the family and the larger community, which have an influence on different aspects of food security. Women's opportunities as farmers were limited by societal stereotypes that males are stronger than women, and they were forced to perform labour-intensive or basic tasks in their fields (Rao, 2006). This stereotype has led to little influence of women in the decisions made about different aspects of agriculture and households, though she performs the most arduous work in houses, farms, and animal care.

Each household needs a decision-making process since the effectiveness of family resource management depends on how well decisions are made (Godara et al., 2014). Rural women's contributions have not received much consideration, as it is viewed as highly unacceptable to respect women's decisions. This is due to the fact that women's skills have been disregarded and weakened since creating policy has historically been seen as a male task (Godara et al., 2014). Women have fewer possibilities for navigating any crisis and face greater risks than men of sacrificing their assets due to the barriers they face in accessing extension services, monetary resources, and farming resources; in addition, they have limited legal advantages and security; substantial time burdens; and a lack of leadership power (Botreau and Cohen, 2020). Contrary to popular belief, intrafamily dynamics do not exist in a vacuum from socioeconomic influences (Aggarwal, 1997). The decision-making and bargaining power of women in houses may be characterized by a number of quantitative characteristics that go beyond income. Making sure that women are capable of making decisions at the farm level is essential. They are mostly excluded from decision-making processes that impact their financial well-being, and female agricultural output is still lower than that of males. The conventional norms still include formalized restrictions on what women can do inside their four walls, as well as poor living and working decisions (Nain and Kumar, 2010).

In general, women are considered to be the most oppressed and disadvantaged group in India's agricultural sector, despite their significant engagement, and they want credit and compensation for their hard work. In this background, the current research examines the impact of socio-economic factors on the decision-making abilities of women engaged in agriculture as cultivators and agricultural labourers in the state of Kerala.

2. REVIEW OF LITERATURE

There are several studies on women's empowerment and how their socio-economic factors influence their ability to take decisions. Young (1993) asserts that empowerment gives women the ability to make decisions about their own lives. Women's empowerment stands apart from other theories in part because it emphasizes the necessity for them to have a significant role as reformers in the process of transformation. A crucial component of empowerment and one that enhances a woman's overall wellbeing is her capacity to make choices that impact her own unique situation, as stated in the study of Acharya et al. (2010). This is not different in the case of women engaged in agriculture. Das (2023) used an ex post facto research design to carry out a study in the Indian area of North Bengal. The study revealed that the majority of farm women make decisions about the farm in tandem with their male family members; their degree of decision-making capacity was judged to be medium, and the independent factors The key elements influencing rural women's decision-making abilities regarding farm management include information sharing, limitations, communication skills, sources of farm information, land ownership, scientific orientation, and farm expertise. A woman's opinion is heeded

whether she is elderly or the head of the family—a mother, grandmother, mother-in-law, or daughter—but she is not expected to make autonomous decisions. Women's ability to make decisions is also influenced by the size and nature of their families. In nuclear families, men and women make decisions together, while in joint families, the male leader of the home makes most of the decisions (Kavitha and Kumar, 2012). According to research by Mittal et al. (2013), women still play a little part in decision-making when it comes to important agricultural operations, despite an increase in their labour share. Cultural and societal constraints, as well as the gender disparity in terms of awareness, experience, and education, limit this. The study discovered that women play distinct roles in particular activities within the wheat production chain, with modest variations between states. When the role of women in decision-making at the various stages of wheat production is examined, it is discovered that nearly all decisions about the technology to be used, the marketing, storage, and consumption of produce are made by men alone, occasionally in conjunction with women in the household, and pertain to all states under study. Fewer than 1% of homes have indicated that women make all of the decisions. Hence, still the problem of equal involvement in the decision-making exists.

Though this has been contradicted by Aregu et al. (2011). According to Aregu et al. (2011), women are frequently contacted during the decision-making process and, if they possess the necessary skills, can have an impact on the decision's result. Women handle the majority of choices and actions pertaining to raising livestock and selling produce in poor nations (Khan et al., 2012). It is recognized that because women engage in a wide range of activities, their responsibilities in agriculture are significantly greater than those of men. However, it states that farm women in communities are overworked and completely absorbed with managing the home, the land, and the livestock.

3. OBJECTIVES

The objectives of the present study are:

- To analyze the influence of the demographics of women agriculturalists on their decision-making
- To examine how socio-economic factors affect women agriculturalists differently based on their roles as agricultural labourers and cultivators.
- To evaluate and compare the overall decision-making skills of women agriculturalists in their roles as agricultural labourers and cultivators.
- To examine the effect of socio-economic factors on the decision-making skills of women engaged in agriculture

4. METHODOLOGY

This descriptive study was based on a quantitative, cross-sectional, correlational, non-experimental analysis. The population under investigation is comprised by all women who work in agriculture, either as cultivators or as agricultural labourers. The study is based on primary data that was collected from a subgroup of women who work in agriculture using a standardized questionnaire. A pilot study was conducted using the original survey that was given to fifty women who worked in agriculture. The preliminary questionnaire was revised after a thorough study of the data from 56 respondents was carried out, identifying any deviations. Therefore, a reliability study was carried out on the responses pertaining to the socio-economic factors impacting women decision making using 30 statements that were evaluated on a five-point scale.

Table 01. Cronbach Alpha for the variables selected for the study

SL. No	Variable	No of Statements	Cronbach's Alpha
1	Access to Land and Property Rights (ALP)	05	**0.945**
2	Access to Financial Resources (AFR)	05	**0.948**
3	Market Access and Pricing (MAP)	05	**0.918**
4	Education and Training (ET)	05	**0.936**
5	Cultural and Gender Norms (CGN)	05	**0.961**
6	Decision Making (DM)	05	**0.926**

Source: Survey data

Considering a 5 percent level of significance in the estimates of the means of the 56 responses, the sample size was calculated using the variance data from the pilot study. With "d" representing the standard error of the population parameter estimate, "s" denoting the estimated standard deviation, "n" representing the sample size, and 1.96 representing the critical value from the normal test at the five percent significance level, the formula $n \geq (1.96\ s/d)^2$ is utilized. The computed sample size of 343 was the greatest of all the sample sizes obtained from the answers to all the claims. Consequently, a final sample size of 360 was determined for the study.

To choose a sample of women agriculturalist from the entire population of women employed in agriculture, a multi-stage stratified random sampling technique was used. Kerala was therefore split into three zones in the first stage: the South, Central, and North zones. The women agriculturalist was then categorized based on whether they are agricultural labours or cultivators. In phase two, a district was selected from each zone. Idukki district was chosen from south zone, Palakkad District from central zone and Wayanad district from north zone having highest population of women engaged in agriculture as cultivators and agricultural labours based on 2011 census data. In the third stage, women agriculturalist was selected proportionately from each category in each district in order to provide the required sample size of 360 (120 from each district and 60 from each category).

Quantitative data was entered in Microsoft Excel and subsequently cleaned, organized, coded, and analyzed using SPSS 23 (George and Mallery, 2016). The demographic characteristics of the respondents were explained through the use of a descriptive analysis. The study employed a Chi-square test for examining the association between the demographic factors and decision- making skill of women agriculturalist. MANOVA, and one-way ANOVA used to investigate sector wise comparison of impact of socio-economic factors of women agriculturalist and sector wise comparison of decision-making skill of women agriculturalist respectively. Furthermore, SEM was developed to investigate how five essential elements affecting the decision-making skill of women's' employed in agriculture. To determine whether the sample size was sufficient, the Kaiser-Meyer-Olkin (KMO) and Barlett's Test of Sphericity (BTS) were utilized. Table 02 shows the results of the KMO and BTS tests. The BTS was significant with 68.14 of the total variances recovered ($\chi 2 = 4356.478$, $p<0.000$).

Table 02. KMO and Bartlett's Test

KMO Measure of Sampling Adequacy.		.826
BTS	Approx. Chi-Square	4356.478
	Df	359
	Sig.	.000

Source: Survey data

The results of the test of normality are shown in table 03 below, with a statistically insignificant normality of 0.24 (p = 0.256). As a result, the Shapiro-Wilk test result is 0.947. It depicts a correctly distributed set of data.

Table 03. Test of Normality

	Kolmogorov-Smirnova [a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Quartile	0.241	254	.256*	0.947	254	0.365

This is a lower bound of the true significance.

Lilliefors Significance Correction”

Source: Survey data

5. RESULTS

5.1 Demographic characteristics of women engaged in agriculture

Around half of the respondents reside in rural areas (48.89 percent). 70 percent of the respondents belong to the age group of 31- 50. The majority of the women agriculturalists are married. Most of them followed Hinduism. Around 80 percent of them belong to the nuclear family, with 46 percent of respondents having 4 members in the family. Most of the respondents have an educational qualification of high school and above. With regards to education, 36 percent of respondents have experience between 5 and 10 years (table 04).

Table 04. Demographics features

Variables	**Category**	**No. of respondents**	**%**
Area of residence	Urban	105	29.17
	Semi-urban	79	21.94
	Rural	176	48.89
Age (in years)	21-30	41	11.39
	31-40	109	30.28
	41-50	151	41.94
	51 and above	59	16.39

Marital Status	Married	304	84.44
	Unmarried	49	13.61
	Widow/widower	7	1.94
Religious affiliation	Hindu	214	59.44
	Muslim	54	15.00
	Christian	92	25.56
	others	0	0.00
Family pattern	Nuclear	288	80.00
	Joint	72	20.00
Number of family members	3	39	10.83
	4	169	46.94
	5	73	20.28
	6	38	10.56
	7	34	9.44
	8	7	1.94
Academic level	Primary	26	7.22
	High School	129	35.83
	Higher Secondary	63	17.50
	Graduation	48	13.33
	Others	94	26.11
Experience	Below 1	24	6.67
	1 year- 5 year	84	23.33
	6 year- 10 year	132	36.67
	Above 10	120	33.33

Source: Survey data

5.2 Effect of Demographics of women agriculturalist on decision making

The results of chi-square tests are shown in Table 05, which shows that there is no significant correlation between the sample of demographics of women agriculturalist and decision making. These factors include age, educational attainment, and experience. The p-values were all more than 0.05.

Table 05. Demographic influences on Women Agriculturalist and Decision Making

Demographics	Chi-square	p- Value
Age	56.321	0.241
Education	73.325	0.448
Experience	88.369	0.612

Source: Survey data

5.3 Sector wise comparison of Socio-economic (SE) measures of Women Agriculturalist

The MANOVA test was used to examine the differences in access socio-economic measures of women engaged in agriculture as agricultural labours and cultivators. Tables 06, 07, and 08 below present the analysis' findings.

Table 06. MANOVA (SE)

Effect		Value	F-value	Sig.
Intercept	Pillai's Trace	.914	14585.516[b]	.000*
	Wilks' Lambda	.005	14585.516[b]	.000*
	Hotelling's Trace	114.369	14585.516[b]	.030*
	Roy's Largest Root	114.369	14585.516[b]	.000*
Agricultural categories	Pillai's Trace	.066	2.596	.020*
	Wilks' Lambda	.978	2.4[b]	.013*
	Hotelling's Trace	.061	2.448	.014*
	Roy's Largest Root	.043	3.748[c]	.005*

Source: Survey Data; *Significant at 5 per cent level

Table 07. Tests of Between-Subjects Effects- (SE)

Source	Dependent Variable	F	Sig.
Categories	Access to Land and Property Rights (ALP)	6.125	.002*
	Access to Financial Resources (AFR)	3.236	.031*
	Market Access and Pricing (MAP)	4.569	.003*
	Education and Training (ET)	4.614	.015*
	Cultural and Gender Norms (CGN)	4.125	.018*

Source: Survey Data; Significant at 5 per cent level

Table 08. Mean scores of SE variables

SE Variables	Sectors	Mean	Std. Error
Access to Land and Property Rights (ALP)	Cultivators	48.145	.296
	Agricultural labours	51.569	.741
Access to Financial Resources (AFR)	Cultivators	54.569	.378
	Agricultural labours	58.289	.895
Market Access and Pricing (MAP)	Cultivators	30.369	.189
	Agricultural labours	34.556	.639
Cultural and Gender Norms (CGN)	Cultivators	33.251	.369
	Agricultural labours	31.254	.457
Education and Training (ET)	Cultivators	68.145	.144
	Agricultural labours	65.361	.896

Source: Survey Data

The aggregate mean scores of the employers on the five socio-economic measures for the two categories were significantly different, as shown in Tables 05, 06, and 07, respectively. At the 5% level, the potent Pillai's Trace test-driven MANOVA is significant (p=0.01). When the five sector-based variables are taken into account independently, the variation can be found statistically significant for all the variables in the test of Between-subject effects (p=0.002, 0.031, 0.003, 0.015, 0.018).The Estimated Marginal Means of the variables show that women agriculturalist engaged as cultivators have higher levels of "Access to Land and Property Rights (ALP)", "Access to Financial Resources (AFR)", "Market Access and Pricing (MAP)" than women engaged as agricultural labours and women engaged as agricultural labours have higher level of "Cultural and Gender Norms (CGN)" and "Education and Training (ET)" than women engaged as cultivators .

5.3 Sector wise comparison of Decision-Making skill of Women Agriculturalist

One Way ANOVA was used to assess the variation in the "Decision-Making Skill" of women engaged in various sectors of agriculture as cultivators and labours in the state, and the findings are shown in Tables 09 and 10.

Table 09. Sector wise Estimated Marginal Means of Decision- Making Skill

Sectors (Independent variable)	Mean	Std. deviation
Agricultural Labours	41.2569	3.56474
Cultivators	45.2478	2.78412
Total	43.4084	3.17443

Source: Survey Data

Table 10. One way ANOVA

Tests of Between-Subjects Effects					
Decision- Making Skill (Dependent Variable)					
Source	Sum of Squares	df	Mean Square	F	Sig.
Between sectors	269.147	3	139.845	15.478	.000
Within sectors	3415.2697	356	8.569		
Total	3568.857	359			

Source: survey data; **Significant at 1 per cent level

The ability of women engaged in agriculture to take decision in matters related to agriculture varies significantly depending on the category of agriculture they have been involved, as seen in Tables 07 and 08 above. The average decision- making skill scores for women involved in agriculture as agricultural labours and cultivators are 41.2569, and 45.2478 respectively. At a 5 per cent level, the mean variation is statistically significant (F value 15.478, and p value less than 0.05). Thus, it can be

stated that among the two categories, women engaged as cultivators have the highest level of decision-making skill, followed by women engaged as agricultural labours.

5.4. Effect of Socio-economic factors on decision making skill of women engaged in agriculture

5.4.1 Calculating model, reliability and validity

Confirmatory factor analysis (CFA) has been undertaken before SEM. The CFA technique, which examines measurement models that are constructed a priori, explicitly defines the number of components and their relationship to the indicators. CFA (fig. 1) is used to assess the model's fit to the data. The CFA results are displayed in the table below. Table 11 shows that utilizing a higher number of samples (sample size = 360) resulted in a computed value of 0.1000, which is less than the value of 0.05. Conversely, the model's well-fitting is indicated by the CMIN/DF ratio of 2.654, which resolves the previously mentioned problem. In this case, the CFI value is 0.943. Additionally, the findings indicate that the root mean square residuals (RMR) and root mean square error of approximation (RMSEA) are 0.0365 and 0.0421, respectively, below the generally accepted 0.08 proposed by Hair et al. (2006).

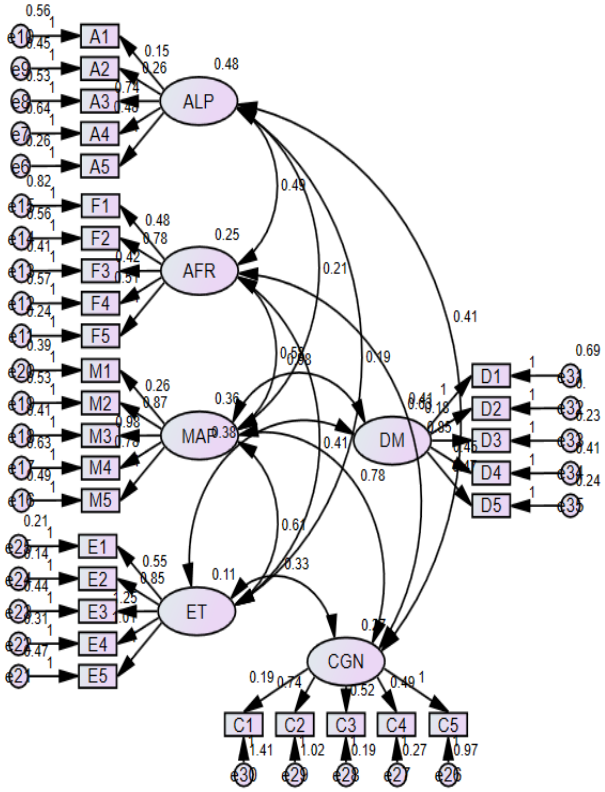

Fig. 01 Confirmatory Factor Analysis

Table 11. CFA Results

Indices	Model fit Result	Suggested value
CMIN/DF	2.654	< 5.00 (Hair et al., 1998)
P value	0	> 0.05 (Hair et al., 1998)
GFI	0.991	> 0.90 (Hu and Bentler, 1999)
AGFI	0.945	> 0.90 (Hair et al. 2006)
NFI	0.92	> 0.90 (Hu and Bentler, 1999)
CFI	0.943	> 0.90 (Hooper et al., 2008)
TLI	0.963	> 0.90 (Byrne, 1994)
RMR	0.0365	< 0.08 (Hair et al. 2006)
RMSEA	0.0421	< 0.08 (Hair et al. 2006)
PNFI	0.745	> 0.50
PCFI	0.654	> 0.50

Source: Survey data

Hair et al. (2006) state that even when the model satisfies the model of measurement fit criteria, it is important to consider the construct validity and dependability of the model before moving on to the structural model. According to Hair et al. (2010), the measuring framework for latent ideas must satisfy the three categories of validity: discriminant validity, convergent validity, and construct validity. The measurement model's fitness indexes are used to evaluate construct validity, the average variance extracted (AVE) is used to evaluate convergent validity, and a summary of the discriminant validity index is generated to evaluate discriminant validity. Using IBM SPSS AMOS, we assessed and calculated the component-to-component correlation coefficient. The results demonstrate that no component has a correlation value with any other component that is higher than 0.85. Consequently, this study may suggest that the measurement model's construct has achieved discriminant validity.

5.4.2 SEM analysis

The impact of variables like “Access to Land and Property Rights", “Access to Financial Resources”, “Market Access and Pricing”, “Education and Training,” and “Cultural and Gender Norms” on decision making skill of women involved in agriculture has been investigated by a SEM utilizing AMOS. Table 12 demonstrates that the calculated p value is 0.026, which was less than 0.05, as a result of a larger sample size of n = 360. Nevertheless, the issue appears to have been resolved based on the CMIN/DF ratio of 4.269, which denotes a perfect match. The construct measurements yielded a chi-square value of 27.697 (df = 20), indicating a statistically significant fit for the model. The current dataset shows a perfect match with values greater than 0.90 for the "trucker-lewis index (TLI)" at 0.972, the "adjusted goodness of fit index (AGFI)" at 0.963, and the "goodness of fit index (GFI)" at 0.981. Furthermore, perfect fit is indicated by the computed values of the "normal fit index (NFI)" (0.969) and "comparative fit index (CFI)" (0.955). Moreover, Hair et al. (2006) argue that a perfect fit is indicated by values of

the "root mean square error of approximation (RMSEA)" and “RMR” by 0.0869 and 0.031, respectively, both of which are below the criterion of 0.08.

Table 12. Model fit summary of Structural Equation Model

Indices	Value	Suggested value
Chi-square value	27.697	
DF	20	
P value	0.026	> 0.05 (Hair et al., 1998)
Chi-square value/DF	4.269	< 5.00 (Hair et al., 1998)
GFI	0.981	> 0.90 (Hu and Bentler, 1999)
AGFI	0.963	> 0.90 (Hair et al. 2006)
NFI	0.969	> 0.90 (Hu and Bentler, 1999)
CFI	0.955	> 0.90 (Hooper et al., 2008)
RMR	0.031	< 0.08 (Hair et al. 2006)
RMSEA	0.0869	< 0.08 (Hair et al. 2006)
TLI	0.972	> 0.90 (Byrne, 1994)
PNFI	0.647	> 0.50
PCFI	0.59	> 0.50

Source: Survey data

All variables like “Access to Land and Property Rights", “Access to Financial Resources”, “Market Access and Pricing”, “Education and Training,” and “Cultural and Gender Norms” have a high positive impact on the decision- making skill of women engaged in agriculture, as demonstrated by Table 13 and from fig. 2, where the unstandardized coefficient of “Access to financial resources (AFA)” is highest with a value of 0.53 when all other route factors are held constant. That is, women decision making skill is increased by 0.53 for every unit rise in “Access to financial resources”.

Additionally, the unstandardized coefficient of “Access to Land and Property Rights (ALP)" on satisfaction, which is 0.47. The positive sign indicates that the influence of " Access to Land and Property Rights (ALP)” is positive, with decision making skill increasing by 0.41.for every unit increase in ALP. The coefficient value is relevant at the 1% level. The coefficient of " Cultural and Gender Norms (CGN)", " Education and Training (ET)", and “Market Access and Pricing (MAP)” on decision making ability of women, which is 0.41, 0.36, and 0.29 respectively, also holds other route elements constant and indicates a somewhat positively impact the ability to take the decision. At the 1% level of significance, the coefficient value is noteworthy.

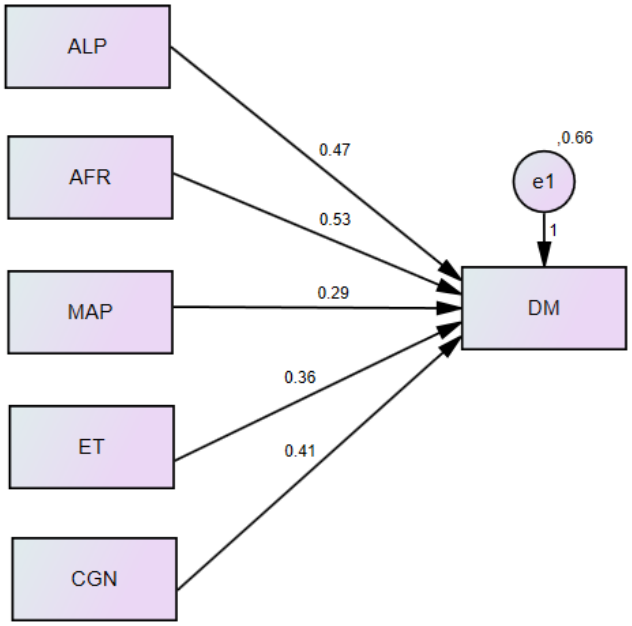

Fig 02. SEM Analysis

Table 13. Structural Equation Model (SEM) based on Standardized Coefficient

			Estimate	S.E.	t-value	P -Value
DM	<---	ALP	0.47	0.042	6.451	< 0.001**
DM	<---	AFR	0.53	0.061	5.142	< 0.001**
DM	<---	MAP	0.29	0.056	6.254	< 0.001**
DM	<---	ET	0.36	0.059	8.987	< 0.001**
DM	<---	CGN	0.41	0.044	4.036	< 0.001**

Note: denotes significant at 1% level

Source: Survey data

6. DISCUSSIONS

The current study examines the impact of the socio-economic factors on the decision-making skills of the women engaged in agriculture. The research has employed a chi-square test to examine the influence of demographic factors in the decision-making skill. The study found that demographic factors such as age, experience, and education influence the decision-making skills of women. This was in line with the findings of Dudi and Meena (2017) and Mittal et al., (2018). Dudi and Meena (2017) revealed farm women's participation and patterns of decision-making were found to be significantly influenced by a number of factors, including age, education, family size, property size,

social engagement, extension involvement, information-seeking behaviour, exposure to training, and leadership orientation. According to the findings of the study by Mittal et al. (2018), women participate more in decision-making in families with low levels of male head of household engagement, low levels of personal education, and relatively low levels of wealth. This suggests that women have a significant role in decision-making on agricultural matters in homes with high female involvement rates.

However, this was contradictory to the result found by studies by David (1994), Beriso et al. (2023), as well as Das (2023). Filipino families' involvement of men and women in decision-making within the home was examined by David, F.P. (1994). It has been observed that the decision-making pattern within a home is also influenced by the age, experience, and educational background of men and women. This study has demonstrated the distinction between the effects of living in an urban or rural area on decision-making. Living in an urban area is said to be more democratic than living in a rural one. At the same time, another study by Beriso et al. (2023), which examines the empowerment of women engaged in agricultural activities in Ethiopia, states that age, being the female head of the family, education level of the woman, the husband's education, and annual household income were among the most significant factors in favour of women's empowerment, which in turn means that all the above-mentioned demographic factors influence the decision-making ability of women.

A MANOVA test was employed to investigate the difference in access to socio-economic factors among women engaged as cultivators and labours. It was found women engaged have a higher level of access to ALP, AFA, and MAP, whereas women agricultural labours have a higher level of CGN and ET. Such a finding was supported by Das (2015), Rao, (2006), Chayal et al. (2013). Das (2015) states that because they cannot provide the necessary documentation (such as land ownership documents or sharecropper certificates from landlords) to register their names for the sale of their product, they are unable to access government procurement centres while they are labours (Das, 2015); hence, cultivators have more access to land, finance, and market pricing set by the government. Women's ability to make decisions is hindered by their lack of access to modern technologies, credit options, information sources, and appropriate training (Rao, 2006, Chayal et al. 2013). According to a study by Birle et al. (2021), women who work as cultivators exhibit the highest level of decision-making behaviour when it pertains to sowing, as this process is easily handled by farm women. This is followed by the winnowing process, as women are experts in this area. Other decision-making behaviours include seed processing, irrigation management, harvesting, storing, field preparation, selecting a variety of seeds, marketing, applying manures and fertiliser, weeding, harvesting, seed This is consistent with our results that female cultivators had greater knowledge and training about the farming process.

One-way ANNOVA was used to analyze which category of women agriculturalists have higher ability of decision-making skills; it was found women cultivators have more ability than women engaged as labours. A Goudappa et al. (2012) study found that a significant portion of farm women were involved in making decisions at awareness and initiating solutions for solving problems related to agricultural operations, such as hand weeding, harvesting, cultivation, purchasing and selling the land and machinery, preparation of the land, and fertiliser application. It shows that farm women are extremely alert and aware of the demands on the land. They have also developed the knowledge and skills to recognise issues and take the initiative to seek solutions.

Then, the study employed SEM analysis to know which factor influences the decision-making ability of women more. All five factors have a positive influence on the decision-making skills of women, with access to financial resources (AFA) having the highest influence. There are few studies that are in line with our study. Studies such as Didana's (2019) on socioeconomic variables including age, family size, and educational attainment have shown a number of components that influence how much women are empowered in agriculture. These include elements like the income of the household, work status,

ownership of real estate, or even having access to credit and being close to a market. Another study conducted by Akudugu et al. (2009) states that the demographic, technical, and institutional factors that affect women farmers' access to credit include education, application processes, access to property, income level, farm size, membership in economic connections, savings, type of crops grown, interest rate, and distance to regional banks. Deshpande et al. (1987) observed that since adult women influence family decisions, it was essential to teach and inspire them in the early phases of women training programs. Women who work in agriculture frequently encounter a range of difficulties and obstacles that may reduce their output and ability to generate revenue. Lack of legal rights, social and cultural hurdles, physical restrictions, violence and discrimination, and restricted or nonexistent access to resources and information are all examples. Women are always behind because of these barriers, but they can be overcome by taking steps like implementing laws and policies that support gender equality, offering educational and training opportunities, and promoting societal and cultural change. These actions can help empower women farmers and improve their standard of living (Sharma, 2013).

7. CONCLUSION

In summary, the influence of socioeconomic variables on the ability to make decisions of women working in agriculture as workers and cultivators provides important new information. The ability of women to make decisions is influenced by a variety of circumstances, including their age, the size of their families, the amount of land they own, and their involvement in other jobs outside agriculture. Age of the women and amount of land held were related to household decision-making. Compared to big farm households, small farmer households are predicted to have more women making decisions (Rao, 2006).

Though the study found that demographic factors do not influence the decision-making ability, the MANOVA test result shows that women engaged as cultivators have more access to finance, land, and markets. And one-way ANOVA findings state that women engaged as cultivators have more decision-making ability than women labourers since they have more access to finance, land, and marketing information. Study by Jagerskog and Clausen (2012) have shown that, in comparison to males, women in agriculture frequently have reduced or no access to resources. Inequalities between genders will always be a major problem in the agriculture industry. Women are mostly employed as unskilled labourers and have minimal control over who owns the property. Women who work as cultivators frequently have easier access to markets, financing, and land, which greatly increases their economic empowerment. When women work in agriculture, they have access to funds intended specifically for female business owners, which allows them to make improvements to their farms. Moreover, land rights efforts frequently give equal rights to women and men, giving women more ownership and influence over agricultural property. Networks and cooperatives that assist women farmers provide better access to marketplaces, enabling them to more successfully market their goods. This all-encompassing strategy promotes food security and community development in addition to the empowerment of individual women (Pathak, 2022).

The study state that when characteristics like education and training, cultural and gender norms, market access and pricing, access to land and property rights, and most importantly, access to financial resources are compared, it is clear that the latter has the most beneficial impact. It becomes clear that having access to financial resources is essential to helping women in agriculture become more capable decision-makers. With this access, women are more equipped to make strategic investments, implement contemporary farming methods, and successfully handle market dynamics. Women in agriculture are much more empowered when they have access to financial resources, which improves their capacity for making decisions. Their ability to make educated decisions about crop choice, resource management, and technology adoption is made possible by their financial independence, which eventually boosts sustainability and production (Nain and Kumar, 2010; Ibrahim et al., 2012).

Furthermore, having financial independence helps people to get over prejudices and conventional gender roles, which promotes autonomy in decision-making. Following that, access to land property has more impact on decision making. For women working in agriculture, having access to land is essential because it gives them social and economic power. Women who own property or have legal access to it are better able to make investments in their farms, adopt sustainable farming methods, and grow a wide variety of crops. Their decision-making skills are improved by this autonomy, which enables them to make long-term plans and boost output (Arun, 1999). Although other elements like market access, education, and cultural norms are equally important, their effects differ depending on the socioeconomic and geographical circumstances. It is imperative to tackle these complex issues in a comprehensive manner in order to advance gender parity and empower women in the agriculture industry globally. As a result, it can be concluded that encouraging fair access to financial resources is a powerful way to improve the ability of women in agriculture to make decisions. This will not only empower women but also advance sustainable agricultural growth and overall socioeconomic advancement. The study can be further extended by adding factors such as access to information or how schemes introduced by the government are especially related to women agriculturalists.

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Appendix A
Table 1Trends and External Debt - GDP Ratio
(In US billion dollars &Percentage)

Sr. No.	Year	External debt	External Debt - GDP ratio
3.	1991	84.85	28.7
4.	1995	93.80	30.9
5.	2000	101.13	22
6.	2005	121.10	18.5
7.	2010	290.40	18.5
8.	2015	478.80	23.8
9.	2020	570.00	20.9
10.	2021	573. 00	21.2

Source: RBI Handbook on Indian Economy.

Appendix B

Table 2 Data Sources

Variable	Data Source	Unit of Measurement
External Debt	RBI Handbook on Indian Economy	Percentage of GDP
Real GDP	Economic Survey Statistical Appendix	Crore
Gross Capital Formation	Economic Survey Statistical Appendix	Crore
FDI	Economic Survey Statistical Appendix	US Billion Dollar
Research and Development Expenditure	Department of Science and Technology (DST)	Percentage of GDP
Education Expenditure	World Bank Development Indicators	Percentage of GDP
Population growth rate	World Bank Development Indicators	Percentage Annual Change
Trade Openness Index	Department of Economic Affairs	Percentage of GDP
Labour Force Participation Rate	World Bank Development Indicators	Percentage of Labour Force

Source: Author's compilation.

Appendix C

Table 3 Results of Regression Analysis

Variable	Co-efficient	T – Statistics	P- Value
X_1	0.0207	2.030*	0.05*
X_1^2	-0.0004	-2.164*	0.04*
X_2	-0.0040	-1.589	0.12
X_3	0.05623	27.23*	0.00*
X_4	0.02090	1.647	0.10*
X_5	0.00066	1.135	0.26
X_6	0.14792	1.817	0.08**
X_7	-0.0068	-1.737	0.09**
R- Square		0.98	
Adjusted R- Square		0.98	
D -W Statistics		1.8	
F – Statistics		76.2	
Turning Point		23.9 Percent	

Source: Author's Calculations.

Appendix D

Table 4 Result of Heteroskedasticity Test

F-Statistics	**2.38***
P-Value	0.06*
Observed R-Square	14.3

Author's calculations.

Appendix E

Table 5 Result of Autocorrelation Test

F-Statistics	**0.50***
P-Value	0.60*
Obs R-Squared	1.43

Author's calculations.

Appendix F

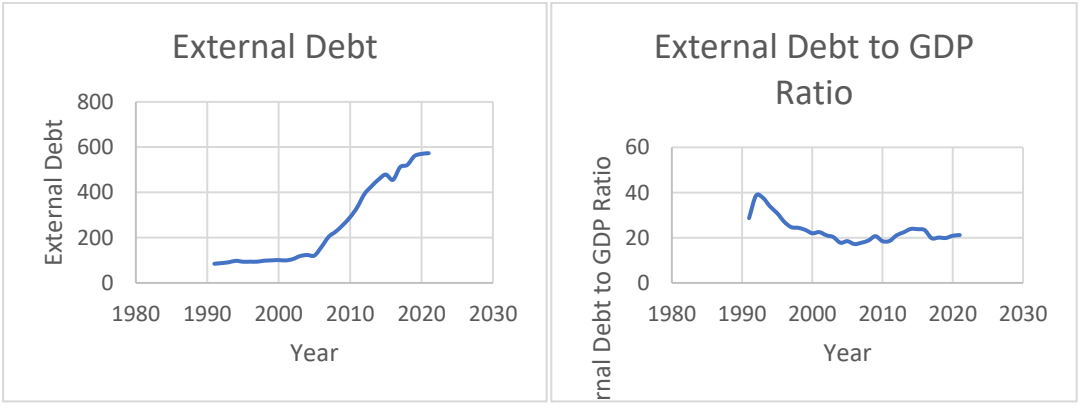

Figure-1 Trends and External Debt to GDP Ratio

Appendix G

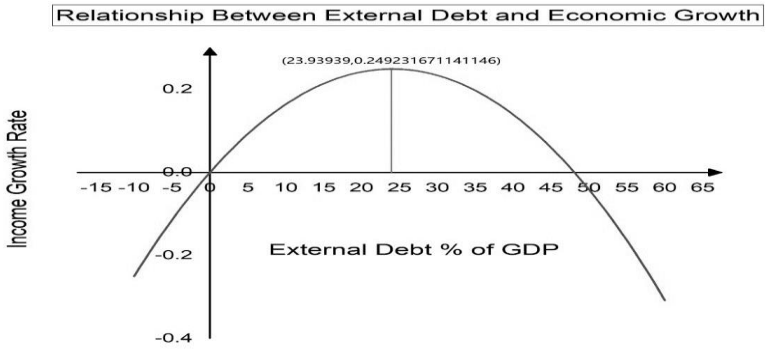

Figure 2 External Debt Laffer Curve

Appendix H

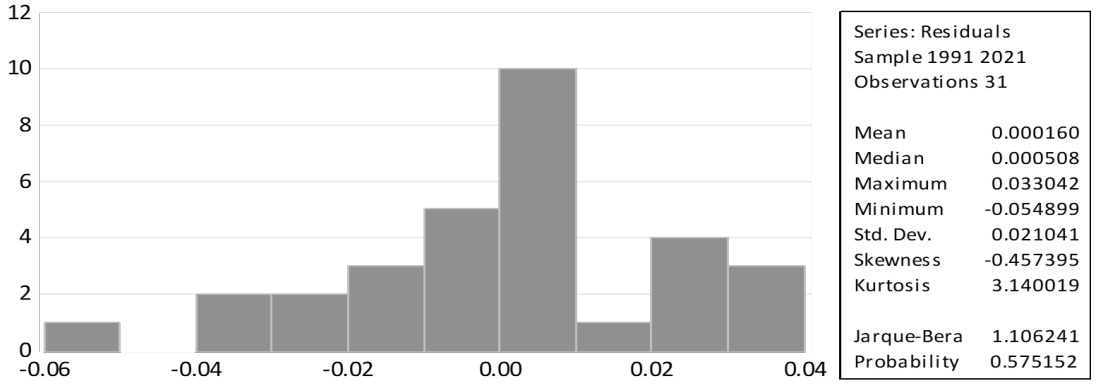

Figure – 3 Result of Normality Test

Technical Efficiency of Maternal Healthcare Services in Haryana

Ishu Garg [*]
Karnika Gupta[**]

Abstract

This paper examines the technical efficiency of maternal health services in various district of Haryana by using the technique of data envelopment analysis (DEA). Here, technical efficiency indicates the ability of a district's maternal health services in obtaining maximum feasible output while using a given set of inputs. In present context, three input variables (including number of health centres, number of ASHAs, and number of pregnant women receiving antenatal care) and one output variable (namely number of institutional deliveries) are considered. Available data on these variables belong to the year 2021-22 and are collected from mainly two sources including Department of Economic and Statistical Affairs, Haryana, and National Health Mission, Haryana. For the analysis, output oriented model of DEA is utilized as output maximization within available inputs is most suitable in case of governmental health services due to inability to frequently raise inputs. The results reveal that only two districts of Haryana, namely Faridabad and Rohtak possess fully technically efficient maternal health services, while in district of Jhajjar, the least efficient maternal health services prevail. Indeed, in districts of Charkhi Dadri, Nuh, and Panchkula, maternal health services are technically inefficient due to scale inefficiency; in district of Yamunanagar, technical inefficiency is caused by managerial inefficiency; whereas, in remaining districts including Ambala, Bhiwani, Fatehabad, Gurugram, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Mahendergarh, Palwal, Panipat, Rewari, Sirsa, and Sonipat, the technical inefficiency of maternal healthcare services is the outcome of both managerial and scale inefficiencies. Thus, there is rationale to overcome all kinds of inefficiencies in maternal health services so that maternal health outcomes can be improved which is a crucial component of health related SDGs.

Key-words: Maternal health services, ANC, ASHAs, efficiency, DEA, districts.

1. INTRODUCTION

Maternal health is a crucial component of the health policy and refers to the health condition of a woman during her pregnancy, delivery, and post-delivery or post-partum period. Health services which care women' health during their pregnancy, delivery (child-birth), and post-delivery are known as maternal health services **(Ray et al., 2018; Istifa et al., 2021)**. In Millennium Development Goals (MDGs: 2000-2015), improving maternal health was included as fifth goal. Similarly, in Sustainable Development Goals (SDGs: 2015-2030), maternal health is still at important place as third goal (SDG 3) is related with good health and well-being for all **(Chauhan et al., 2021)**. Recognizing this, the maternal health has become an important agenda for the government because pregnant and lactating women is one of the most vulnerable segments of the population from the health point-of-view **(Ramachandran, 2018)**. Accordingly, the scheme namely Pradhan Mantri Matru Vandana Yojana (PMMVY) have been initiated by the government to provide financial protection to women during their pregnancy and lactation period. Further, a very significant move has been the modification of the Maternity Benefit Act, allowing working women 26 weeks of paid maternity leave. Since, a healthy woman can be an empowered woman; therefore, the Ayushman Bharat Programme, National Nutrition

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Mission, Janani Suraksha Yojana etcetera take care of the health requirements of Indian women.

Haryana, one of the most progressive States of India, has been lagging behind in maternal health as maternal mortality ratio or MMR (which refers to the numbers of maternal deaths per 100000 live births) has increased to 110 in 2018-20 from 91 in 2016-18. Indeed, the MMR of districts including Rohtak (226), Palwal (150), Karnal (138), Panipat (130), Charkhi Dadri (129), Fatehabad (119), Hisar (115), and Jind (112) going forward the State average; whereas the districts of Rewari, Ambala and Panchkula experienced the lowest MMR in terms of 69, 61, and 45 respectively. To reduce MMR, adequate, accessible, affordable, and efficient maternal health care services are required **(Goel, 2011; Ramachandran, 2018; Pati, 2022; Kumar, 2022)**.

The rest of this paper is organized as follows: Section 2 deals with review of literature along with research gap and research objective; Section 3 describes research methodology; Section 4 is dedicated to analyses and interpretation; Section 5 concludes the study with policy implications; Section 6 throws light on limitations and further research directions.

2. REVIEW OF LITERATURE

Maternal healthcare is an interesting research area for the researchers all over the world, therefore, there is no dearth of literature. However, in present context following studies has been reviewed:

Kruk et al. (2007) conducted a cross-national analysis to determine the association between health care financing and utilization of maternal health services in 42 low-income and lower-middle-income countries. By using multi-variable regression analysis, the study revealed that government health expenditure as a percentage of total health expenditure have significant association with utilization of skilled birth attendants and Caesarean section but not with antenatal care. In an analysis of maternal health services in Gujarat State of India, **Mavalankar et al. (2009)** identified shortage of skilled human resources, non-availability of blood banks in rural areas, lack of managerial capacity, and infrastructural as well as supply constraints as various challenges in improving maternal health services in the concerned State. Evaluating the technical efficiency of 40 public district hospitals in Madhya Pradesh with special reference to maternal health services, **Jat and Sebastian (2013)** found that 50 per cent of the district hospitals in the study were operating inefficiently. The study implicated the need to identify the causes of the observed inefficiencies and to take immediate actions to increase efficiency of these hospitals. While quantifying the economic burden of maternal health care services on Indian households, **Leone et al. (2013)** estimated that over 80 per cent of the households spent for maternal health care services, with those using private care facilities paying almost four times more than those using public facilities. **Ramachandran (2018)** concluded that under-nutrition and anaemia were major nutritional problems among Indian women. In their study on efficiency of maternal health services in the aspirational districts of EAG (Empowered Action Groups) states in India, **Sharma and Sharma (2020)** revealed that 84 per cent of aspirational districts were inefficient. They implicated that these districts need to improve management of resources in maternal health services. Further, in a sample of 645 mothers from Nuh (Mewat) District of Haryana for the year 2015-16, **Singh et al. (2021)** found that any ANC (antenatal care) and full ANC services was availed by only 58.3 per cent and 11.7 per cent of respondents respectively. Indeed, the major determinants of maternal health care service utilization includes women' age, literacy status, parity, socioeconomic status and their occupation. Albeit the factors including lower age group, and low decision-making capacity were proved to be responsible for not obtaining full ANC services. In a study based on Ballabgarh block of district Faridabad, Haryana, **Singh et al. (2023)** determined the utilization of maternal healthcare services while undertaking the sample of 520 women. They proved that full ANC was received by only 15.3 per cent of women; 45 per cent of women had less than four antenatal visits; 30.9 per cent of women had cesarean delivery; gravidity was negatively associated with full ANC as per the results of multivariate

logistic regression; no significant association was found to exists between utilization of full ANC services and age, education, economic status, and caste.

Research Gap

Generally, researchers in the field of health economics remain quite interested in examining the efficient utilization of health care resources/infrastructural facilities or the efficiency of health service providers **(Culyer & Newhouse, 2000; Culyer, 2014)**. And from the literature that has been reviewed above, it has been found that only two studies namely **Jat and Sebastian (2013)** and **Sharma and Sharma (2020)** analyses the efficiency of maternal health services, where the former belongs to Madhya Pradesh while the later study is in context of aspirational districts of EAG states in India. However, State of Haryana was not covered under these studies. Accordingly, these two studies provide motivation to judge efficiency of maternal health services for the State of Haryana. However, efficiency (which assesses that whether current use of resources is in accordance with the optimal usage) have two measures namely technical efficiency (which ensures that for given technology, there is no wastage of inputs in producing the given amount of output) and allocative efficiency (that refers to whether inputs, for a given output level and input prices, are chosen to minimize the cost of production). Generally, efficiency is measured in terms of technical efficiency because no information on input prices is required in that case **(Steering Committee, 1997; Hollingsworth, 2014; Mbau et al., 2023)**.

Research Objective

The objective of present study is to examine the technical efficiency of maternal health services in various districts of Haryana.

3. RESEARCH METHODOLOGY

The methodology adopted in present research work is explained under following sub-sections 3.1, 3.2, and 3.3.

3.1 Data Envelopment Analysis (DEA) Technique

In present study, DEA is used to compute the technical efficiency of maternal health services. The method of DEA gives technical efficiency scores ranging between 0 and 1 for each decision making unit (DMU) under consideration. A DMU obtaining score 1 is said to be fully (100 per cent) efficient whereas a DMU having score 0 will be fully inefficient DMU. In other words, DMUs obtaining scores between 0 and 1 will be classified as technically inefficient.

3.1.1 Basic DEA Models

DEA models are classified into CCR **(Charnes, Cooper, and Rhodes, 1978)** model and BCC **(Banker, Charnes, and Cooper, 1984)** model. However, BCC model (which assumes variable returns to scale) is an improved version of CCR model (which considers returns to scale as constant). These DEA models can be input-oriented (works on input-minimization for a given level of output) or output-oriented (works on output-maximization for a given level of input) or both. If a researcher aims to find out how much inputs can be reduced for existing output level then, input-oriented DEA (CCR or BCC models) must be applied, whereas if the objective is to investigate how much output can be increased with the current level of inputs, then output-oriented DEA (CCR or BCC models) will be good.

3.1.2 Concepts of Technical Efficiency, Managerial Efficiency, and Scale Efficiency

DEA via CCR model computes constant returns to scale technical efficiency (CRSTE) or overall

technical efficiency which refers to the capability of a decision making unit (DMU) to achieve maximum possible output from a given set of inputs **(Farrell, 1957)**. While estimation of BCC model gives variable returns to scale technical efficiency (VRSTE) or managerial efficiency or pure technical efficiency or non-scale technical efficiency (which is the amount of technical efficiency attributable to the effective conversion of input into output given the scale size or managerial efficiency demonstrates the managers' ability in utilizing available inputs). The ratio of CRSTE to VRSTE gives score of scale efficiency which measures the degree to which a decision making unit can benefit from returns to scale by adjusting its size towards optimal scale **(Steering Committee, 1997)**.

3.1.2 DEA Model Specification

In present context, output-oriented BCC model of DEA is used. The reason for choosing output-orientation is that the output maximization within available inputs is the chief objective of governmental health system in any country due to inability to frequently raise inputs **(Coelli, 1996; Steering Committee, 1997; Shanmugam et al., 2012)**. On the other hand, selection of BCC model is due to the fact that running BCC model in DEAP software developed by Coelli (1996) gives all three kinds of efficiency scores namely technical efficiency, managerial (or pure technical) efficiency, and scale efficiency.

Based on **Coelli (1996)**, output-maximization oriented DEA linear program is considered as:

Maximize E_n (the efficiency score for n^{th} DMU that is decision making unit; here DMU refers to the district's maternal healthcare services) with respect to weights (w_1,w_2, …..,w_n) and E_n

Subject to the constraints:

$\sum_{j=1}^{N} w_j\, y_{ij} - E_n\, y_{in} \geq 0$ …… (1) $[i = 1,2, \ldots, I]$

$\sum_{j=1}^{N} w_j\ x_{kj} - x_{kn} \leq 0$ ……..... (2) $[k = 1,2, \ldots, K]$

$\sum_{j=1}^{N} w_j = 1$ ……..... (3) $[j = 1,2, \ldots, N]$

$w_j \geq 0$ ……. (4)

This linear program indicates that there are 'n' number of DMUs in the sample which are producing 'I' different outputs by using 'K' different inputs. The terms y_{in} and x_{kn} indicate the observed amounts of output 'i' and input 'k' respectively for nth DMU. The term 'w_j' express weights applied across 'n' DMUs; when linear program for n^{th} DMU is solved, these weights helps in determining the most efficient method of producing n^{th} DMU's output. The efficiency score (E_n) for the n^{th} DMU should be maximized subject to a number of constraints. Here, the first constraint implies that the output of hypothetical weighted average has to be at least as great as n^{th} DMU's output (scaled up by the factor E_n). Besides, the second constraint state that weighted average of inputs cannot be larger than n^{th} DMU's input. Further, third constraint shows weights must sum to unity which has the effect of pulling the frontier (isoquant) in to envelop the observations more closely whereas fourth constraint implies the non-negativity of weights. However, the weights help in forming the hypothetical DMU lying on the efficient frontier or isoquant. Actually, the considered linear program has to be run for each selected DMU to obtain full set of efficiency scores.

3.2 Specification of Inputs and Outputs

Keeping in view the data availability and following the study of **Sharma and Sharma (2020)**, three input variables and one output variable of maternal health services are undertaken.

Input Variables

Health Centres (in number): Health centres comprising district hospitals (DHs), sub-district or sub-divisional hospitals (SDHs), primary health centres (PHCs), community health centres (CHCs), and

sub-health centres (SHCs), is an important part of health infrastructure in delivering curative, preventive, and promotive healthcare services for all citizens. These provide antenatal care (that is care during pregnancy), delivery or intranatal care (or care during delivery or child-birth), and post-delivery or postnatal care (or care after child-birth). SDHs work as First Referral Units (FRUs) in providing emergency maternal health care (obstetrics care). Being an infrastructural variable, health centres is an input for maternal health services.

ASHAs (in number): An ASHA, or accredited social health activist, is a woman with training in community health activism who serves as a liaison between the public health system and the community. She brings pregnant women for check-ups, married couples for family planning measures, and children to immunization to the health centres. Thus, ASHAs (as health workers) can be undertaken as an input variable for maternal health services.

Pregnant women receiving antenatal care (ANC) four or more times (in number): Antenatal care (ANC) or prenatal care is a kind of preventive health/medical care provided by skilled health personnel to women throughout their pregnancy for the prevention and management of pregnancy-related or concurrent diseases. It is necessary for the women to take ANC at least four times during their pregnancy. However, it can be hoped that utilization of ANC will encourage the women for institutional deliveries (that is delivery in health centre). Thus, the number of pregnant women getting ANC becomes an input variable in the system of maternal health services.

Output Variable

Institutional deliveries (in number): This refers to the number of deliveries (giving child-birth) that taken place in health centre/facility. This is the outcome/output of maternal health services.

3.3 Data Collection

In present study, data are collected from existing documents published by Government of Haryana, accordingly, this study is secondary data based. However, the data source and the time period of selected variables has been shown in table 1.

Table 1: Data Source and Time Period of Selected Variables

Name of the Variable	Source of data	Time period
Health Centres (in numbers)	Department of Economic and Statistical Affairs, Haryana 2023	2021-22
ASHAs (in numbers)	National Health Mission, Haryana, 2021	2021-22
Institutional deliveries (in numbers)	Department of Economic and Statistical Affairs, Haryana 2023	2021-22
Pregnant women receiving ANC four or more times (in numbers)	Department of Economic and Statistical Affairs, Haryana 2023; Researchers' computation from the data on percentage of pregnant women receiving four or more ANC to the total number of pregnant women registered for ANC	2021-22

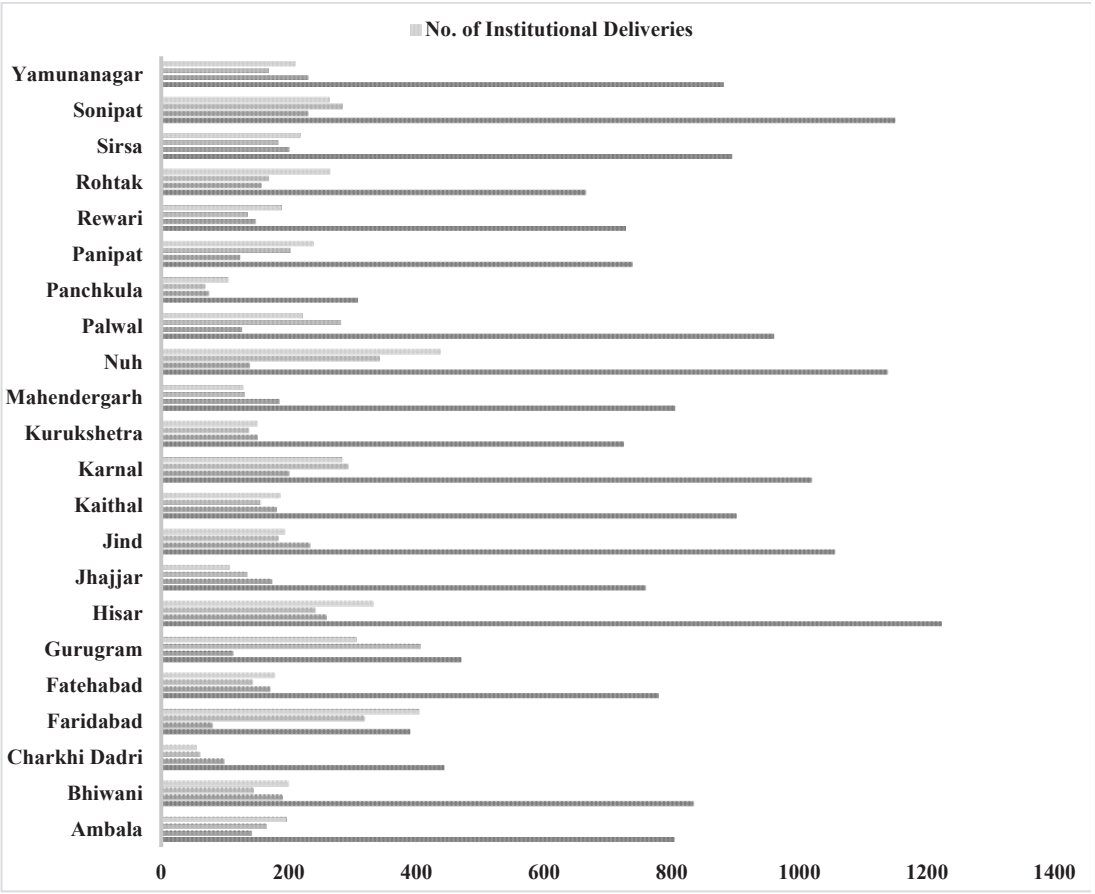
Source: Authors' compilation.

4. ANALYSES AND INTERPRETATIONS

4.1 Overview of Selected Variables

A comparative picture of the selected inputs (numbers of ASHAs, health centres, and pregnant women receiving ANC four or more times) and output (number of institutional deliveries) of maternal healthcare services in various districts of Haryana is presented in terms of figure 1. It is found that among three inputs, district of Hisar has the largest numbers of ASHAs and health centres (because the horizontal length of corresponding bars are maximum for Hisar) while district of Panchkula is at lowest place in this regard. On the other hand, highest number of women have received ANC four or more times in district of Gurugram (because, horizontal length of concerned bar is largest in that case) while in Charkhi Dadri, this number is lowest but Panchkula is ahead of Chakhi Dadri. Interestingly, the district of Nuh (or Mewat) is achieving highest number of institutional deliveries, followed by Faridabad, Hisar, and Gurugram. However, Charkhi Dadri is experiencing lowest number of institutional deliveries (as visible from the horizontal length of concerned bar in that case)

Figure 1: Status of Inputs and Output of Maternal Healthcare Services in Various Districts of Haryana



Source: Draw by researchers using data given in Appendix A

Note: No. of Institutional Deliveries and No. of Pregnant women receiving ANC four or more times are shown in 00's

4.2 Measurement of Efficiency Scores

Technical Efficiency (TE)

In table 2 the column of technical efficiency scores reveal that only two districts namely Faridabad and Rohtak have attained highest score 1 (100 per cent) thereby possessing fully technically efficient maternal healthcare services. In other words, these two districts are obtaining the maximum possible output (number of institutional deliveries) while utilizing the existing level of inputs (numbers of health centres, ASHAs, and pregnant women received ANC four or more times). It may be due to the fact that their weighted sum of inputs is quite less than in comparison of other districts while output is high for example Faridabad and Rohtak are producing 2nd and 6th largest output respectively in the sample of twenty two districts (see Appendix A). However, the remaining districts are technically inefficient that is maternal healthcare services in these districts are failed to achieve maximum possible output. Among technically inefficient districts having efficiency score above 0.9 include Panchkula (0.982) and Nuh or Mewat (0.959) can be termed as 98.2 per cent and 95.9 per cent efficient respectively relative to best practice (fully efficient districts of Faridabad and Rohtak); thus, these could produce 1.8 per cent and 4.1 per cent more outputs respectively with their present level of inputs. Further, the districts where efficiency level of maternal health services is below 90 per cent (0.9) but above 80 per cent (0.8) comprise Rewari (0.890), Bhiwani (0.882), Hisar (0.876), and Panipat (0.822); thus, these four districts have experienced shortfall in outputs by 11 per cent, 11.8 per cent, 12.4 per cent, and 17.8 per cent successively relative to the optimum level. Moreover, maternal health services in the districts of Yamunanagar (0.793), Fatehabad (0.792), Ambala (0.773), Kaithal (0.765), and Sirsa (0.763) have produced 79.3 per cent, 79.2 per cent, 77.3 per cent, 76.5 per cent, and 76.3 per cent output in comparison of optimum level of output. In simple words, maternal healthcare services of these districts could produce 20.7 per cent, 20.8 per cent, 22.7 per cent, 23.5 per cent, and 23.7 per cent more output while using existing level of inputs. Besides, the efficiency level of maternal healthcare services in the districts including Kurukshetra, Jind, Karnal, Gurugram, Mahendergarh or Narnaul, and Sonipat is found to be less than 70 per cent but above 60 per cent as their efficiency scores are 0.699, 0.674, 0.664, 0.628, 0.625, and 0.611 respectively; that is their maternal healthcare services potentially could produce 30.1 per cent, 32.6 per cent, 33.6 per cent, 37.2 per cent, 37.5 per cent, and 38.9 per cent more output respectively. Lastly, the maternal healthcare services in districts including Palwal (score=0.582), Charkhi Dadri (score=0.574), and Jhajjar (score=0.509) are found to produce just 58.2 per cent, 57.4 per cent, and 50.9 per cent output in comparison of best practice districts (Faridabad and Rohtak). Indeed, the mean technical efficiency score is found to be 0.767 which indicates that on an average, maternal healthcare services in various districts of Haryana potentially could produce 23.3 per cent more output while utilizing current level of inputs.

Managerial Efficiency (ME)

It is found that the districts of Faridabad, Rohtak, Charkhi Dadri, Nuh (Mewat), and Panchkula have managerially efficient maternal healthcare services as their scores in the column of managerial efficiency are 1 (100 per cent). Thus, in these five districts of Haryana, the managerial practices involved in converting inputs of maternal healthcare services into outputs are best. But, the healthcare services in remaining districts are inefficient on managerial grounds; thus, there exist potentiality of raising output of maternal healthcare services up to optimum level via improving managerial practices while using given level of inputs. Moreover, the managerial efficiency score above 0.9 (but less than 1) is achieved by maternal healthcare services of Hisar (0.984), thereby implying the shortfall in output of maternal healthcare services by 0.16 per cent due to the under-performance of management.

However, the districts having managerial efficiency level beyond 80 per cent but less than 90 per cent include Rewari (score=0.893), Bhiwani (score=0.884), and Panipat (score=0.825); whereas the maternal healthcare services in the districts including Fatehabad (score=0.794), Yamunanagar (score=0.793), Sirsa (score=0.785), Ambala (score=0.776), Kaithal (score=0.766), Gurugram (score=0.750), Karnal (score=0.730), and Kurukshetra (score=0.701) possess managerial efficiency level above 70 per cent but below 80 per cent. Besides, the maternal healthcare services in the districts of Jind, Sonipat, and Mahendergarh are managerially efficient only by 69.5 per cent, 69.2 per cent, and 62.7 per cent respectively. Moreover, the level of managerial efficiency is found to be below average (less than 60 per cent) in districts of Palwal (score=0.593) and Jhajjar (score=0.511), thus, their maternal healthcare services are producing 59.3 per cent and 51.1 per cent output (due to managerial reasons) in comparison of fully efficient districts. Moreover, the mean score of managerial efficiency is 0.809, which implies that on an average, via improving managerial practices, the output of maternal healthcare services in various districts of Haryana, could potentially be raised by 19.1 per cent.

Scale Efficiency (SE) and Returns to Scale (RTS)

According to **Gulati (2011),** any DMU is said to be scale-efficient if it operates under constant returns to scale (proportional change in output is equal to the proportional change in inputs) or at the minimum point of its long-run average cost curve. While a scale-inefficient DMU faces either increasing returns to scale (proportional change in output is more than the proportional change in inputs that is DMU is operating at the falling portion of its long-run average cost curve) or diminishing returns to scale (proportional change in output is less than the proportional change in inputs that is DMU is operating at the rising portion of its long-run average cost curve). Accordingly, any scale-inefficient DMU experiencing increasing or diminishing returns to scale could increase or reduce its scale of operations up to optimal scale (that is minimum point of long-run average cost curve) to become scale efficient.

As per table 2, maternal healthcare services in three districts Faridabad, Rohtak, and Yamunanagar are found to be scale efficient or of most productive scale size. While the remaining districts are found to be scale inefficient thereby experiencing increasing or diminishing returns to scale. In this regard, the maternal healthcare services experiencing increasing returns to scale in the districts including Kaithal (SE score=0.999); Bhiwani and Fatehabad (SE scores=0.998); Ambala, Jhajjar, Kurukshetra, Mahendergarh, Panipat, and Rewari (SE scores=0.997); Panchkula (SE score=0.982); Charkhi Dadri (SE score=0.574). Accordingly, output of maternal healthcare services in these districts could potentially be raised by 0.1 per cent (in Kaithal), 0.2 per cent (in Bhiwani and Fatehabad), 0.3 per cent (in Ambala, Jhajjar, Kurukshetra, Mahendergarh, Panipat, and Rewari), 1.8 per cent (in Panchkula), and 42.6 per cent (in Charkhi Dadri) via increasing the scale of operations of maternal healthcare services up to the optimal scale for the given input-output mix. On the other hand, diminishing returns to scale are occurring in districts of Palwal (SE score=0.981); Jind and Sirsa (SE scores=0.971); Nuh (SE score=0.959); Karnal (SE score=0.910); Hisar (SE score=0.891); Sonipat (SE score=0.883); Gurugram (SE score=0.837); consequently, by reducing the scale of operations of maternal healthcare services up to the optimal scale, the output of maternal healthcare services in these districts could potentially be raised by 1.9 per cent (in Palwal), 2.9 per cent (in Jind and Sirsa), 4.1 per cent (in Nuh), 9.0 per cent (in Karnal), 10.9 per cent (in Hisar), 11.7 per cent (in Sonipat), 16.3 per cent (in Gurugram). Finally, the mean score of scale efficiency is 0.952 which indicates the possibility of increasing the output of maternal healthcare services in various districts of Haryana by 4.8 per cent via altering the scale of operations of these services towards optimal level.

Decomposition of Technical Inefficiency

It is found that among twenty two districts, twenty have technically inefficient maternal healthcare services. The technical inefficiency of maternal healthcare services as an outcome of scale inefficiency

is found to exist in case of Charkhi Dadri, Nuh, and Panchkula; whereas, solely managerial inefficiency is proved to be the cause of technical inefficiency in case of Yamunanagar. Indeed, the technical inefficiency of maternal healthcare services in remaining sixteen districts (Ambala, Bhiwani, Fatehabad, Gurugram, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Mahendergarh, Palwal, Panipat, Rewari, Sirsa, and Sonipat) is outcome of managerial as well as scale inefficiency. Technical inefficiencies, management inefficiencies, and scale inefficiencies are, on average, 23.3 per cent, 19.1 per cent, and 4.8 per cent, respectively. The combination of scale inefficiency (4.8 per cent) and managerial inefficiency (19.1 per cent) is the technical inefficiency.

Table 2: Efficiency Scores Based on Output Oriented DEA

Maternal Health Services in Districts	Technical Efficiency (TE)	Managerial Efficiency (ME)	Scale Efficiency (SE = $\frac{TE}{ME}$)	Returns to scale (RTS)	Ranking based on Technical Efficiency
Ambala	0.773	0.776	0.997	IRS	10th
Bhiwani	0.882	0.884	0.998	IRS	5th
Charkhi Dadri	0.574	1.000	0.574	IRS	20th
Faridabad	1.000	1.000	1.000	CRS	1st
Fatehabad	0.792	0.794	0.998	IRS	9th
Gurugram	0.628	0.750	0.837	DRS	16th
Hissar	0.876	0.984	0.891	DRS	6th
Jhajjar	0.509	0.511	0.997	IRS	21st
Jind	0.674	0.695	0.971	DRS	14th
Kaithal	0.765	0.766	0.999	IRS	11th
Karnal	0.664	0.730	0.910	DRS	15th
Kurukshetra	0.699	0.701	0.997	IRS	13th
Mahendergarh/Narnaul	0.625	0.627	0.997	IRS	17th
Nuh/Mewat	0.959	1.000	0.959	DRS	3rd
Palwal	0.582	0.593	0.981	DRS	19th
Panchkula	0.982	1.000	0.982	IRS	2nd
Panipat	0.822	0.825	0.997	IRS	7th

Rewari	0.890	0.893	0.997	IRS	4th
Rohtak	1.000	1.000	1.000	CRS	1st
Sirsa	0.763	0.785	0.971	DRS	12th
Sonipat	0.611	0.692	0.883	DRS	18th
Yamunanagar	0.793	0.793	1.000	CRS	8th
Mean	**0.767**	**0.809**	**0.952**		

Source: Researchers' calculations in software DEAP 2.1

Note: Shaded districts possess fully technical efficient maternal health services because their TE=1 (100%)

Ranking of Districts based on Technical Efficiency

Clearly, maternal healthcare services of Faridabad and Rohtak jointly have attained 1st rank in technical efficiency with score 1. While, the districts of Panchkula and Nuh with technical efficiency scores less than 1 but greater than 0.9 occupy 2nd and 3rd ranks respectively. However, the maternal healthcare services of Rewari (TE score=0.890), Bhiwani (score=0.882), Hisar (TE score=0.876), and Panipat (TE score=0.822) having efficiency score less than 0.9 but greater than 0.8 capture ranks 4th to 7th respectively. Further, ranks 8th to 12th are attained by the districts namely Yamunanagar (TE score=0.793), Fatehabad (TE score=0.792), Ambala (TE score=0.773), Kaithal (TE score=0.765), and Sirsa (TE score=0.763), having efficiency scores resting between 0.7 and 0.8. Moreover, for the technical efficiency scores varying between 0.6 and 0.7, ranks are 13th to 18th which respectively goes to the maternal healthcare services of Kurukshetra (TE score=0.699), Jind (TE score=0.674), Karnal (TE score=0.664), Gurugram (TE score=0.628), Mahendergarh (TE score=0.625), Sonipat (TE score=0.611). However, the next two ranks that are 19th and 20th exist for the maternal healthcare services of Palwal (TE score=0.582) and Charkhi Dadri (TE score=0.574) successively. Albeit, the last rank (21st rank) is experienced by the district of Jhajjar with lowest score of technical efficiency that is 0.509.

5. Conclusion and Policy Implications

To sum up, maternal health services are found to be technically efficient (or achieving maximum possible output within existing level of inputs) in only two districts including Faridabad and Rohtak in Haryana. In remaining twenty districts, maternal health services have failed to produce maximum possible output within current inputs usage. Besides, the district of Jhajjar is suffering from the least efficient maternal health services. Despite of being managerially efficient, maternal health services in districts of Charkhi Dadri, Nuh, and Panchkula, are technically inefficient due to scale inefficiency (non-optimal scale of operations maternal health services). On the other hand, in district of Yamunanagar, technical inefficiency is caused by managerial inefficiency (which can be credited to faulty managerial practices). In residual sixteen districts comprising Ambala, Bhiwani, Fatehabad, Gurugram, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Mahendergarh, Palwal, Panipat, Rewari, Sirsa, and Sonipat, the technical inefficiency of maternal healthcare services is the outcome of both managerial and scale inefficiencies. Moreover, on an average, the scale of operations of maternal health services in Haryana are better than the managerial practices involved in these services.

The findings implicate that to make maternal health services fully technical efficient in all districts of Haryana, there is need to improve managerial efficiency as well as scale efficiency of these services. However, managerial efficiency of maternal health services can be enhanced by assimilation of female/lady doctors in management issues or managerial decision-making regarding these services as their knowledge about maternal healthcare is better than others. Besides, the scale efficiency can be enhanced by optimal scaling of the operational size of maternal health services. The districts where increasing returns to scale are experienced in maternal healthcare services, the percentage of inputs can be increased as this will raise the output more than the percentage increase in inputs. While, where diminishing returns to scale are present, there is need to reduce input usage as this causes reduction in output but by lesser percentage in comparison of input reduction. Moreover, inputs from the districts facing diminishing returns to scale can be transferred to the districts enjoying increasing returns to scale in the maternal health services. Further, to get increase in technical efficiency of maternal health services, the proper utilization of these services is required for which the government, NGOs, and other stakeholders must organize maternal health awareness camps in rural as well as urban areas in all districts of Haryana. Besides, health workers must be provided with adequate salary status and working environment so that they can perform their duties efficiently. Moreover, health centres must be equipped as per latest technology so that all the patients can receive satisfactory medical care and the achievement of health related SDG can become possible. Last but not least, the regular publication of data regarding maternal health services is the need of the hour to continue research in this field.

6. Limitations and Further Research Directions

There are some limitations of the present research work. Firstly, the technique DEA has been applied which have its own shortcomings that the results of DEA are very sensitive to the selection of inputs and outputs, and sample size. Secondly, an important input variable of maternal health services that is number of auxiliary nurse midwives (ANMs) has not been included due to the unavailability of that data. Thirdly, the computation of efficiency scores is based on the data for the year 2021-22.

The present research can be extended by analyzing the determinants of the technical efficiency of maternal health services by using Tobit regression, depending upon the availability of data for suitable variables. Besides, technical efficiency computed in present research work can be compared with the technical efficiency calculated by including ANMs as another input variable if data will be available. Moreover, more advanced technique that is Malmquist Index (which measures the efficiency change over time) can be utilized by considering at least two time-periods data for input and output variables of maternal health services.

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Appendix A Data on Inputs and Output Variables Used in DEA						
Districts	**Number of ASHAs (2021-22)**	**Number of Health Centres (2020-21)**	**Percentage of Pregnant women Receiving ANC four or more times to the total number of Pregnant Women Registered For ANC 2021-22**	**Number of Pregnant Women Registered For ANCs (2021-22)**	**Number of Pregnant Women Receiving ANC four or more times (2021-22)**	**Number of Institutional Deliveries (2021-22)**
Ambala	804	141	92.2	17867	16473	19625
Bhiwani	834	189	77.8	18501	14394	19967
Charkhi Dadri	443	98	75.8	7968	6040	5450
Faridabad	390	80	61.6	51593	31781	40420
Fatehabad	779	170	82.5	17293	14267	17772
Gurugram	470	112	71.0	57118	40554	30570
Hisar	1223	258	78.1	30862	24103	33218
Jhajjar	759	173	77.9	17209	13406	10743
Jind	1055	232	78.4	23304	18270	19383
Kaithal	901	180	79.6	19456	15487	18643
Karnal	1019	199	101.3	28827	29202	28376
Kurukshetra	725	150	85.3	16044	13686	15042
Mahendergarh/ Narnaul	805	184	88.9	14631	13007	12781
Nuh/Mewat	1138	138	65.2	52300	34100	43799
Palwal	960	126	87.8	31961	28062	22198
Panchkula	308	74	60.1	11341	6816	10533
Panipat	738	123	66.9	30211	20211	23782
Rewari	728	147	85.6	15746	13479	18876
Rohtak	665	156	91.4	18390	16808	26438
Sirsa	894	199	87.0	20978	18251	21890
Sonipat	1150	229	92.5	30683	28382	26346
Yamunanagar	881	229	76.2	22048	16801	20950

Source: National Health Mission, Haryana, 2021; Department of Economic and Statistical Affairs, Haryana, 2023; Researchers' estimation.

Socio-Economic Disparities in Access to Energy Sources in Household Activities of India

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Abstract

Access to clean energy for cooking, heating, and lighting is a crucial aspect of development. The dependence on traditional fuel and lack of access to modern energy is an important issue in India, where 160 million households depend on solid fuel such as firewood, charcoal, cow dung, and agricultural waste for their cooking and heating needs. This paper studies the access to modern fuel for cooking and heating activities using NSS 78th round data. Access to traditional fuel and modern fuel in cooking and heating, and both activities collectively is used as outcome variables. Descriptive analysis and multivariable logistic regression are applied. It was found that after mutually adjusting for wealth quintile, education level, and other socio-economic status, urban household has a higher likelihood of having access to modern fuel in cooking, heating, and both cooking and heating activities. Among the wealth quintiles, the odds of using modern fuel for the richest quintile were more than double in cooking and heating, and it is more than three times for both activities collectively. The probability of using modern fuel for cooking, heating and both activities is significant for urban areas, educated heads of family, other caste, richest population and other religious group when compared with base categories such as rural areas, illiterate family heads, Schedule Tribe (ST), poorest population and Muslim religion respectively. Findings show that the area of living, education level of household head, household size, wealth status, caste, and religion of household have significant and positive impacts on the access to modern fuel in cooking, heating and in both activities in India. This study emphasises the importance of information dissemination through campaigns to spread awareness about the harmful consequences caused by traditional fuel. It highlights the importance of government assistance for people experiencing poverty, living in remote and rural areas, and belonging to socially backward classes.

Keywords: Energy, traditional fuel, modern fuel, cooking, heating

Introduction

Access to modern energy sources is essential for overall development. It is vital to remove the hindrances to modern energy access to achieve Sustainable Development Goal (SDG 7). The contribution of energy supply to climate change and secure modern energy supply are two deciding challenges for the energy sector with the objective of a sustainable future (Abbasi & Abbasi, 2011). Still, billions of people cannot access essential energy services, clean cooking, and electricity facilities, with minimal possibility of changing this situation in the next 20 years, even if it can deteriorate in some respects (Hodge, 2017). World Energy Outlook 2016 projections estimated that 1.18 billion people have no access to electricity, and the 2.74 billion population, most of them living in India, Sub-Saharan Africa and other developing Asian countries, still rely upon traditional fuel for cooking with severe health consequences. Households in developing countries have to depend on traditional and unclean fuel for their activities, and this is either because of the cheap traditional fuel availability or the constant lack of modern fuel (Behera & Ali, 2016; Karimu, 2015). So sustainable access to modern

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fuel and efficient use of energy can contribute to the eradication of energy poverty, energy-related health and environmental impacts and can improve energy security (Bonjour et al., 2013; Khandker et al., 2012).

Various development activities are performed in household sectors, and it consumes more than 30 percent of global energy (Wang et al., 2024). The energy ladder hypothesis is used to explain the shift of households from traditional fuel to transitional fuel and then finally towards modern fuel as their economic conditions improve (Ado & Darazo, 2016). Although income remains an essential factor in determining household sector fuel demand, many non-income factors still have a strong influence that resisted the complete forgoing of the use of traditional fuel in developing countries (Farsi et al., 2007; Hou et al., 2018; Ma et al., 2022). After the implementation of Pradhan Mantri Ujjwala Yojana (PMUY), accessibility of clean fuel is not the primary concern, but the lack of acceptance of LPG as a primary source of cooking energy resource continues to exist as a big problem for the targeted population due to the availability and accessibility of traditional fuel free of cost or at a meagre cost in rural India (Ranjan & Singh, 2020). However, despite the implementation of this scheme, the majority of households in rural areas still rely upon traditional sources of energy. A significant relationship was analysed between fuel choice for cooking and the distance to wood sources, income level, access to road, level of education, size of the family, and cost of technology in rural southern Ethiopia. It revealed the importance of non-income factors in encouraging the continuous use of clean fuel (Wassie et al., 2021).

Existing studies have examined the impact of socioeconomic factors on cooking and lighting household activities. Therefore, this study tries to access the primary source of energy in household cooking and heating activities as India has achieved universal electrification by 2019 (Patil & Kumar, 2022). This indicates that electricity access as the primary source of light is the least problematic, while the study does not discuss the duration, reliability, and affordability of modern fuel for electricity (Jain et al.,2015). This study examines the access to energy sources in cooking and heating household activities among different areas, social and economic classes, and households with different characteristics. This paper analyze the role of household socioeconomic status and social identity in access to modern energy sources in cooking, heating, and both activities simultaneously.

Review of literature

Various factors such as demographics Farsi et al. (2007), economic conditions Hou et al. (2018), different ethnicity Ma et al. (2022), and household socioeconomic characteristics Alem et al. (2016) affect the fuel choices adopted by households. Empirical evidence related to energy access confirmed the energy ladder hypothesis as economic status, demographic characteristics, and social variables are found to be the determinants of energy access in households. Buba et al. (2017) shows households move upside on ladder with the increase of income by replacing traditional fuel with transitional fuel then increase the use of modern fuel (Ado & Darazo, 2016: Mekonnen & Kohlin, 2009; Mirza & Kemp, 2011). Alongside income, there are studies which highlights that socio-economic variables such as household size, educational level, consumption expenditure, and awareness of energy and environment have their impact on energy poverty. Sharma et al. (2019) studied the implication of socio-economic factors on energy access in India (Sadath & Acharya, 2017).

The differences in rural-urban areas, economic status, ownership of television and education of household head were observed as significant contributors to the disparities in access to clean fuel for cooking in Ghana (Tabiri et al., 2022). Balachandra (2011) emphasizes the need to analyse the impact of socio-economic factors on the choices of modern fuel in cooking, lighting, and heating activities. The poor and minority population of Vietnam rely upon traditional fuel for energy, which highlights the importance of poverty eradication programs with future assistance to ethnic minorities and the poor

population (Nguyen et al., 2019). Global unequal access to energy needs policy debate, which leads to the incorporation of universal accessibility of reliable, affordable and modern energy for achieving sustainable development goals (Bonan et al., 2017)

Households using traditional fuels for their activities bear enormous environmental and health burdens such as indoor pollution and lung diseases, and women's health keeps evolving due to solid fuel gathering, and females suffer from neck aches, headaches, and backache health-related issues (Pathak et al., 2019). Parikh (2011) found a positive impact of clean fuel use and the individual's ability to perform daily work, especially for females and elder people (Liu et al., 2020). Access to clean fuel for cooking in rural areas has a significant positive impact on overall mental and physical health, life satisfaction, and overall well-being (Wang et al., 2023).

Decreasing poverty and increasing education, electrically connected households were observed as the primary determinant for switching from dung fuel to clean fuel, whereas households with large family sizes and aged household heads had resulted to be less likely to adopt clean fuel in Afghanistan (Paudel et al., 2018). Income, age, education, gender, access to electricity, house location and cost-effective energy source were observed as the main determinants of energy choice in Bhutan (Das et al., 2014). The affordability and low opportunity cost of collecting traditional fuels impacted fuel choices, as fuel switching was possible for higher-income groups in the urban area. In contrast, fuel stacking dominated lower, middle, and higher-income groups in rural areas and lower-income groups in urban areas in Guatemala, indicating that LPG uptake often goes hand in hand with traditional fuels (Heltberg, 2005).

The existing literature creates the importance of analysing the socio-economic disparities in access to modern fuel and its determinants in household activities all over India. It creates the need to find out the related variables and their effectiveness on household fuel choices for cooking as well as heating activities. This study highlights that the disparity in modern fuel access for heating activity is severe compared to modern fuel access for cooking activity. The marginal effect in logistic regression analysis is calculated to assess the partial effects off the explanatory variables for cooking, heating, and both activities simultaneously.

Methodology

Sample design

To assess the socioeconomic disparities in access to energy resources in India, we use household-level Energy data from the Multiple Indicator Survey (MIS) of the 78th round of the National Sample Survey (NSS), conducted from January 2020 to August 15, 2021, by the National Statistical Office (NSSO). It is a nationally representative survey and collected information from 276409 households across the entire country.

Outcome variables

The objective of this study is to analyse the socio-economic disparities of clean energy access as a primary energy source for cooking and heating in Indian households. We classified the outcome variable as modern and traditional energy sources based on which types of fuels are used as the primary sources of heating and cooking in Indian household activities. Table. 1 shows the conceptual derivation of outcome variables where all the outcome variables are binary in nature. '1' indicates access to modern fuel, and '0' indicates access to traditional fuel as the primary source of energy in cooking and heating activities of the household.

Explanatory variables

The 78th round of the National Sample Survey, which carried out multiple indicator surveys related to the information of individuals, households, and communities, collected information on socioeconomic status and demographic-selected households. As the literature suggests about the determinants of access to modern and traditional sources of energy in India, our explanatory variables include the place of residence (rural-urban), household size, level of education of household head, religion (Hindu, Muslim and Other), caste such as Schedule Tribe (ST), Schedule Caste (SC), Other Backward Class (OBC) and Other, usual monthly per capita expenditure (MPCE) as a measure of economic status (Ado & Darazo, 2016; Buba et al., 2017; Balachandra, 2011)

Statistical analysis

Frequency characteristic is used for bivariate descriptive statistics. As the primary outcome variables are binary in nature, logistic regression is an appropriate tool to identify the predictors associated with access to modern energy sources in cooking and heating activities. For each outcome, separate regression models are applied. The adjusted odds ratios are obtained using multivariable logistic regression models after mutually adjusting household heads' level of education, caste, wealth quintile, religion, and area of residence to account for the effects of other covariance. The estimated odd ratios are reported with a 95% confidence interval. For a better understanding, the probabilities of access to energy sources for different activities are estimated using the margins command in Stata version 15.1.

Results

Disparities in access to energy sources for cooking and heating activities

The disparity in access to primary sources of energy in the cooking and heating activities in the Indian household sector is presented in Table 1. Overall, 50.34 percent of households in rural India have no access to modern fuel as their primary energy source for cooking activity, and 83.99 percent of rural households' population use traditional fuel as their primary source of heating. Only 14.04 percent of households in rural India use modern fuel as their primary source of energy in both heating and cooking activities. In contrast, 85.96 percentage of rural households use traditional fuel for both activities simultaneously. Level of education has a positive impact on reducing the use of traditional fuel and increasing the use of modern fuel. of the total households, 51.87 percent with illiterate heads used traditional fuel for cooking in comparison to this, the households with graduated heads are only 9.17 percent.

Table 1: Access to Sources of Energy in India by Socioeconomic Status

Socio-economic status	Energy source for Cooking		Energy Sources for Heating		Energy Sources for Cooking and Heating		Total (n) weighted
	Traditional	Modern	Traditional	Modern	Traditional	Modern	
Place of residence							
Rural	50.34	49.66	83.99	16.01	85.96	14.04	187,923
Urban	9.61	90.39	37.67	62.33	38.89	61.11	88,486
Sex of head							
Female	36.47	63.53	68.32	31.68	70.26	29.74	35,621

Male	37.43	62.57	69.29	30.71	70.98	29.02	240,765
Education level of household head							
Illiterate	51.87	48.13	83.06	16.94	84.50	15.50	85,025
Primary	44.26	55.74	75.76	24.24	78.05	21.95	58,495
Middle	39.21	60.79	72.62	27.38	74.61	25.39	41,610
Secondary	24.28	75.72	60.31	39.69	61.84	38.16	37,845
Senior secondary	20.40	79.60	54.26	45.74	56.15	43.85	24,053
Graduation and above	9.17	90.83	34.52	65.48	35.68	64.32	29,381
Household size							
Less than 4	34.56	65.44	64.77	35.23	66.74	33.26	163,410
4 to 8	41.14	58.86	75.28	24.72	76.68	23.32	102,887
8 and above	42.60	57.40	77.81	22.19	78.95	21.05	10,112
Household size							
Hindu	37.20	62.80	69.18	30.82	70.84	29.16	232,257
Islam	41.45	58.55	71.67	28.33	74.05	25.95	29,383
Other	30.55	69.45	63.93	36.07	65.39	34.61	14,769
Caste							
ST	68.20	31.80	90.52	9.48	91.59	8.41	25,612
SC	46.54	53.46	77.39	22.61	79.39	20.61	57,896
OBC	33.17	66.83	69.53	30.47	70.83	29.17	122,556
Other	25.65	74.35	53.99	46.01	56.46	43.54	70,345
MPEC Quintile							
Lowest	62.24	37.76	88.80	11.20	90.04	9.96	55,289
Lower	50.40	49.60	84.01	15.99	85.81	14.19	55,288
Medium	36.76	63.24	76.69	23.31	78.68	21.32	55,281
Higher	25.63	74.37	61.24	38.76	63.26	36.74	55,271
Highest	11.46	88.54	35.07	64.93	36.64	63.36	55,280

Note: Total observations are 276409 while there are 276387 observations for gender and 276396 observations for kitchen type socio economic characteristics, MPCE: monthly per capita expenditure

Source: Authors' own estimates from unit-level data.

Eighty-three percent of households with illiterate heads and only 34.52 percent of the households with graduated heads have no access to modern fuel as the primary energy source in heating. The same relation was observed between education and modern energy use for cooking and heating activities simultaneously. As the family size increases, the use of traditional fuel also increases in cooking, heating and both activities collectively. There is inequality in access to energy resources for different social groups. Among different castes, Schedule Tribe households have less access to modern fuel in comparison to OBC and Other caste groups in cooking, heating and both activities simultaneously. The wealth quintile significantly impacts primary fuel use in cooking, heating, and other activities. Sixty-two percent of total households with the lowest wealth quintile use traditional fuel for cooking; this percentage decreases as the wealth of the household increases, and only 11.46 percent of the richest households have no access to modern fuel for cooking. The access to modern fuel for heating and both activities simultaneously increases as the level of wealth quintile increases.

Predictors of access to modern fuel for cooking, heating and both cooking and heating

To find out the factors associated with the likelihood of accessing modern fuel, multivariable logistic regression was used, and the results are depicted in Table 2. The odds ratios are obtained after mutually adjusting for the area of living, head education, religion, caste and wealth status.

Table 2: Results of Multivariable logistic regression for access to energy resources in cooking, heating and lighting activities by socio-economic status in India.

Socio-economic characteristic	Dependent Variables					
	Modern fuel (Cooking)		Modern fuel (Heating)		Modern fuel (cooking and heating)	
	AOR	(95% CI)	AOR	(95% CI)	AOR	(95% CI)
Place of residence						
Rural	Ref		Ref		Ref	
Urban	4.92***	4.9 – 4.9	3.87***	3.8 – 3.8	4.28***	4.2 - 4.2
Education level of head						
Not Literate	Ref		Ref		Ref	
Primary	1.02***	1.0 – 1.0	1.16***	1.1 – 1.1	1.10***	1.1- 1.1
Middle	1.15***	1.5 – 1.5	1.22***	1.2 – 1.2	1.19***	1.1- 1.1
Secondary	1.82***	1.8 – 1.8	1.58***	1.5 – 1.5	1.59***	1.5 – 1.5
Senior secondary	1.93***	1.9 – 1.9	1.68***	1.6 – 1.6	1.66***	1.6 – 1.6
Graduation and above	3.04***	3.0 – 3.0	2.45***	2.4 – 2.4	2.47***	2.4 – 2.4

Caste						
Schedule tribe	Ref		Ref		Ref	
Schedule caste	2.10***	2.1 – 2.1	2.01***	2.0 – 2.0	2.02***	2.2- 2.02
OBC	3.08***	3.0 - 3.0	2.33***	2.3 – 2.3	2.47***	2.4 – 2.4
Others	2.87***	2.8 – 2.8	3.19***	3.1 – 3.1	3.17***	3.1 – 3.1
Household size						
Less than 4	Ref		Ref		Ref	
4 to 8	1.15***	1.1- 1.1	1.03***	1.0 – 1.0	1.06***	1.0- 1.0
8 and above	1.17***	1.1- 1.1	1.13***	1.1 – 1.1	1.18***	1.1- 1.1
MPCE quintile						
Lowest	Ref		Ref		Ref	
Lower	1.34***	1.3 – 1.3	1.23***	1.2 – 1.2	1.20***	1.2 – 1.2
Middle	1.95***	1.9 – 1.9	1.59***	1.5 – 1.5	1.56***	1.5 – 1.5
Higher	2.24***	2.2 – 2.2	2.27***	2.2 – 2.2	2.25***	2.2 – 2.2
Highest	2.79***	2.7 – 2.7	2.55***	2.5 – 2.5	3.52***	3.3 – 3.5
Religion						
Muslim	Ref		Ref		Ref	
Hindu	1.55***	1.5 – 1.5	1.26***	1.2 -1.2	1.32***	1.3 – 1.3
Others	1.82***	1.8 – 1.8	1.24***	1.2 -1.2	1.34***	1.3 – 1.3
N	**276,409**		**276,409**		**276,409**	

Note: AOR-Adjusted Odds Ratio.

Source: Authors' own estimates from unit-level data.

Households in urban areas are more likely to use modern fuel as a primary source of energy (AOR 4.92; 95% CI 4.9-4.9) for cooking, heating (AOR 3.87; 95% CI 3.8-3.8) and (AOR 4.28; 95% CI 4.2-4.2) for both activities. Households with graduated heads are more likely to use modern fuel (AOR 3.04; 95% CI 3.0-3.0) for cooking (AOR 2.45; 95% CI 2.4-2.4) for heating and (AOR 2.47; 95% CI 2.4-2.4) for cooking and heating simultaneously in comparison to the households with illiterate heads. The higher wealth quintile households have a greater likelihood of access to modern fuel as their primary energy source compared to the poorest to richer households in rural and urban areas. This existing disparity is visible in earlier studies, which resulted area of residence, wealth, and education of household head as the important determinants of clean energy access (Haq et al., 2024; Tabiri et al.,

2022; Wassie et al., 2021) Among social groups, the odd of using modern fuel is more than thrice for OBC and Other groups in cooking and heating. The Hindu and Other groups of households are more likely to use modern fuel compared to Muslim religion households which reveals unequal modern energy access to all sections of society (Pelz et al., 2021).

Average Marginal Effects for access to energy resources in household activities by socio-economic status in India

The marginal effects of modern fuel access are estimated to quantify the odd ratio's magnitude. Table 3 shows that after adjusting all other socio-economic variables, the probability of using modern fuel as the primary energy source is 26 percent point, 24 percent point, and 25 percent point high for households in urban areas compared to rural areas for cooking, heating and both activities simultaneously. The probability of using modern fuel is 18 percent point higher for households with a graduated head for cooking and 14 percent point higher for households with a graduated head in heating in comparison to households with uneducated heads. Caste-wise disparities are also observed as other caste groups' probability of using modern fuel in both cooking and heating activities is 15 percent point higher in comparison to Schedule tribe, and the probability is 19 percent point higher for the OBC caste for cooking in comparison to Schedule tribe. The class-wide disparities are visible as the probability of using modern fuel for cooking, heating, and both activities collectively is higher for the wealthiest households. These results are aligned with earlier studies which highlight the gap in access to modern fuel among different sections of the population based on different levels of income, residence, and social status (Aryal et al., 2024; Majumdar et al., 2023).

Table 3: Average Marginal Effects for Access to energy resources in household activities by socio-economic status in India.

Socio-economic characteristics	Dependent Variables					
	Modern fuel (Cooking)		Modern fuel (Heating)		Modern fuel (Cooking and Heating)	
	AME	(95% CI)	AME	(95% CI)	AME	(95% CI)
Place of residence						
Rural	Ref.		Ref.		Ref.	
Urban	0.26	0.26 - 0.26	0.24	0.24 – 0.24	0.25	0.25 – 0.25
Education level of head						
Not literate	Ref.		Ref.		Ref.	
Primary	0.00	0.00 – 0.00	0.02	0.02 – 0.02	0.01	0.01 – 0.01
Middle	0.02	0.02 – 0.02	0.03	0.03 – 0.03	0.02	0.02 – 0.02
Secondary	0.10	0.10 – 0.10	0.07	0.07 – 0.07	0.06	0.06 – 0.06
Senior Secondary	0.11	0.11 – 0.11	0.08	0.08 – 0.08	0.07	0.07 – 0.07

Graduation and above	0.18	0.18 – 0.18	0.14	0.14 – 0.14	0.14	0.14 – 0.14
Caste						
Schedule tribe	Ref.		Ref.		Ref.	
Schedule caste	0.13	0.13 – 0.13	0.09	0.09 – 0.09	0.08	0.08 – 0.08
OBC	0.19	0.19 – 0.19	0.11	0.11 – 0.11	0.11	0.11 – 0.11
Others	0.18	0.18 – 0.18	0.16	0.16 – 0.16	0.15	0.15 – 0.15
MPCE quintile						
Lowest	Ref.		Ref.		Ref.	
Lower	0.05	0.05 – 0.05	0.02	0.02 – 0.02	0.02	0.02 – 0.02
Medium	0.12	0.12 – 0.12	0.06	0.06 – 0.06	0.06	0.06 – 0.06
Higher	0.14	0.14 – 0.14	0.12	0.12 – 0.12	0.12	0.12 – 0.12
Highest	0.18	0.18 – 0.18	0.21	0.21 – 0.21	0.19	0.19 – 0.19
Religion						
Muslim	Ref.		Ref.		Ref.	
Hindu	0.07	.07 - .07	0.03	.03 - .03	0.03	.03 - .03
Others	0.10	0.1 – 0.1	0.03	.03 - .03	0.04	.04 - .04
N	**276,409**		**276,409**		**276,409**	

Source: Authors' own estimates from unit-level data.

The access to modern fuel for cooking, heating, and both activities simultaneously is varied along with the geographical location. In states like Chhattisgarh, Odisha, Jharkhand, West Bengal, Meghalaya, Nagaland, Rajasthan and Assam, around 60 percent of households have no access to modern fuel as the primary source of energy for cooking (Appendix Figure 1). The use of traditional fuel as the primary source of energy in heating is much higher, as around 75 percent of households in Bihar, Uttar Pradesh, Himachal Pradesh, Assam, Jharkhand, Meghalaya, Manipur, and Nagaland use traditional fuel for household heating activities (Appendix Figure 2).

Discussion

As we are reaching the sustainable development goal post-2030, it is crucial to assess the progress on SDG 7, which has implications for several other goals and targets. The present finds that more than 85 percent of households in rural India use traditional fuel as their primary source of energy in both cooking and heating activities. This poses a challenge to provide equitable access to modern fuel for all household activities, which is essential to achieving Sustainable Development Goal 7 (SDG 7). The study shows that only 9 percent of urban households use traditional cooking fuel for cooking compared

to 50 percent of rural households, reflecting the rural-urban disparity in access to modern fuel (Haq et al., 2024). There is a lack of significant difference in modern energy access with the household having male and female heads for cooking, heating, and both activities simultaneously, although many studies show that the lack of modern fuel for household activities disproportionately affects the household whose head is a women (Oparaocha & Dutta, 2011; Wang et al., 2023). The level of the head's education significantly affects access to modern fuel for household activities. As the level of education increases, the likelihood of using traditional fuel as the primary energy source reduces. These findings align with earlier studies showing a negative relation between traditional energy fuel choice and higher education level (Ali et al., 2019; Haq et al., 2024). This study shows the significant effect of household wealth status on the fuel choices for cooking, heating, and both activities simultaneously. As a household's wealth status improves, the likelihood of using modern fuel as the primary source of household activities increases. This result is aligned with the previous studies (Majumdar et al., 2023; Tabiri et al., 2022; Wassie et al., 2021). Caste plays a vital role in access to basic facilities such as modern fuel and basic hygiene (Kumar & Kharb, 2024). We also found that disadvantaged caste households are less likely to use clean fuel than their upper caste counterparts. The dependence of ethnic minorities rely heavily on traditional fuel to fulfil their energy demand (Nguyen et al., 2019; Pelz et al., 2021). Our study also shows that Muslim households are less likely to use modern fuel for cooking, heating, and both activities simultaneously in comparison to Hindus and other religions. This study highlights the existing gap in access to modern fuel as the primary source of energy among different sections of the population based on different levels of income, residence, social caste system, different levels of education, and geographical location (Aryal et al., 2024; Majumdar et al., 2023; Rao et al., 2007).

Conclusions

This study examines the effect of socioeconomic characteristics in determining households' fuel choices for cooking, heating, and both activities simultaneously. The findings reveal that economic status, education level of household head, area of residence, social caste, and religion are the important determinants of modern energy access. The disparity in modern energy access between rural-urban areas, among different social groups and religions, indicates that the probability of using modern fuel is high for urban residents, privileged castes, and the religious majority, respectively.

By identifying the key factors and quantifying the inequality in access to energy sources for household activities present study provides evidence for the need to provide equitable access to energy sources to achieve Sustainable Development Goal 7 by 2030. The government should emphasise better integrated and social policies to remove socio-economic, cultural, and technical barriers (Tucho & Kumsa, 2020). Decreasing poverty and increasing education significantly increased the probability of switching from dung fuel to clean fuel. Paudel et al. (2018) emphasised that the government needs an incentive strategy to promote the adoption of clean energy.

This study highlighted that the importance of information dissemination through campaigns about health and environmental hazards caused by traditional fuel. Energy-related reforms should consider caste-based inequities and disadvantaged social groups and target the poorest general caste households and rural residences to encourage equitable and fair progress towards sustainable modern energy access for all sections of the population.

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Appendix

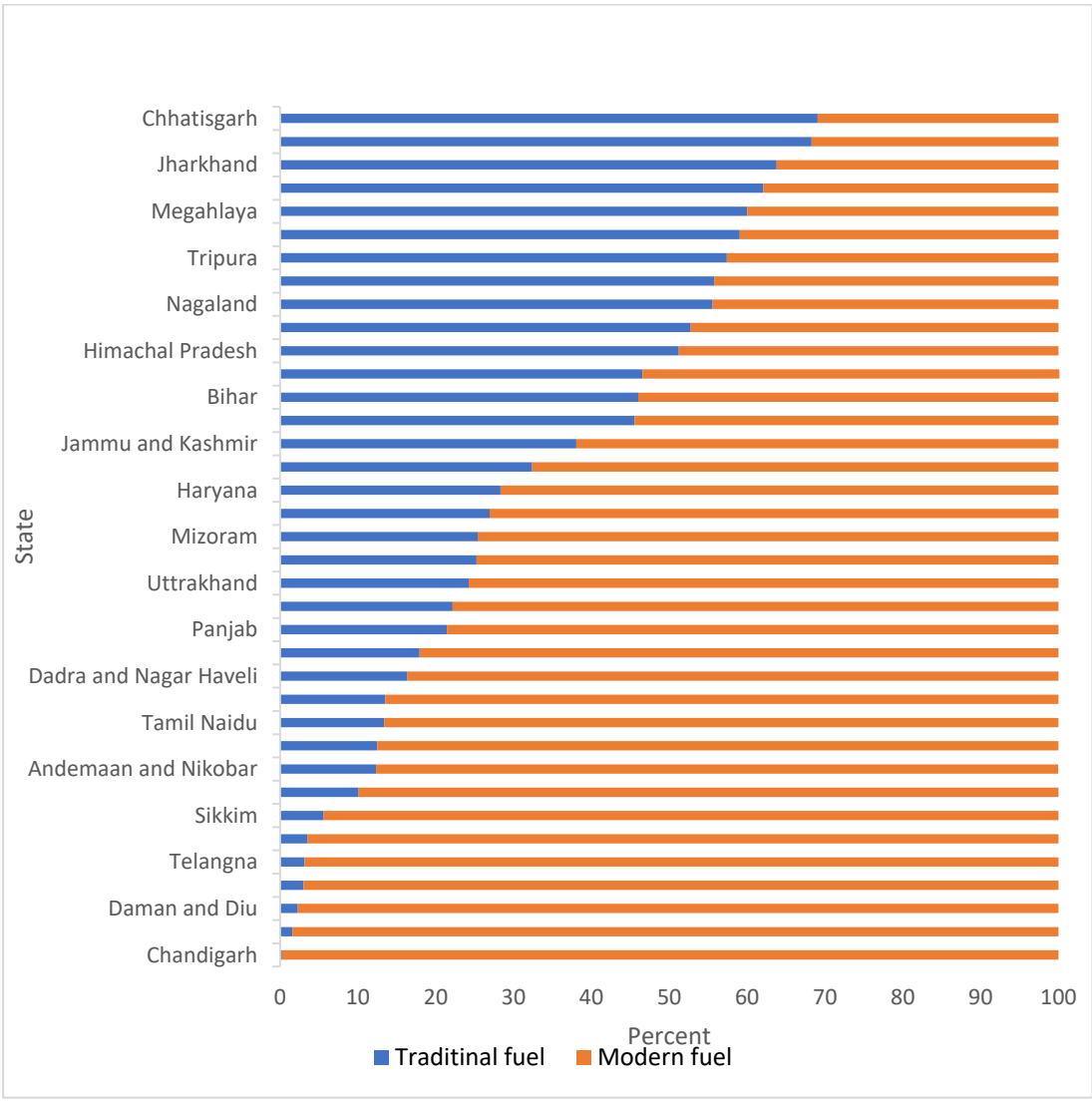

Figure A1: State-Level Access to Cooking Fuel in India

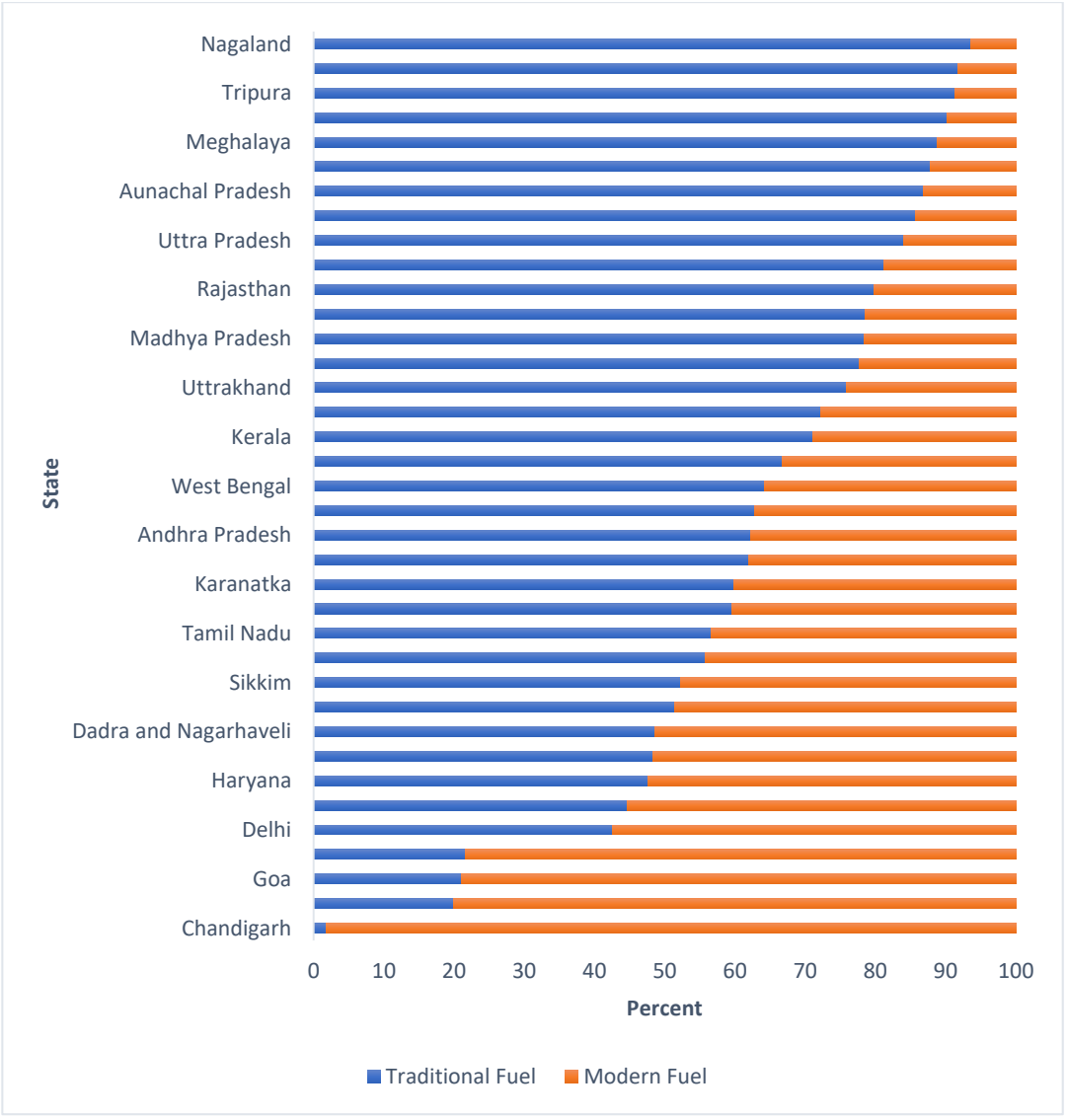

Figure A2: State-Level Access to Heating Fuel in India

A Temporal Analysis of Child Health Outcomes and Access to Basic Facilities across Indian States

Tanaya Majumder [*]
Awantika Rajauria

ABSTRACT

Children's health outcomes are pivotal for achieving India's SDG goals as they directly impact multiple targets including child mortality (SDG 3) and ending malnutrition (SDG 2). Healthy children are more likely to contribute to sustainable development, thereby supporting broader objectives like poverty reduction (SDG 1) and reducing inequalities (SDG 10). Improved child health also reflects better access to clean water, sanitation (SDG 6) and overall well-being, crucial for building sustainable and resilient communities (SDG 11). This research paper uses Principal Component Analysis (PCA) to develop a holistic child health outcome index for 28 Indian states (including the UT of Delhi), capturing the temporal changes in state rankings between the NFHS rounds 4 and 5. The study finds a notable decrease in inequality in the child health outcomes index across these two rounds. To understand the underlying factors behind this decreasing inequality, a basic facility index including indicators such as access to basic household facilities, vaccination coverage and institutional births is constructed (by doing PCA analysis). Next, a correlation analysis is done that reveals a positive relationship between the facilities available and child health outcomes. The study concludes that it is the reduction in inequality in essential household facilities, vaccination coverage and institutional births, that contributes significantly to the decreasing inequality in child health outcomes across states. By demonstrating a link between decreasing inequality in essential facilities and child health outcomes, this research provides novel insights for policymakers aiming to foster inclusive and sustainable development in India.

Keywords: Sustainable development goals, Child health outcomes, Basic facilities, State rankings

1. INTRODUCTION:

Achieving good health is the major goal, which every economy tries to achieve in order to ensure the holistic development of its citizens and pave the way for sustainable development of the country. When it comes to child health, the matter becomes even more concerning as the future path of the country's growth and development depends heavily on the strong and healthy future generation. Maintaining high standards of child health also gains more importance in view of the global commitments towards achieving Sustainable Development Goals (SDGs). In India, out of the total population of 1.428 billion people (roughly around 17.8% of global population), 18.6% are children aged 0-17 years (UNICEF Country Office Annual Report, 2023). Ensuring high levels of child health is a critical issue in a country possessing a diverse set of socio-economic landscapes requiring a diverse set of healthcare infrastructure and facilities. India has shown marked improvement in achievement of overall Sustainable Development Goals (SDGs) and has moved from 121st position in 2022 to 112th position in 2023 (UNICEF Country Office Annual Report, 2023). Children's health outcomes are pivotal for achieving India's SDG goals as they have a direct bearing on other related goals spanning child mortality (SDG 3) and ending malnutrition (SDG 2). Healthy children are more likely to contribute to sustainable development, thereby supporting broader objectives like poverty reduction (SDG 1) and reducing inequalities (SDG 10). Improved child health also reflects better access to clean water,

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sanitation (SDG 6) and overall well-being, crucial for building sustainable and resilient communities (SDG 11).

India has made significant improvements at the national levels to improve its child health score and has moved ahead in achieving its sustainable development goals. The Ministry of Women and Child Development (MoWCD) has initiated the three flagship schemes for women and child development and empowerment, called 'Mission Shakti', 'Mission POSHAN', and 'Mission Vatsalya'. These schemes, together with various other initiatives at the central as well as state levels, helped the country to register a continuous improvement in some areas like, immunization, access to safe sanitation and clean drinking water. As per the data cited by UNICEF, in 2023, under-five mortality rates have reduced at an annual rate of 4.6 percent. However, the country still lags behind its targets with respect to neonatal mortality, malnutrition outcomes, etc. Over the past decade, the joint malnutrition estimates of 2023 indicate a 10 percent point decline in stunting prevalence, although, reduction in nutritional wasting did not register the expected decline, while the rates of anaemia have increased. To address the issue of anaemia among children the Government of India launched Anaemia Mukt Bharat (AMB) scheme in 2018 under the aegis of POSHAN Abhiyan with the target to reduce anaemia by 3 percent every year. However, achievement of the target remains a grey area with practically no targeted budget allocation for the said scheme in the Budget 2023-24. Additionally, the share of children in the Budget 2023-24 declined with only 2.3% being allocated for them. Another alarming aspect indicating a dubious commitment towards 'inclusivity' and 'prosperity' is the continuous decline in the share of children in the Union Budget during the past 11 years, with the share consistently declining from 4.76% in 2012-13 to 2.3% in 2023-24. In addition, the budget allocation in percentage terms for the department of Health and Family Welfare has also declined by 0.23% in 2023-24 as compared to 2022-23 (Centre for Child Rights, Budget for Children 2023-24). However, if we compare the total health expenditure done by the government between the NFHS round 4 and 5 in various states, there has been an increase, with Uttar Pradesh registering the maximum increase while Sikkim the lowest, as depicted in the figure given below.

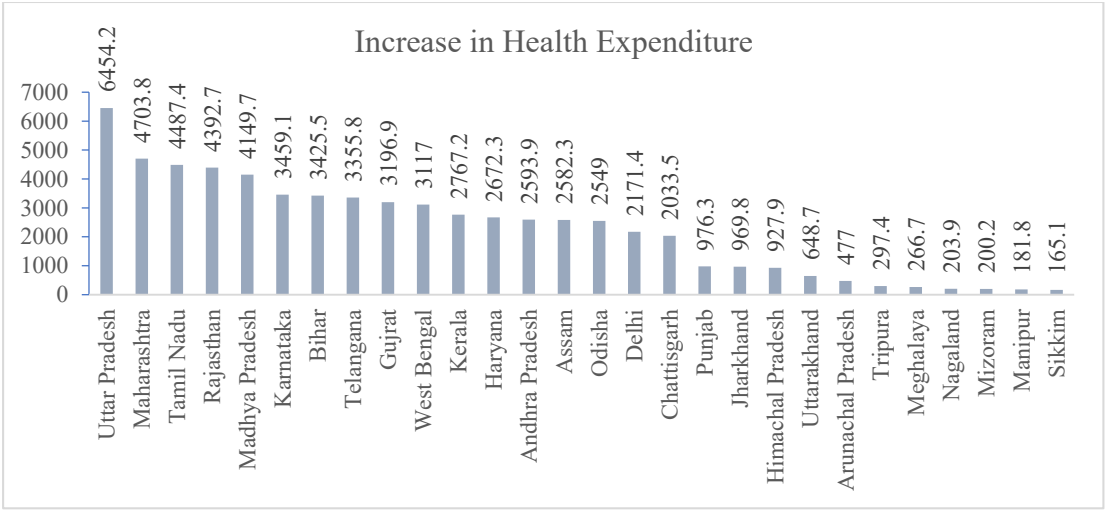

Figure 1: State wise increase in health expenditure across NFHS rounds 4 and 5 (in Rs. Crores)

Source: National Health Profile, Central Bureau of Health Intelligence, Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India.

Although the budget allocated for healthcare increased among the various states, the lop-sided distribution of the family and healthcare facilities among different states makes the objective of equitable distribution of resources a bit difficult to achieve, which clearly reflects in the differences in child health outcomes among various states.

This paper aims to explore the disparity in child health outcomes across different Indian states, examining the impact of basic household facilities on these outcomes across two rounds of NHFS – NFHS 4 and NFHS 5. By analysing key indicators such as access to clean fuel, clean water, sanitation facilities along with vaccination coverage and the prevalence of institutional births, the study seeks to identify the extent to which these basic facilities contribute to the variation in child health outcomes. In this paper, we would construct two indices to quantify both household facilities available and child health outcomes. The study will then employ correlation analysis between changes in these household facilities and the observed changes in child health disparities to provide insights into whether enhancing basic facilities can contribute to reducing health inequalities among children. In addition, the study incorporates inequality measures to assess whether disparities in child health outcomes and the availability of basic facilities are increasing or decreasing over time.

2. LITERATURE REVIEW

Over the period, a number of studies majorly highlighted the issue of the existence of disparity among different Indian states with respect to child health outcomes due to various underlying reasons.

Government initiatives like National Health Mission and Integrated Child Development Services aim to address the disparity amongst the Indian states through targeted interventions and ensuring that states with poorer health indicators receive additional allocations and support under these programs, more specifically with respect to maternal and child healthcare, immunization, nutritional supplementation, etc. (Malqvist et al., 2013). Despite these efforts, there still exists a gap in achievement of equity with respect to these health outcomes between the states. The prevalence of varied cultural practices and the socio-economic makeup of the different states in India adds up to difficulty to even a greater extent. All these factors lead to a stark contrast with respect to under-five mortality rates among the various states. The northern states of Uttar Pradesh (UP) and Bihar as well as the eastern states have been constantly reporting high levels of child mortality rates, in contrast with southern states like Tamil Nadu and Kerala. The obvious and a major contributor to a good performance among the southern states have been stronger social-development, higher literacy rates, better access to healthcare facilities, etc. to name a few (Striessnig & Bora, 2020). On the contrary, the northern states suffer heavily from poverty, inadequate availability of and access to sanitation and healthcare facilities, which ultimately reflect in their dismal performance in controlling malnutrition among children and reducing child mortality rates (Singh S et al, 2019). Another aspect influencing the level of child health outcomes is the education levels of mothers, with the existence of a high correlation between maternal education and increased incidences of child survival and better nutritional status (Prasetyo et al., 2023). Educated mothers tend to be more aware of the availability and usability of the healthcare facilities and seek timely help. They also tend to adopt healthier practices for their children (Mondal et al, 2019). States like Kerala, registering higher female literacy rates have significantly lower child mortality and malnutrition rates. Additionally, earning status of women coupled with their enhanced exposure to information and knowledge of issues relating to maternal and child health, also has a bearing on better access to and usage of such services (Navaneetham & Dharmalingam, 2002).

Type of healthcare service provider, i.e. public or private, also has a bearing on the levels of healthcare outcomes of mother as well as child. Women enjoying higher income parity and better purchasing power tend to opt for private healthcare providers, assumed to provide better facilities and services due to stiff competition. However, the states of Punjab, Rajasthan, Chhattisgarh, Madhya Pradesh, Bihar,

Jharkhand, Odisha, Goa, Maharashtra, Andhra Pradesh and Karnataka registered increased neonatal mortality in private hospital deliveries as compared to public hospitals (Dixit P et al., 2023). This very fact defies the general perception about poor quality of services provided by public hospitals. A focussed approach adopted towards increasing the reach of such facilities can give positive outcomes not only in child health but also in female health.

Another important and emerging issue with respect to children's health and safety is the existence of disaster risks. As per the data cited by the UNICEF report titled -The Climate Crisis is the Child Crisis, "Emerging areas of importance is disaster risk reduction and mitigating the effects of climate change, with nearly 90 per cent of the disease burden attributable to climate change are borne by children under the age of five." The issue gains even more prominence with the increasing incidence of natural calamities in India, with major Indian states like Kerala, Assam, Bihar, Orissa, Uttar Pradesh, Andhra Pradesh, etc. facing severe flood crises every year. Additionally, the longest coastline of India also makes it prone to cyclones and the related disasters. Nonetheless, the Himalayan states and Union Territories - Ladakh, Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and Assam, are also prone to various naturals disasters like earthquakes, landslides, snow avalanches, floods, cloud bursts and forest fires, etc. (Pandey K, 2024).

2. METHODOLOGY

This study involves analysis of state level information on children healthcare outcomes from two NFHS rounds – round 4 (2015-2016) and round 5 (2019-2021). 27 major Indian states and the UT of Delhi is considered for the study. States are chosen as a unit of analysis because states in India have considerable autonomy in health policy and resource allocation, leading to significant inter-state variation in healthcare infrastructure and outcomes. Additionally, inter-state comparison allows to capture the diverse socio-economic, cultural and demographic contexts that influence health indicators thereby providing a more comprehensive understanding of regional disparities and progress. NFHS 4 and 5 covered approximately 601,509 and 636,699 households respectively and is a reliable data source that is used for planning and making state level and national policies (International Institute for Population Sciences, 2021).

In order to construct both the child health outcomes index (CHI) and the basic facilities index (BFI) a large number of indicators need to be considered. The indicators chosen for the construction of these indices and the dimensions they address are given in the following table (Table 1):

Table 1: Indicators chosen for CHI and BFI

Indicators	Definition in NFHS series	Domains addressed
Child Health Outcomes index (CHI)		
H1	Neonatal mortality rate (NNMR)	These indicators cover the domain of child survival at different early stages of life which are critical measure of overall child health and healthcare quality
H2	Infant mortality rate (IMR)	
H3	Under-five mortality rate (U5MR)	
H4	Prevalence of diarrhoea in the 2 weeks preceding the survey (%)	These indicators address the domain of disease burden indicating the prevalence of

H5	Prevalence of symptoms of acute respiratory infection (ARI) in the 2 weeks preceding the survey (%)	common, acute childhood illness that significantly impact child health
H6	Children under 5 years who are stunted (height-for-age)(%)	These indicators cover the domain of nutritional health measuring various forms of malnutrition and anaemia. These are critical determinants of child growth, development and long-term health outcomes
H7	Children under 5 years who are wasted (weight-for-height)(%)	
H8	Children under 5 years who are severely wasted (weight-for-height) (%)	
H9	Children under 5 years who are underweight (weight-for-age)(%)	
H10	Children under 5 years who are overweight (weight-for-height)(%)	
H11	Children age 6-59 months who are anaemic (%)	
Basic Facilities Index (BFI)		
F1	Population living in households with electricity (%)	Access to electricity improves household living conditions, contributing to improved child health
F2	Population living in households with an improved drinking-water source (%)	Clean water and proper sanitation facilities help reduce waterborne and infectious diseases, thereby contributing to better child health
F3	Population living in households that use an improved sanitation facility (%)	
F4	Households using clean fuel for cooking (%)	Use of clean fuel reduces indoor air pollution thereby significantly reducing respiratory infections in children.
F5	Institutional births (%)	Ensures that newborns receive skilled care during delivery that reduces mortality among newborns
F6	Children age 12-23 months fully vaccinated based on information from either vaccination card or mother's recall (%)	Ensures that the risk of preventable diseases reduce significantly thereby contributing to overall better healthcare outcomes among children

Source: Compiled by authors from NFHS reports

The indicators chosen to compute the CHI captures essential aspects of child health, addressing survival, disease burden and nutritional status which are essential for understanding and improving children's health outcomes across regions. On the other hand, the indicators chosen to construct the BFI are integral in understanding the determinants of child health and align with global health objectives like the SDGs.

Principal component analysis (PCA) is used to combine all the above-mentioned indicators into a single aggregate index of child health outcomes and basic facilities available to the households for both the NFHS rounds. The indices are derived by assigning loadings or weights to different indicators calculated by PCA according to the variability of the indicators. Before doing the PCA analysis various procedures were employed to check for outliers and ensure the linearity of association between the variables that included histograms and descriptive statistics. The next step was to standardise the data for each indicator. The maximum and the minimum values of each indicator across all the states were considered and the following formula is used $I_{ij} = \frac{Maximum\ X_{ij} - Observed\ X_{ij}}{Maximum\ X_{ij} - Minimum\ X_{ij}}$ for negative indicators while $I_{ij} = \frac{Observed\ X_{ij} - Minimum\ X_{ij}}{Maximum\ X_{ij} - Minimum\ X_{ij}}$ is used for positive indicators, where I_{ij} represents the component index of the i^{th} indicator belonging to the j^{th} state. The standardised values for constructing CHI and BFI of both NFHS rounds are available in Appendix 1 and 2. For us, all the indicators used for constructing CHI are negative indicators (lower values implying better outcomes) while all the indicators used for constructing BFI are positive indicators (higher values implying better outcomes).

Using some ingenuity, we then applied PCA to the standardized values of the indicators to assign weights to each indicator (Raychaudhuri and Halder, 2009). This method was chosen to avoid arbitrary assigning of weights, ensuring an appropriate and economically intuitive approach.

Algebraically, PCs are linear combinations of the 'k' random variables $X_1, X_2, \ldots X_k$. Only the covariance matrices ($\sum$) or correlation matrix (ρ) of $X_1, X_2, \ldots X_k$ are required for PCs (Johnson and Wichern, 2006). Let us assume the following: the covariance matrix $\sum$ with eigen values $\lambda_1 \geq \lambda_2 \geq \ldots\ldots \lambda_k \geq 0$ for a random vector $X' = [X_1, X_2, \ldots X_k]$.

Using the property of mean vector and variance covariance matrix ($\sum$) for the following linear combinations:

$$Z_1 = a_1' X = a_{11}X_1 + a_{12}X_2 + \ldots\ldots + a_{1k}X_k$$

$$Z_2 = a_2' X = a_{21}X_1 + a_{22}X_2 + \ldots\ldots + a_{2k}X_k$$

.

.

. ……. (1)

$$Z_m = a_m' X = a_{m1}X_1 + a_{m2}X_2 + \ldots\ldots + a_{kk}X_k$$

We have,

Var (Zi) = ai' $\sum$ai ……(2) i= 1, 2, …, k and

Cov (Zi, Zj) = ai' $\sum$aj ……(3) i,j = 1, 2, ……,k.

The PCs are those uncorrelated linear combinations whose variance (in equation (2)) are as large as possible. The first PC is the linear combination with maximum variance, that is, it maximizes Var (Z_1) subject to $a_1a_1' = 1$. The second PC is the linear combination that maximizes Var (Z_2) subject to $a_2a_2' = 1$ and Cov ($a_1'X$, $a_2'X$) = 0 and so on.

To illustrate the PCA technique for assigning weights, let's consider the example of child health outcomes for NFHS 4. To find out the CHI for the NFHS-4 across 28 states of India we have run the PCA with all the 11 indicators pertaining to child health (H1 to H11) and have identified the initial eigenvalues which are more than one. In the case of child health, the eigenvalues are 5.857, 1.960, 1.263. In our present case three principal components explain 82.55% variance of the variables included in the analysis. The Rotated Component Matrix shows the three principal components for child health outcomes for NFHS-4.

Table 2: Rotated component matrix for child health indicators for NFHS - 4

	Principal Component Factors		
Indicators	**1**	**2**	**3**
H1	0.9	0.32	0.1
H2	0.96	0.1	0.14
H3	0.95	0.14	0.19
H4	0.4	0.12	0.82
H5	0.1	0.06	0.94
H6	0.71	0.47	0.27
H7	0.16	0.97	0.02
H8	-0.01	0.91	0.12
H9	0.57	0.78	0.13
H10	-0.41	-0.32	-0.11
H11	0.13	0.79	0.25

We multiplied the first eigenvalue by the first extracted component column (0.9, 0.96, 0.95, 0.4, 0.1, 0.71, 0.16, -0.01, 0.57, -0.01, 0.57, -0.41, 0.13), the second eigenvalue by the second extracted component and so on, considering absolute values for the calculation and treating negative values as positive. The final weight of an indicator is then calculated by summing the products of the eigenvalues and the extracted component row-wise.

The explanatory power of the principal components through the PCA taken to calculate the CHI and the BFI for different rounds of NFHS are given in the (Table 3) below:

Table 3: Number of Principal Components with Variance explained for child health outcomes and basic facilities

Dimension	Name of indicators	Number of Principal components (PCs)	% variance explained
Child health outcomes	H1, H2, H3, H4, H5, H6, H7, H8, H9, H10, H11	3 PCs for NFHS 4	82.55
		3 PCs for NFHS 5	83.31
Basic facilities	F1,F2,F3,F4,F5,F6	2 PCs for NFHS 4	71.37
		2 PCs for NFHS 5	70.52

In the similar manner, as described above the weights are calculated for all the indicators of CHI for NFHS 5 and for all the indicators of BFI for both the NFHS rounds. The table below (Table 4) depicts the weights of all the indicators across the two NFHS rounds.

Table 4: Calculated Weights of CHI and BFI across NFHS 4 and 5

Indicators	NFHS 4	NFHS 5
Weights of CHI Indicators		
H1	6.024	6.236
H2	5.995	6.27
H3	6.078	6.273
H4	3.614	2.487
H5	1.89	2.684
H6	5.421	4.389
H7	2.864	2.724
H8	1.994	2.194
H9	5.032	4.593
H10	3.168	4.032
H11	2.626	3.97
Weights of BFI Indicators		
F1	2.812	2.34
F2	1.425	2.245

F3	2.763	1.715
F4	2.815	1.9
F5	1.092	2.645
F6	1.896	2.629

After calculating the weights, the following formula is used to calculate the CHI and the BFI for both the NFHS rounds:

$SI^c_n = \frac{\sum_{i=1}^{n} X_i \left(\sum_{j=1}^{n} |W_{ij}|. \, EV_j\right)}{\sum_i \left(\sum_{j=1}^{n} |W_{ij}|. \, EV_j\right)}$ where SI^c_n is the child health index of the n^{th} state, X_i is the standardised value of the i^{th} indicator, W_{ij} is the factor loading (weight) of the j^{th} factor and EV_{ij} is the eigenvalue of the jth factor. The table in the Appendix 3 shows the CHI and the BFI values along with the ranks of the states (mentioned in brackets).

To determine the relationship between child health outcomes and access to basic facilities, we employed Pearson's correlation coefficient. Running the correlation test is significant because it quantifies the strength and direction of the relationship between basic facilities and child health outcomes. The positive correlation between the two would suggest that states with better access to basic facilities tend to have better child health outcomes. This finding would underscore the importance of improving access to essential services and amenities to enhance health and well-being of children. Conversely, a negative or weak correlation would indicate that other factors may be influencing child health outcomes and further investigation would be needed to identify these factors.

In addition to the correlation test, we conducted inequality measurements for both child health outcomes and basic facilities to assess whether the existing disparity in child health outcome and access to basic facilities is increasing or decreasing over time. To capture the same, we have employed inequality metrics based on generalised entropy (GE) measures. Unlike the Gini coefficient and other widely used inequality metrics, GE offers several advantages. The Gini coefficient is distribution insensitive, whereas GE's parameter α allows for the adjustment of the distribution to give different areas of the distribution more weights. The generalised form of the Entropy class measure of inequality is given as follows:

$$GE\ (\alpha) = \frac{1}{n(\alpha^2 - \alpha)} \left[\sum \left(\frac{X_i}{\bar{X}}\right)^{\alpha} - 1\right] \ldots\ldots\ldots\ldots (4)$$

The Mean log deviation (MLD or GE(0)), Theil Index (GE(1)) and the coefficient of variation (CoV or GE(2)) belongs to the entropy (GE) class measure of inequality. While GE(1) is sensitive throughout the distribution, GE(0) and GE (2) are sensitive at the lower and the upper ends of the distribution respectively. Setting α to 0,1 and 2, the above equation becomes indeterminate. This issue can be solved by using L' Hospital's rule (Hembram et. al, 2020). Thus, for α = 0,1 and 2 the above equation simplifies to:

$$GE(0) = \frac{\sum ln\left(\frac{\bar{X}}{X_i}\right)}{n} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$GE(1) = \frac{\sum \frac{X_i}{\bar{X}} ln \frac{X_i}{\bar{X}}}{n} \quad \text{.....(6)}$$

$$GE\ (2) = \frac{1}{2} \frac{Var\ (X)}{\bar{X}^2} = \frac{1}{2}.CoV^2 \text{.....(7)}$$

3. RESULTS AND DISCUSSIONS

When we computed the child health outcomes index and the basic facilities index, we found significant disparities in the outcomes across NFHS rounds among the states concerned. Choropleth maps are used (Figure 2 and Figure 3) to highlight the geographic distribution of disparities in child health outcomes and basic facilities across the two rounds of NFHS. These maps enable a visual representation of the variation in index scores across different states. The dark shades in the map represent states with higher index scores, indicating better performance in child health outcomes and basic facilities, while the areas with lower scores are shaded lighter, reflecting poorer outcomes.

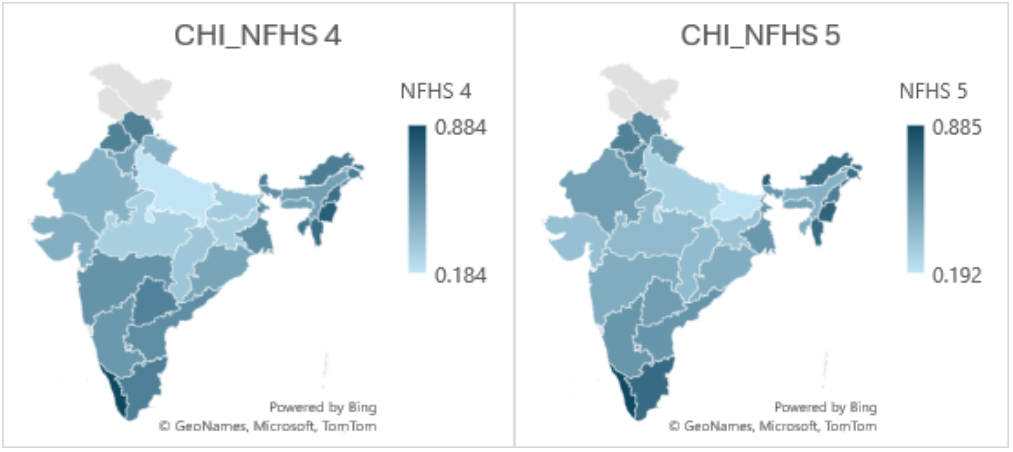

Figure 2: Disparity in CHI across Indian states – NFHS 4 and 5

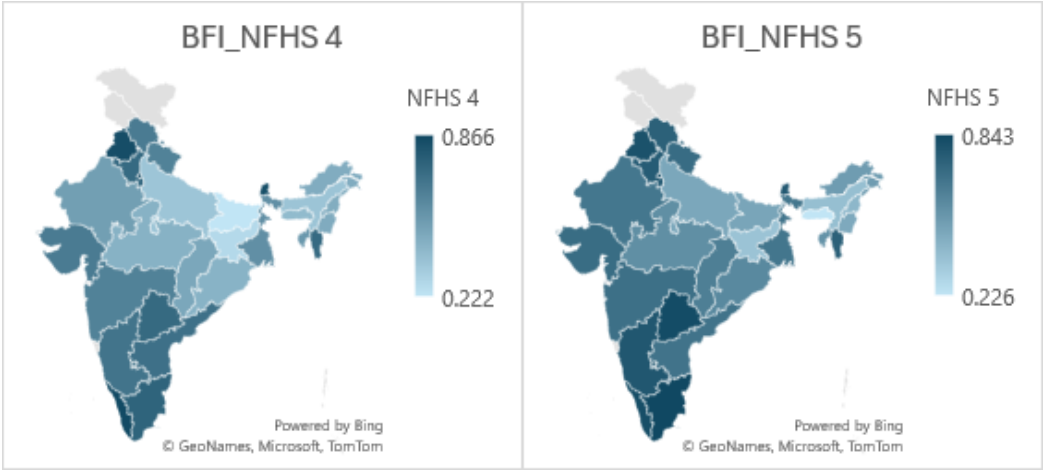

Figure 3: Disparity in BFI across Indian states – NFHS 4 and 5

The disparities across states in child health outcomes and access to basic facilities indicate that while some states have made considerable progress in improving child health outcomes and access to basic facilities, other states lag behind. In NFHS 4, Kerala, Delhi, Punjab, Sikkim and Tamil Nadu were the top performers, while Uttar Pradesh, Bihar, Jharkhand, Chhattisgarh and Madhya Pradesh performed poorly. Manipur, Nagaland, Gujarat, and Uttarakhand, on the other hand, were among the states showing mixed performance. For NFHS 5, Kerala, Delhi, Punjab, Tamil Nadu, Telangana, Himachal Pradesh, Sikkim, Haryana, and Karnataka were the top performers while Bihar, Uttar Pradesh, Jharkhand, Meghalaya, Assam and Chhattisgarh performed poorly. Arunachal Pradesh, Nagaland, Odisha, Madhya Pradesh, Manipur, Gujarat, West Bengal, Uttarakhand, Tripura, Maharashtra, Rajasthan and Mizoram were among the mixed performers. The presence of these disparities emphasizes on the heterogeneity of localized challenges in achieving uniform progress for reducing further inequalities and achieving SDGs at the state level thereby specifying the need for targeted policy interventions to address the specific challenges faced by states with poorer outcomes.

The Pearson correlation test between the CHI and the BFI reveals a positive and significant relation between child health outcomes and access to basic facilities for both the NFHS rounds (Table 5). This indicates that improvements in basic facilities such as clean cooking fuel, sanitation, vaccination coverage and institutional births are strongly associated with better child health outcomes validating the importance of these facilities in enhancing child health and supporting policy interventions aimed at reducing health disparities, thereby contributing significantly to the attainment of several SDGs.

Table 5: Rank Correlation between child health outcomes and basic facilities

NFHS round	Pearson Correlation Coefficient between Child Health outcomes and basic facilities	Prob |t| for H_0 = Variables are independent
NFHS – 4	0.59	0.001
NFHS – 5	0.42	0.024

Enhancing access to clean cooking fuel, proper sanitation, vaccination coverage and institutional births directly supports SDG 3 by reducing child mortality, combating malnutrition and preventing diseases, thereby ensuring good health and well-being. Improved water and sanitation facilities align with SDG 6, ensuring that children have access to clean water and proper sanitation, which are essential for preventing waterborne diseases. Access to clean cooking fuel supports SDG 7 by reducing indoor air pollution and associated health risks, particularly respiratory infections. Furthermore, equal access to essential health services and basic facilities helps achieve SDG 10 by reducing health disparities and promoting equality. Thus, improving basic facilities may drive progress towards achieving a broad range of interconnected SDGs.

In order to understand the performance of the states over time in both child health outcomes and basic facilities, we also analysed their positional changes across NFHS rounds 4 and 5. The figure below (Figure 4) shows the positional changes of the states with respect to child health outcomes and access to basic facilities across the two NFHS rounds.

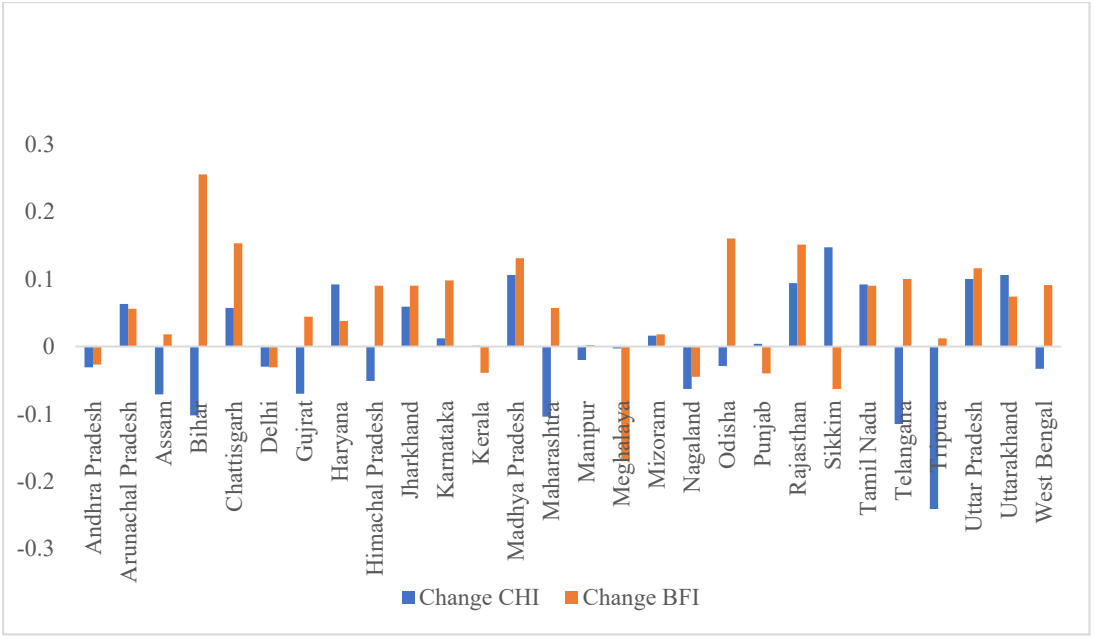

Figure 4: Positional Change in CHI and BFI scores across NFHS 4 and NFHS 5

After tracking the positional changes of the states across the two NFHS rounds we classified the states into four categories based on their performance across the two NFHS rounds: The states with rising CHI and BFI, the states with rising CHI but falling BFI, the states with falling CHI but rising BFI and the states with falling CHI and BFI. By classifying states in this manner, we can better identify specific areas of strength and weakness, enabling more precise policy recommendations. This approach also allows us to understand the interconnectedness of child health outcomes and basic facilities and to strategize interventions that can address more holistic development. The table below (Table 6) shows the positional classification of the states concerned.

Table 6: Positional Classification of States

	BFI rise	**BFI fall**
CHI rise	Arunachal Pradesh Chhattisgarh Haryana Jharkhand Karnataka Madhya Pradesh Mizoram	Kerala Punjab Sikkim

	Rajasthan Tamil Nadu Uttar Pradesh Uttarakhand	
CHI fall	Assam Bihar Delhi Gujrat Himachal Pradesh Maharashtra Manipur Odisha Telangana Tripura West Bengal	Andhra Pradesh Meghalaya Nagaland

Arunachal Pradesh, Chhattisgarh, Haryana, Jharkhand, Karnataka, Madhya Pradesh, Mizoram, Rajasthan, Tamil Nadu, Uttar Pradesh and Uttarakhand have shown significant improvement in both the indices. It is imperative for these states to sustain the ongoing initiatives and efforts in enhancing child health and improving access to essential services. Encouraging investment in health and basic facilities infrastructure can further boost the performance of these states.

Kerala, Punjab and Sikkim have witnessed a rise in CHI despite a fall in BFI. This suggests that while child health outcomes are getting better there may be challenges in the future in maintaining the child health outcomes given the positive relation between the two. Identifying specific areas where basic facilities are lacking and targeting policies to address these gaps can help improve the child health outcomes in the future.

Assam, Bihar, Delhi, Gujrat, Himachal Pradesh, Maharashtra, Manipur, Odisha, Telangana, Tripura, West Bengal have seen a decline in child health outcomes despite improvements in basic facilities. This indicates that other factors, possibly beyond basic facilities, are negatively impacting child health in these regions. These states should prioritise targeted health interventions while continuing to provide basic facilities to its population.

Andhra Pradesh, Meghalaya and Nagaland have shown a decline in both child health outcomes and basic facilities. These states may prove to be the obstacles in India’s attainment of SDG goals in the

long run. The localised challenges faced by these states need urgent attention and targeted interventions to reverse the downward trend in both the domains of child health and basic facilities.

On applying the GE measures to the child health outcome index and the basic facilities index, across the two NFHS rounds, we observed a significant reduction in inequality for both the indices across the two rounds. This notable improvement in equality indicates that disparities in child health outcomes and the availability of basic facilities among households have decreased over time.

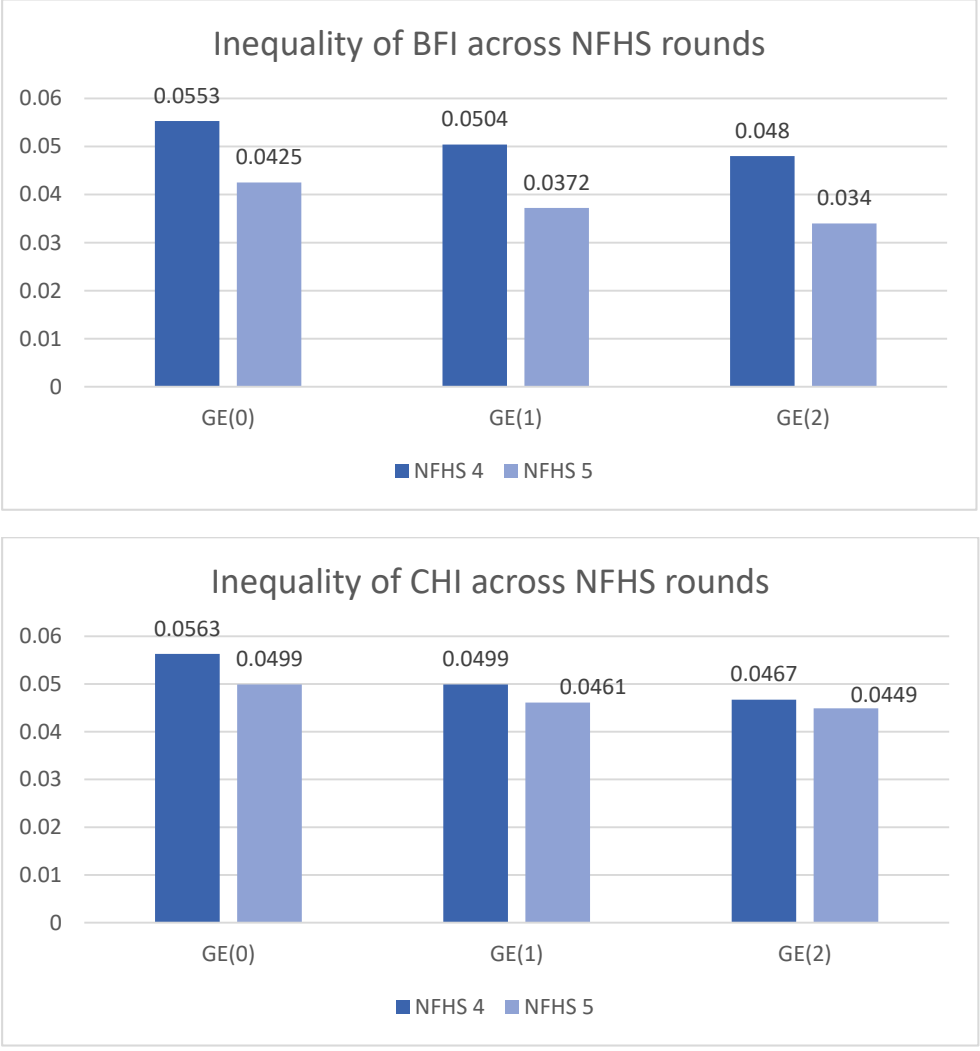

Figure 5: Inequality reduction in BFI and CHI across NFHS 4 and NFHS 5

This improvement signifies that child health outcomes and access to essential services have become more equitable across different states in India. Such an improvement is significant as it aligns positively with India's aspiration to attain the SDG goals. Additionally, it strengthens the proposed relationship between access to basic facilities and child health outcomes in our study. The decline in basic facilities

inequality, which is positively correlated with child health outcomes, may be a significant contributing factor to the reduced inequality in child health outcomes.

The observed reduction in inequality in both the child health outcome index and the basic facilities index across NFHS rounds 4 and 5 marks notable progress towards achieving Sustainable Development Goals (SDGs) for India, particularly SDG 3 (good health and well-being) and SDG 10 (reduced inequalities). Improved equity in child health outcomes reflects better access to healthcare services, which is a core target of SDG 3. Additionally, the enhancement of basic facilities—such as clean cooking fuel, clean water, and sanitation—contributes directly to better health, reducing disease prevalence and improving overall well-being. These advancements align with the goal of ensuring universal access to essential services. Moreover, the decrease in inequality in these indices highlights progress towards SDG 10, which aims to reduce disparities within and among states. Thus, the observed trends not only reflect progress towards specific SDG targets but also indicate broader strides towards creating a more equitable and healthy society.

4. CONCLUSION

The study identifies the existence of disparities among the various Indian states with respect to access to basic facilities, a combination of household as well as health, and child health outcomes. The states registering improved performance on various parameters should work towards forming a list of best practices adopted by them in order to help the states lagging behind in using these best practices as the milestones in order to achieve their targets. Additionally, targeted policy interventions are needed with focused resource allocations for state-specific needs. In fact, a more district level targeting would further be instrumental in achieving the improved outcomes at the grass-root levels. The existence of disparities emphasize on the complexity of achieving uniform progress and suggests that localized efforts are crucial for further reducing inequalities and achieving SDGs at the state level.

The states, which have registered a rise in both CHI and BFI values across the NFHS rounds, should ensure sustained initiatives and aim at progress enhancement, as they would help India to improve its SDG rankings in the time to come. The existence of a direct correlation between reduced basic facilities inequality and improved child health outcomes indicates policy initiatives for encouraging investments in innovative health technologies and provision of basic facilities infrastructure. Examples of the state of Kerala, Punjab and Sikkim, which have witnessed a rise in CHI despite a fall in BFI across the NFHS rounds is indicative of the fact that better access to these facilities can be obtained through creating substantial awareness among the target groups. In addition, the Kerala model of decentralising some of the administrative functions to the Local Self Governments (LSGs) can go a long way in improving primary and secondary government health facilities and sanitation facilities, and ensuring greater access to safe drinking water and sanitation facilities by making the local services more responsive to local needs (Madore et al., 2018).

States like Andhra Pradesh, Meghalaya and Nagaland, which have deteriorated in terms of both CHI and BFI across the NFHS rounds, call for a comprehensive plan for overhauling the health and basic facilities. They require creation of a robust policy targeted towards resource mobilisation and creation of innovative solutions in order to ensure that they do not act as obstacles in India's attainment of SDG goals.

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APPENDIX 1

Standardised values for calculating CHI – NFHS 4

STATES	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11
Andhra Pradesh	0.5283	0.4940	0.5254	0.6842	0.9636	0.5909	0.5153	0.7500	0.4441	0.9367	0.2500
Arunachal Pradesh	0.8182	0.7012	0.6366	0.6908	0.6727	0.6608	0.5109	0.3696	0.7933	0.4684	0.3340
Assam	0.3022	0.2746	0.3042	0.9276	0.8727	0.4161	0.5240	0.5652	0.5028	0.7975	0.6870
Bihar	0.2064	0.2660	0.2817	0.4342	0.6000	0.0000	0.3581	0.4783	0.1089	0.9367	0.1565
Chhattisgarh	0.0737	0.1641	0.1944	0.5197	0.6545	0.3741	0.2576	0.3261	0.2821	0.7215	0.5744
Delhi	0.6708	0.5579	0.5056	0.4868	0.6182	0.5734	0.5721	0.7391	0.5810	0.9367	0.2290
Gujrat	0.4496	0.5060	0.4873	0.5658	0.8000	0.3427	0.1135	0.2065	0.2374	0.8481	0.1737
Haryana	0.5651	0.5302	0.5211	0.6053	0.4727	0.5000	0.3406	0.2609	0.5140	0.6962	0.0000
Himachal Pradesh	0.4816	0.5043	0.5704	0.6842	0.7636	0.7692	0.6681	0.8152	0.7430	0.8481	0.3435
Jharkhand	0.2973	0.3402	0.3352	0.6645	0.4727	0.1049	0.0000	0.0000	0.0000	0.8987	0.0344
Karnataka	0.6536	0.6321	0.6563	0.7697	0.7818	0.4231	0.1266	0.0978	0.3520	0.7595	0.2061
Kerala	1.0000	1.0000	1.0000	0.8947	0.9091	1.0000	0.5808	0.5326	0.8855	0.6582	0.6870
Madhya Pradesh	0.2015	0.2124	0.1901	0.4934	0.6727	0.2203	0.1397	0.2391	0.1397	0.8734	0.0534
Maharashtra	0.7101	0.6874	0.6958	0.5592	0.6182	0.4825	0.1485	0.2174	0.3296	0.8481	0.3416
Manipur	0.7248	0.7219	0.7352	0.7368	0.7455	0.6783	0.9694	1.0000	0.9497	0.6962	0.9122
Meghalaya	0.6437	0.5803	0.5423	0.4211	0.0000	0.1573	0.5983	0.5326	0.5279	0.5949	0.4523
Mizoram	0.8329	0.4041	0.4521	0.6184	0.6545	0.7063	1.0000	0.9891	1.0000	0.5570	1.0000
Nagaland	0.7027	0.5872	0.5718	0.7829	0.8000	0.6888	0.7729	0.7826	0.8687	0.6076	0.8645
Odisha	0.4152	0.4128	0.4225	0.4737	0.6182	0.4965	0.3755	0.5435	0.3743	0.7595	0.5172
Punjab	0.5872	0.5924	0.6324	0.6842	0.3091	0.7902	0.5852	0.6304	0.7318	0.7975	0.2882
Rajasthan	0.3759	0.3834	0.3859	0.6316	0.6727	0.3217	0.2620	0.3043	0.3101	0.8228	0.2176
Sikkim	0.5971	0.5872	0.6465	1.0000	1.0000	0.6538	0.6463	0.5978	0.9385	0.0000	0.3168
Tamil Nadu	0.7641	0.7478	0.7225	0.5921	0.5455	0.7413	0.4061	0.3804	0.6704	0.4557	0.4008

Telangana	0.6167	0.6183	0.6535	0.5789	0.6909	0.7098	0.4760	0.7174	0.5419	1.0000	0.2099
Tripura	0.7838	0.6356	0.6394	0.7961	0.5818	0.8392	0.5328	0.5543	0.6620	0.7089	0.4466
Uttar Pradesh	0.0000	0.0000	0.0000	0.1316	0.2000	0.0699	0.4847	0.5870	0.2318	0.8987	0.1622
Uttarakhand	0.4226	0.4111	0.4451	0.0000	0.2182	0.5175	0.4148	0.2609	0.5922	0.6456	0.2271
West Bengal	0.5676	0.6218	0.6521	0.7303	0.4545	0.5524	0.3799	0.5326	0.4525	0.8228	0.3340

Standardised values for calculating CHI – NFHS 5

States	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11
Andhra Pradesh	0.4892	0.4370	0.4505	0.6311	0.6400	0.6322	0.6013	0.6533	0.4028	0.9125	0.4094
Arunachal Pradesh	0.8669	0.8152	0.7509	0.8350	0.7000	0.7645	0.7911	0.5867	0.9046	0.0375	0.5732
Assam	0.4087	0.4022	0.3791	0.7961	0.6200	0.4628	0.2468	0.2400	0.2898	0.6375	0.2804
Bihar	0.0372	0.0783	0.0623	0.0000	0.4200	0.1488	0.1709	0.2800	0.0000	0.9500	0.2556
Chhattisgarh	0.1022	0.1326	0.1722	0.9806	0.8200	0.4917	0.4241	0.4533	0.3428	0.7500	0.3102
Delhi	0.5635	0.5630	0.5348	0.3010	0.0000	0.6446	0.9114	0.8000	0.6784	0.7500	0.2605
Gujrat	0.4303	0.4174	0.4066	0.5340	0.9200	0.3099	0.0316	0.0400	0.0459	0.7625	0.0000
Haryana	0.4365	0.3717	0.3864	0.8544	0.6600	0.7851	0.8924	0.8667	0.6890	0.8375	0.2308
Himachal Pradesh	0.4706	0.5391	0.5659	0.8738	0.8200	0.6488	0.5190	0.5333	0.5477	0.5375	0.6030
Jharkhand	0.2322	0.2717	0.2637	0.6311	0.7000	0.2851	0.2025	0.2400	0.0565	0.9000	0.3027
Karnataka	0.6161	0.5435	0.5549	0.7864	0.7800	0.4587	0.3861	0.3333	0.2862	0.8500	0.3524
Kerala	1.0000	1.0000	1.0000	0.9126	0.6400	0.9545	0.6203	0.6800	0.7527	0.7500	1.0000
Madhya Pradesh	0.2074	0.1978	0.1941	0.7087	0.6000	0.4545	0.4177	0.5867	0.2827	1.0000	0.1737
Maharashtra	0.5944	0.5913	0.5824	0.4660	0.4800	0.4669	0.0000	0.0000	0.1731	0.7375	0.2680
Manipur	0.5728	0.5522	0.5458	0.7961	0.7600	0.9545	0.9937	1.0000	0.9788	0.8250	0.9156
Meghalaya	0.4923	0.3935	0.3626	0.3204	0.1600	0.0000	0.8544	0.8267	0.5088	0.7500	0.8586
Mizoram	0.7523	0.6326	0.6557	0.9126	1.0000	0.7273	1.0000	0.8000	1.0000	0.0000	0.8263

Nagaland	0.7895	0.5870	0.4908	1.0000	0.9000	0.5702	0.4114	0.4000	0.4982	0.6375	0.9181
Odisha	0.2693	0.3065	0.3425	0.3883	0.4800	0.6405	0.4747	0.6400	0.3993	0.8125	0.3846
Punjab	0.4303	0.4870	0.4963	0.8544	0.6200	0.9091	0.9494	0.9600	0.8516	0.7375	0.2134
Rajasthan	0.4799	0.4370	0.4066	0.7379	0.5400	0.6074	0.5570	0.4400	0.4735	0.8375	0.2035
Sikkim	0.9505	0.8522	0.8901	0.7961	0.9800	1.0000	0.7532	0.5733	0.9859	0.0500	0.5782
Tamil Nadu	0.7121	0.6913	0.6868	0.9709	0.9000	0.8884	0.6962	0.7200	0.6714	0.7125	0.5533
Telangana	0.5851	0.5217	0.5568	0.6117	0.6800	0.5537	0.2468	0.3200	0.3251	0.8250	0.2407
Tripura	0.3963	0.2783	0.3022	0.7282	0.8600	0.5868	0.4684	0.4800	0.5442	0.2250	0.3821
Uttar Pradesh	0.0000	0.0000	0.0000	0.7864	0.4200	0.2810	0.5253	0.4800	0.3145	0.8625	0.3300
Uttarakhand	0.1022	0.2457	0.2601	0.9029	0.6600	0.8058	0.7848	0.8267	0.7067	0.7375	0.5186
West Bengal	0.6254	0.6174	0.6300	0.6990	0.5600	0.5248	0.3354	0.5067	0.3110	0.7125	0.2655

APPENDIX 2

Standardised values for calculating BFI – NFHS 4

STATES	F1	F2	F3	F4	F5	F6
Andhra Pradesh	0.9849	0.8830	0.4016	0.5518	0.5568	0.8761
Arunachal Pradesh	0.7111	0.6212	0.5000	0.3396	0.0521	0.2896
Assam	0.4598	0.5655	0.3279	0.0911	0.2179	0.5642
Bihar	0.0000	0.9610	0.0205	0.0000	0.4898	0.4627
Chhattisgarh	0.9121	0.7632	0.1339	0.0624	0.7635	0.5582
Delhi	1.0000	1.0000	0.6844	1.0000	0.6220	0.7701
Gujrat	0.9095	0.8914	0.5273	0.4345	0.2793	0.8313
Haryana	0.9774	0.9582	0.7596	0.4295	0.4991	0.7104
Himachal Pradesh	0.9925	0.8635	0.6462	0.2360	0.6350	0.6507
Jharkhand	0.5327	0.3955	0.0000	0.0137	0.4935	0.4343
Karnataka	0.9623	0.8747	0.4481	0.4607	0.5065	0.9134

Kerala	0.9849	0.8607	1.0000	0.4944	0.8696	1.0000
Madhya Pradesh	0.7764	0.5933	0.1339	0.1473	0.3389	0.7164
Maharashtra	0.8417	0.7967	0.3730	0.5256	0.3873	0.8582
Manipur	0.8241	0.0000	0.3770	0.3034	0.5661	0.5418
Meghalaya	0.7990	0.1783	0.4973	0.0499	0.4842	0.2776
Mizoram	0.9045	0.8329	0.8115	0.6030	0.2849	0.7000
Nagaland	0.9221	0.5153	0.7063	0.1873	0.0000	0.0000
Odisha	0.6683	0.7019	0.0683	0.0175	0.8045	0.7836
Punjab	0.9950	0.9944	0.7883	0.6005	1.0000	0.8612
Rajasthan	0.7839	0.8301	0.2883	0.1748	0.3613	0.7642
Sikkim	0.9899	0.9443	0.8839	0.5156	0.8864	0.9239
Tamil Nadu	0.9799	0.9415	0.3757	0.6891	0.6387	0.9866
Telangana	0.9774	0.9415	0.3730	0.6180	0.5978	0.9522
Tripura	0.8241	0.6267	0.5287	0.1760	0.3557	0.7030
Uttar Pradesh	0.3166	0.9610	0.1557	0.1860	0.2924	0.5224
Uttarakhand	0.9497	0.8273	0.5628	0.4145	0.4134	0.5343
West Bengal	0.8618	0.9276	0.3798	0.1248	0.9125	0.6328

Standardised values for calculating BFI – NFHS 5

states	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**
Andhra Pradesh	0.9551	0.8789	0.5659	0.7716	0.4787	0.4399
Arunachal Pradesh	0.4270	0.7444	0.6795	0.3179	0.3144	0.6192
Assam	0.1798	0.3991	0.3895	0.1522	0.3448	0.7098
Bihar	0.5955	0.9910	0.0000	0.0881	0.4381	0.5638
Chhattisgarh	0.8764	0.8251	0.5558	0.0164	0.6146	0.7394
Delhi	1.0000	1.0000	0.6430	1.0000	0.5396	0.8521

Gujrat	0.7416	0.9013	0.4990	0.5224	0.5456	0.8983
Haryana	0.9663	0.9641	0.7221	0.4119	0.5578	0.9094
Himachal Pradesh	0.9551	0.8565	0.6572	0.2955	0.8093	0.7856
Jharkhand	0.3708	0.4260	0.1481	0.0000	0.4970	0.5564
Karnataka	0.9101	0.8161	0.5152	0.7134	0.7039	0.9482
Kerala	0.9663	0.7982	1.0000	0.6000	0.5761	1.0000
Madhya Pradesh	0.8315	0.5336	0.3185	0.1224	0.5619	0.8318
Maharashtra	0.7640	0.7354	0.4584	0.7134	0.4888	0.9057
Manipur	0.7978	0.0000	0.3144	0.5746	0.3935	0.6322
Meghalaya	0.1011	0.0942	0.6795	0.0269	0.2921	0.2292
Mizoram	0.8090	0.8386	0.9310	0.7746	0.4686	0.7412
Nagaland	0.8539	0.6233	0.7769	0.1657	0.1724	0.0000
Odisha	0.6742	0.6278	0.2252	0.0418	0.8337	0.8595
Punjab	0.9775	0.9731	0.7546	0.6687	0.5436	0.8983
Rajasthan	0.7978	0.8700	0.4402	0.1418	0.6288	0.9094
Sikkim	0.9326	0.7040	0.7688	0.6940	0.6329	0.9057
Tamil Nadu	0.9326	0.9641	0.4706	0.7612	0.8073	0.9963
Telangana	0.9663	0.9686	0.5436	0.8940	0.6024	0.9482
Tripura	0.8090	0.4888	0.4909	0.2000	0.4077	0.8041
Uttar Pradesh	0.0000	0.9910	0.3935	0.2627	0.4097	0.6969
Uttarakhand	0.9663	0.8430	0.5963	0.4075	0.6369	0.6932
West Bengal	0.7303	0.9148	0.3773	0.1239	0.7789	0.8503

APPENDIX 3

CHI and BFI Index Scores and Ranking across NFHS -4 and 5

	NFHS 4		NFHS 5	
STATES	**CHI**	**BFI**	**CHI**	**BFI**
Andhra Pradesh	0.574 (13)	0.700 (9)	0.543 (12)	0.673 (14)
Arunachal Pradesh	0.647 (6)	0.455 (20)	0.710 (6)	0.512 (21)
Assam	0.493 (17)	0.357 (25)	0.422 (22)	0.375 (26)
Bihar	0.294 (25)	0.222 (28)	0.192 (28)	0.477 (22)
Chhattisgarh	0.321 (24)	0.476 (18)	0.378 (24)	0.628 (17)
Delhi	0.584 (12)	0.866 (1)	0.554 (11)	0.835 (2)
Gujrat	0.429 (21)	0.655 (12)	0.359 (25)	0.699 (12)
Haryana	0.488 (18)	0.727 (7)	0.580 (10)	0.765 (8)
Himachal Pradesh	0.634 (9)	0.656 (11)	0.583 (9)	0.746 (9)
Jharkhand	0.283 (26)	0.270 (27)	0.342 (26)	0.360 (27)
Karnataka	0.527 (16)	0.685 (10)	0.539 (13)	0.783 (6)
Kerala	0.884 (1)	0.859 (2)	0.885 (1)	0.821 (4)
Madhya Pradesh	0.277 (27)	0.433 (22)	0.383 (23)	0.564 (19)
Maharashtra	0.549 (15)	0.630 (13)	0.445 (19)	0.687 (13)
Manipur	0.784 (2)	0.458 (19)	0.764 (3)	0.460 (24)
Meghalaya	0.482 (19)	0.396 (24)	0.479 (18)	0.226 (28)
Mizoram	0.710 (3)	0.727 (8)	0.726 (5)	0.745 (10)
Nagaland	0.708 (4)	0.453 (21)	0.645 (7)	0.408 (25)
Odisha	0.468 (20)	0.428 (23)	0.439 (20)	0.588 (18)
Punjab	0.630 (10)	0.844 (3)	0.634 (8)	0.804 (5)
Rajasthan	0.409 (22)	0.509 (17)	0.503 (17)	0.660 (16)
Sikkim	0.642 (7)	0.839 (4)	0.789 (2)	0.776 (7)

Tamil Nadu	0.637 (8)	0.753 (5)	0.729 (4)	0.843 (1)
Telangana	0.624 (11)	0.728 (6)	0.509 (16)	0.828 (3)
Tripura	0.678 (5)	0.538 (16)	0.437 (21)	0.550 (20)
Uttar Pradesh	0.184 (28)	0.353 (26)	0.284 (27)	0.469 (23)
Uttarakhand	0.409 (23)	0.628 (14)	0.515 (15)	0.702 (11)
West Bengal	0.571 (14)	0.573 (15)	0.538 (14)	0.664 (15)

India's Dependency on Chinese Imports: Trade Patterns and Industrial Competitiveness with China in Electronics Goods

Manisha Devi*

Abstract

The Indian electronics industry's heavy reliance on imports can be directly attributed to trade and investment policy liberalization and a lack of vertical industrial policy measures to enhance productivity and capabilities. The manufacturing sector employed over 160 million people and contributed nearly 16% to India's gross value added (GVA) in FY19. In this study, we take data from 2011 to 2023 from Trade Map. In this research, we analyze the electronics and machinery sectors in India and China, explore the trade patterns in these industries, and investigate the bilateral trade relations between India and China in the manufacturing sector. The study analyzed the revealed comparative advantage of both India and China in the industrial sector to assess their competitiveness. The share of HS Code 85 exports rose from 2.0% in 2011 to 4.8% in 2019, stabilizing around 4.2% from 2020 to 2023. HS Code 84 exports increased from 2.2% in 2011 to 6.6% in 2022, then slightly fell to 5.8% in 2023. Imports under HS Code 85 grew from $13.24 billion in 2011 to $30.61 billion in 2023. India's import share for HS Code 84 rose from 17.6% in 2011 to 21.8% in 2023. India's top export market is the USA, while its primary source of imports is China. India's Revealed Comparative Advantage (RCA) is lower in comparison to China's, which is more pronounced.

Key Words: Imports Dependence, Revealed Comparative Advantages, Bilateral Trade.JEL Code: F10, F18, F41, F43, F62,

1. INTRODUCTION

China and India are often depicted as rivals in the quest for economic dominance. However, there are also significant opportunities for mutual growth, learning, and collaboration to address common challenges and achieve shared objectives **(Vadra, 2015)**. India's reliance on Chinese imports, particularly in the electronics sector, is influenced by multiple factors. Research underscores the substantial effect of Chinese imports on Indian manufacturing **(Raju, 2023).** The trade patterns between India and China show that Indian exports to China primarily consist of low and medium-technology products, whereas Chinese imports into India are mainly high value-added goods, reflecting a technological gap between the two nations **(Galistcheva & Reshchikova, 2022).** Additionally, the influx of Chinese electronics into the Indian market is driven by competitive pricing and advanced technology, appealing to a cost-conscious middle class and influencing consumer behavior and purchasing decisions **(Dahake & Bansod, 2019). (Batra & Khan, 2005)** suggests that a country's comparative advantage in international trade can be shaped by variations in the rate of accumulation of production factors and the increasing trade integration of other nations. SDG 9 aims to "Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation**."(Denoncourt, 2020).** Inclusive and sustainable industrial development, along with resilient infrastructure and innovation, has been included as Sustainable Development Goal 9 in the 2030 Agenda for Sustainable Development **(Global Sustainable Development Report,2023)**. SDG Goal 9 (Industry, Innovation, and Infrastructure) emphasizes the need for robust infrastructure, sustainable industrial growth, and innovation to reduce reliance on any single country for imports, including dependency on China. The study highlights important structural issues in India's electronics industry by looking at trade patterns and the nation's industrial competitiveness.

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2. REVIEW LITERATURE

India's dependence on Chinese imports, particularly in the electronics sector, has drawn significant attention from scholars and policymakers alike. This literature review consolidates findings from various research studies to provide readers with a comprehensive understanding of the trade dynamics and economic competitiveness between China and India in the electronics industry. A major change in the dynamics of international trade was brought about by China's admission into the World Trade Organization (WTO) in 2001, which had an impact on Indian manufacturing companies in particular. The trade imbalance resulting from China's fiscal stance and efficiency in export-oriented industries makes India's dependence on China for electrical goods and machinery apparent **(Southerland et al., 2014**). The trade deficit that India has with China highlights this dependence and emphasizes the need to rectify the trade disparity **(Goyal & Banerjee, 2018).** China's strength in this area is further demonstrated by its domination in technology-intensive exports to India (Dolla, 2011; Chauhan & Kumar, 2024), with 50% of India's imports in this category coming from Chinese electronics **(Gupta & Gupta, 2021)**. Research **(Saripalle, 2015)** has demonstrated that foreign-owned companies in India rely heavily on imports, pointing to a deficiency in the establishment of backward linkages. Research has also been done on the export competitiveness and trade connections between China, India, and other nations. **(Jayawickrama & Thangavelu, 2010)** found that export specialization gradually shifted to new items, giving China and India a competitive edge in a wide range of manufactured commodities. **(Ahmad et al., 2018)** found that China offers a wider variety of items with embedded technology, whereas India concentrates in technical goods and technologically enhanced products. Reduced variety of goods among Indian manufacturing firms is a result of increased penetration of imports from China **(Pavel and Michael, 2019). (Zhou and Latorre, 2014)** emphasized how China's place in international production networks has been cemented by significant FDI inflows, which have bolstered its role as an electronics production base and export center. Despite this, the geographical pattern of China's electronics exports and imports remains largely unchanged. (**Ying et al., 2023)** noted that China's high-tech product exports to India are influenced by economic size, investment freedom, population size, trade freedom and institutional improvement, with geographical distance having a negative impact. (**Fung et al., 2013)** pointed out that China's significant comparative advantage in manufacturing trade, particularly in electronic and telecommunication components, contrasts with India's limited trade in these components due to its strong focus on service trade. India's reliance on Chinese electronics imports is further attributed to China's better port infrastructure, increased research and development intensity, and higher educational enrollment rates.

This study is crucial to analyze India's heavy reliance on China for electronic goods, which has significant implications for the country's trade deficit, supply chain resilience, and technological growth. It also provides insight into strategies for strengthening domestic manufacturing, diversifying import sources, and shaping trade policies that reduce India's reliance on China while promoting sustainable economic development.

3. RESEARCH METHODOLOGY

3.1 Objectives:

1. Assess the trade patterns between India and China for HS Codes 84 and 85.

2. Analyze the direction of trade for these HS Codes.

3. Analyze the Revealed Comparative Advantages (RCAs) of India relative to China for HS Codes 84 and 85.

3.2 Source of Data

This study utilizes secondary data. Time series data on merchandise trade (exports and imports), classified according to the SITC 2-digit code level, were obtained from the Trade Map Database for the period from 2011 to 2023. This data was used to construct export and import shares, analyze trade direction, determine revealed comparative advantages, and calculate annual growth rates of trade flows. HS Code 84 covers nuclear reactors, boilers, machinery, and mechanical appliances, along with their parts. HS Code 85 pertains to electrical machinery and equipment, including their parts, as well as sound recorders and reproducers, and television apparatus.

3.3 Technique

The study employed percentage analysis, compound annual growth rate, and revealed comparative advantage metrics to achieve its objectives.

3.4 Measuring Revealed Comparative Advantage

The concept of revealed comparative advantage (RCA), as introduced by Balassa (1965, 1977, 1986), relates to the relative trade performance of individual countries in specific commodities. This concept operates on the assumption that the commodity pattern of trade reflects inter-country differences in relative costs and non-price factors, thereby "revealing" the comparative advantage of trading countries. Factors influencing changes in RCA include economic structural changes, increased global demand, and trade specialization. In this paper, we apply Balassa's (1965) measure of relative export performance by country and industry/commodity. This metric is defined as the ratio of a country's share of global exports of a specific commodity to its share of total global exports. The index for country q and commodity r is calculated as follows:

$RCAqr = (Xqr/Xwr)/(Xq/Xw)$

Where

Xqr = qth country's export of commodity r

Xwr = global exports of commodity r

Xq = total exports of country q

Xw = total global exports

4. RESULTS AND DISCUSSION

4.1 India -China Bilateral Trade With Each Other

Table: 1 India -China Bilateral Trade with each other (Value in US Million Dollar)

Year	India's total exports to China	India's total imports from China	Trade balance	China's total imports from India	China 's total export to India	Trade balance
2011	16717.8	55483	-38765.2	23372.3	50536.4	27164.1

2012	14729.3	54140.5	-39411.2	18797.2	47677.5	28880.3
2103	16416.8	51635.4	-35218.6	16970.3	48432.4	31462.1
2014	13434.3	58230.5	-44796.2	16358.7	54217.4	37858.7
2015	9539.5	61641.1	-52101.6	13396	58262	44866
2016	8915	60480	-51565	11748.7	58920.6	47171.9
2017	12500.8	71890.4	-59389.6	16333.4	67925.1	51591.7
2018	16503.4	73845.7	-57342.3	18850	76880.6	58030.6
2019	17278.8	68402.1	-51123.3	17985.9	74825.3	56839.4
2020	19008.3	58798.8	-39790.5	20977.3	66719.5	45742.2
2021	23036.6	87535.1	-64498.5	28137.3	97510.7	69373.4
2022	15084.4	102249.2	-87164.8	17482.8	118501.5	101018.7
2023	16266.5	101338.8	-85072.3	18548.8	117821.3	99272.5

Source: Trade Map Database

Table 1 provides a detailed analysis of the trade relationship between India and China from 2011 to 2023. It includes data on India's total exports to China, India's total imports from China, the resulting trade balance for India, China's total imports from India, China's total exports to India, and the resulting trade balance for China.

Figure:1 India's Bilateral Trade with China

Figure 1 presents data on India's trade with China over the period from 2011 to 2023. In 2011, India exported goods worth $16,717.8 million to China and imported goods worth $55,483 million from

China, resulting in a trade deficit of $38,765.2 million. Over the years, India's exports to China showed fluctuations, peaking at $23,036.6 million in 2021 but generally remaining below $20,000 million in other years. Meanwhile, India's imports from China consistently increased, reaching $102,249.2 million in 2022 and $101,338.8 million in 2023, leading to a widening trade deficit that peaked at $87,164.8 million in 2022.This data highlights the significant trade imbalance between the two countries and the growing dependency on Chinese imports from an Indian perspective. Results supported by (Goyal and Banerjee, 2018).

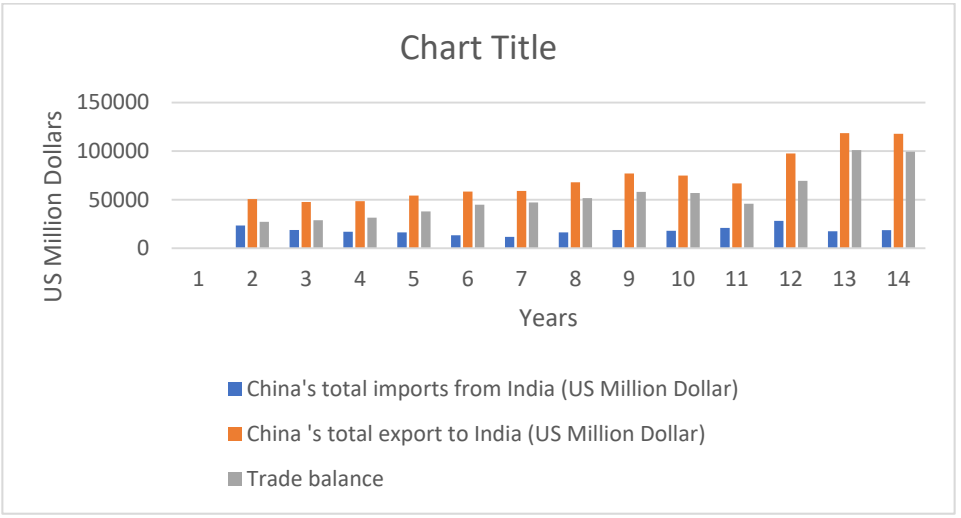

Figure:1.1 India's Bilateral Trade with China

Figure: 1.1 presents data on India's trade with China over the period from 2011 to 2023. China imported goods worth $23,372.3 million from India and exported goods worth $50,536.4 million to India, yielding a trade surplus of $27,164.1 million. On the Chinese side, imports from India showed minor fluctuations, with a peak of $28,137.3 million in 2021. China's exports to India steadily increased, reaching a high of $118,501.5 million in 2022 and $117,821.3 million in 2023. This resulted in China's trade surplus growing over time, peaking at $101,018.7 million in 2022 and slightly decreasing to $99,272.5 million in 2023.

Table: 2 India's Total and Electronic Exports to China: Trade Values, Shares, and Year-over-Year Growth (US Million Dollar)

Year	India's total exports to China	India's Electronic exports to China		India's Electronic exports share to China		Growth Rate	
		HS Code 84	HS Code 85	HS Code 84	HS Code 85	YOY HS Code 84	YOY HS Code 85
2011	16717.8	373.2	327.3	2.2	2.0		
2012	14729.3	402.9	250.9	2.7	1.7	7.9	-23.3

2103	16416.8	508.2	303.6	3.1	1.8	26.1	21.0
2014	13434.3	523.0	311.5	3.9	2.3	2.9	2.6
2015	9539.5	474.8	247.3	5.0	2.6	-9.2	-20.6
2016	8915	465.9	389.9	5.2	4.4	-1.9	57.6
2017	12500.8	665.8	460.1	5.3	3.7	42.9	18.0
2018	16503.4	829.0	538.4	5.0	3.3	24.5	17.0
2019	17278.8	840.5	827.3	4.9	4.8	1.4	53.6
2020	19008.3	718.9	638.7	3.8	3.4	-14.5	-22.8
2021	23036.6	1036.5	986.9	4.5	4.3	44.2	54.5
2022	15084.4	993.7	633.8	6.6	4.2	-4.1	-35.8
2023	16266.5	942.7	677.4	5.8	4.2	-5.1	6.9

Source: Trade Map Database

Table 2 outlines India's total exports to China in million US dollars, with a specific focus on electronic exports classified under Harmonized System (HS) Codes 84 and 85. The table includes the values for India's electronic exports to China and their corresponding share, along with year-on-year (YOY) growth rates for HS Codes 84 and 85.

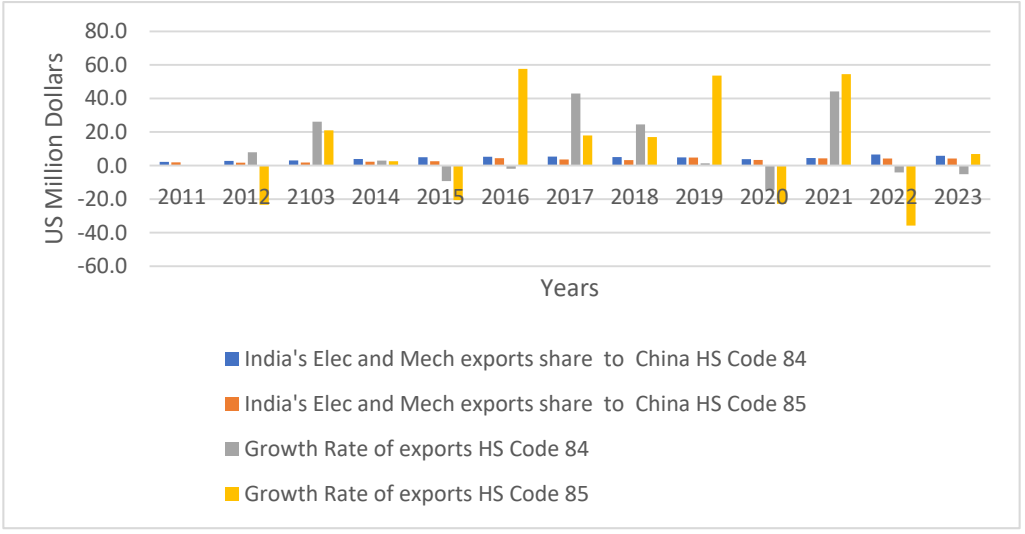

Figure:2 India's Exports and Growth Rate of HS Code 84 and 85

Figure 2 shows the India's total exports to China varied over the years, peaking at 16,717.8 million in 2011 and 23,036.6 million in 2021, with a low of 9,539.5 million in 2015. Exports under HS Code 84 rose from 373.2 million in 2011 to a peak of 1,036.5 million in 2021, before falling to 942.7 million in

2023. Exports under HS Code 85 began at 327.3 million in 2011, peaked at 986.9 million in 2021, and ended at 677.4 million in 2023. The share of HS Code 84 exports grew from 2.2% in 2011 to a peak of 6.6% in 2022, then slightly declined to 5.8% in 2023. The share of HS Code 85 exports increased from 2.0% in 2011 to 4.8% in 2019 and remained around 4.2% from 2020 to 2023. The growth rate for HS Code 84 showed significant fluctuations, with a high of 44.2% in 2021 and negative growth rates in 2015 (-9.2%) and 2020 (-14.5%). The growth rate for HS Code 85 also varied, peaking at 57.6% in 2016 and experiencing a notable decline of -35.8% in 2022. The compound annual growth rate (CAGR) for exports under HS Code 84 is 0.074, while for HS Code 85, it is 0.1.

Table:3 India's Total and Electronic Imports to China: Trade Values, Shares, and Year-over-Year Growth (US Million Dollar)

Year	India's total imports from China	India's Electronic imports from China		India's Electronic imports share from China		Growth Rate	
		HS code 84	HS code 85	HS code 84	HS code 85	HS code 84	HS code 85
2011	55483	9791.6	13240.8	17.6	23.9		
2012	54140.5	10234.0	13114.0	18.9	24.2	4.518009	-0.957
2103	51635.4	9768.3	14444.1	18.9	28.0	-4.5506	10.142
2014	58230.5	9770.0	15977.0	16.8	27.4	0.017833	10.613
2015	61641.1	10590.7	19364.6	17.2	31.4	8.399806	21.203
2016	60480	10727.5	20870.1	17.7	34.5	1.291813	7.7748
2017	71890.4	12798.9	27508.7	17.8	38.3	19.30911	31.809
2018	73845.7	13666.1	23317.7	18.5	31.6	6.775208	-15.24
2019	68402.1	13873.0	19966.0	20.3	29.2	1.514432	-14.37
2020	58798.8	12371.5	17842.4	21.0	30.3	-10.8233	-10.64
2021	87535.1	18796.3	26391.5	21.5	30.1	51.9325	47.915
2022	102249.2	21715.8	30631.7	21.2	30.0	15.53218	16.067
2023	101338.8	22109.0	30606.4	21.8	30.2	1.810464	-0.083

Source: Trade Map Database

Table 3 presents various statistics on India's imports of electrical and mechanical goods from China, specifically those classified under Harmonized System (HS) Codes 84 and 85.

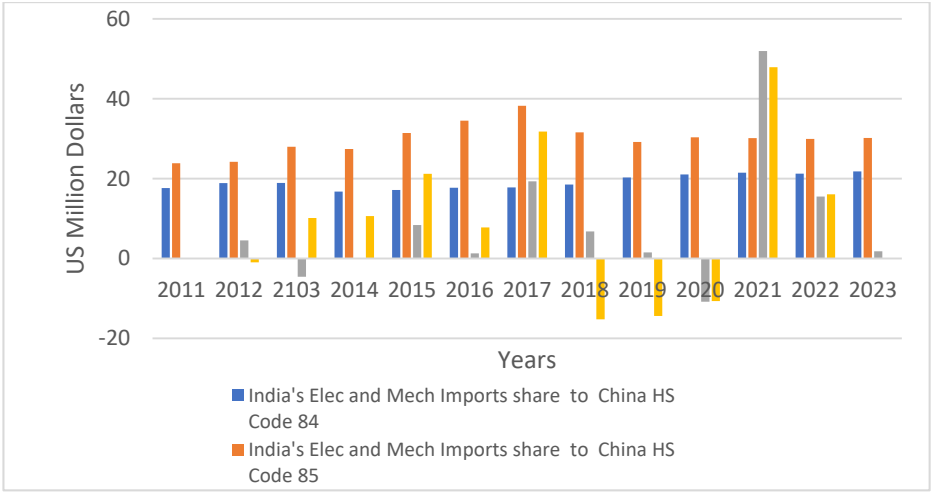

Figure:3 India's Imports and growth rate of HS Code 84 and 85

Figure 3 shows in 2011, India's imports under HS Code 84 were valued at 9,791.6 million, which increased to 22,109 million in 2023. Similarly, imports under HS Code 85 rose from 13,240 million in 2011 to 30,606 million in 2023. The growth rate for HS Code 85 was negative between 2018 and 2020. However, both HS Codes 84 and 85 exhibited an increase in growth rates around 2021. India's import share for HS Code 84 increased from 17.6 percent in 2011 to 21.8 percent in 2023. Likewise, the import share for HS Code 85 grew from 23.9 percent in 2011 to 30.2 percent in 2023. The import share for both codes has variations but does not show a consistent upward or downward trend. The compound annual growth rate (CAGR) for imports under HS Code 84 is 0.06, while for HS Code 85, it is 0.07.

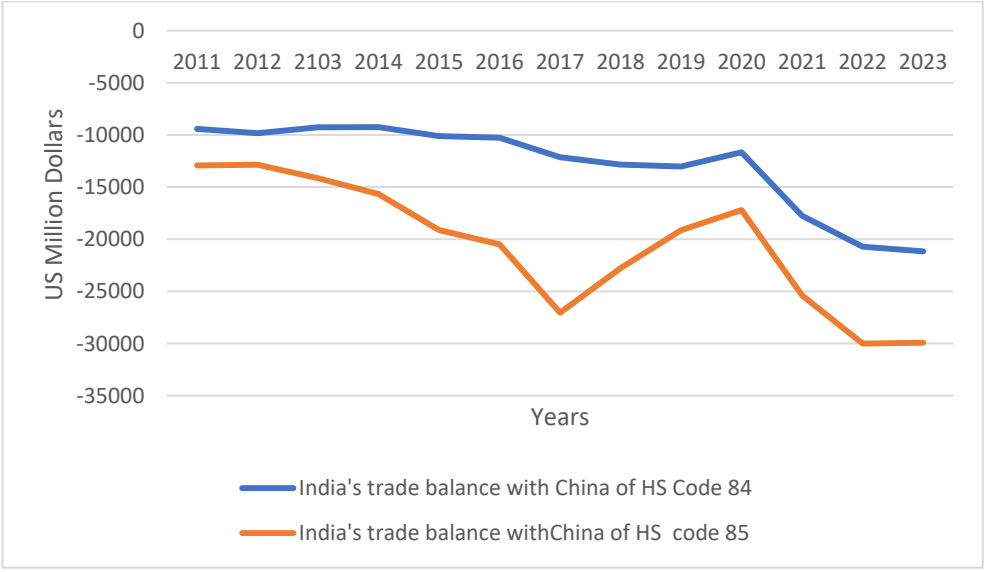

Figure:4 Trade balance of India with China of HS code 84 and 85

The Figure 4 illustrates India's trade balance with China for products categorized under HS Code 84

and HS Code 85 from 2011 to 2023. For HS Code 84, the trade deficit remained relatively stable at around -10,000 million dollars until 2015. Subsequently, the deficit increased, peaking at approximately -25,000 million dollars in 2020, before showing slight improvement in the following years.In contrast, the trade deficit for HS Code 85 (orange line) demonstrates a more pronounced and consistent decline. Starting at around -15,000 million dollars in 2011, the deficit worsened over the years, reaching nearly -30,000 million dollars by 2020. Although there was a brief recovery in 2021, the deficit deepened once more, ending near -30,000 million dollars in 2023.This growing dependence on China, as evidenced by the increasing trade deficit, highlights the need to address the imbalance in trade relations (Goyal and Banerjee, 2018).

4.2 DIRECTION OF TRADE

The direction of trade refers to the flow of goods and services between countries, highlighting key sources and destinations for imports and exports. Analyzing the direction of trade helps identify major trading partners, evaluate trade policies, and strategize economic growth. It reflects global economic interdependence and the dynamic nature of international trade driven by market demand, comparative advantage, and geopolitical factors.

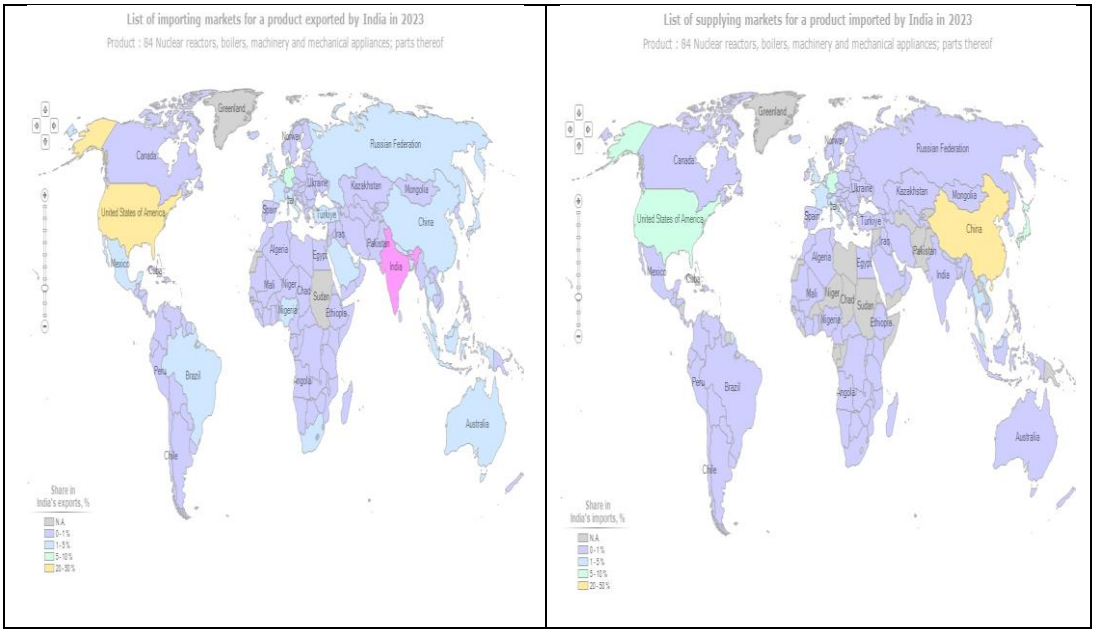

Figure: 4.2.1 Exports and Imports of HS Code 84

Figure 4.2.1 illustrate India's exports for this product make up 1.1% of global exports, ranking 21st worldwide with an export concentration of 0.06. In 2023, India's largest exports under HS Code 84 were to the USA, which comprised 20% of the total. Exports to Germany were 5%, to China and Saudi Arabia 3% each, to the UAE 4%, and to Italy, Turkey, and Brazil 2% each. On the import side, India represents 2.2% of global imports, holding the 14th position with a market concentration of 0.22. That same year, India's imports were predominantly from China, making up 39% of the total, followed by 10% from the USA, 8% from Germany, and 6% from Japan.

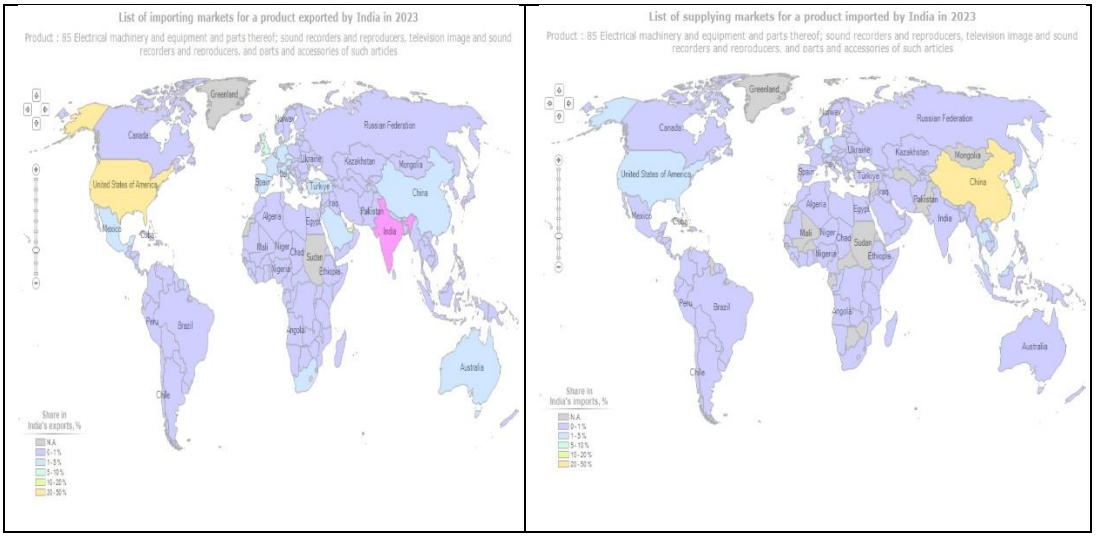

Figure: 4.2.2 Exports and Imports of HS Code 85

Figure 4.2.2 illustrate India's exports of this product constitute 1% of global exports, ranking 20th worldwide with an export concentration of 0.12. The USA received the largest share of HS Code 85, at 31%, followed by the UAE with 11%, and both the Netherlands and the UK with 5% each. China received a modest 2% of India's exports for this product in 2023. On the import side, India represents 2.1% of global imports, ranking 12th with a market concentration of 0.35. In 2023, the majority of India's imports under HS Code 85 came from China, accounting for 40% of the total, with Ireland contributing 7%, and Korea Republic and Vietnam each providing 5%. Imports from the USA were relatively small, at just 3%.

4.3 RCA of India – China

This concept is based on the assumption that the pattern of trade in commodities reflects differences between countries in relative costs and non-price factors, thereby "revealing" the comparative advantage of trading countries.

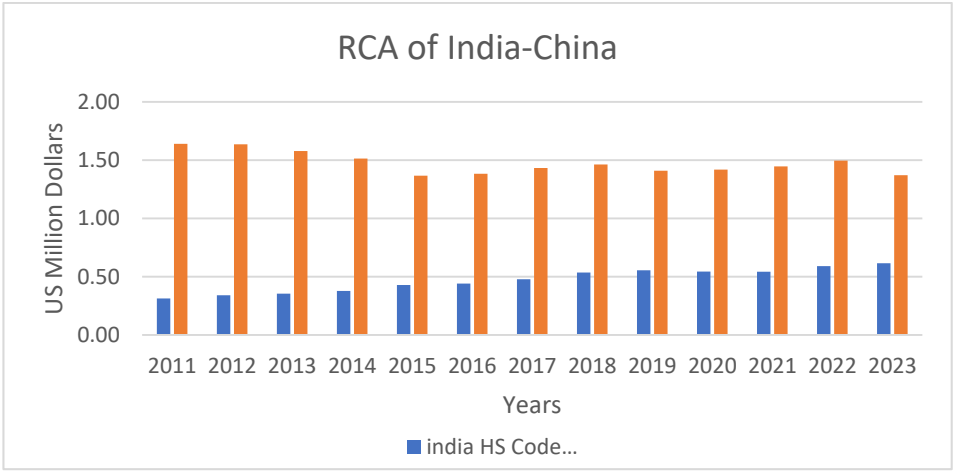

Figure: 4.3.1 RCA of India – China with HS Code 84

Figure 4.3.1 demonstrates the HS Code 84 Revealed Comparative Advantage (RCA) indices for China and India from 2011 to 2023. The RCA index for India increased steadily from 0.31 in 2011 to 0.62 in 2023. This implies that India's comparative advantage in this commodity has gradually improved over -time. China's RCA index, on the other hand, shows some minor decline over the same timeframe, starting at 1.64 in 2011 and reaching 1.37 by 2023, even if it is still significantly higher than India's. This implies that, despite a minor fall in recent years, China has maintained a significant comparative advantage in this product throughout-- time.

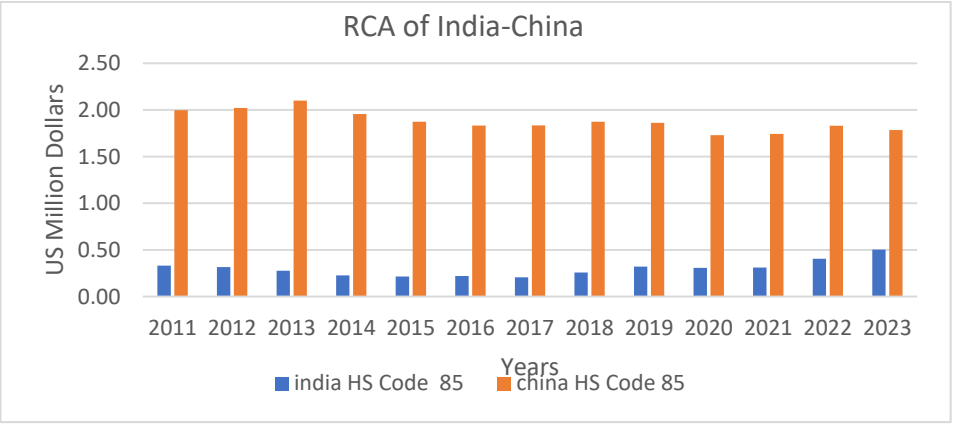

Figure: 4.3.2 RCA of India – China with HS Code 85

The figure 4.3.2 shows the Revealed Comparative Advantage (RCA) indices for China and India for HS Code 85 between 2011 and 2023. India's Revealed Comparative Advantage (RCA) was 0.33 in 2011 and would rise to 0.50 by 2023. The RCA reached its lowest points in 2015 and 2017, following which it began to rise gradually. China's RCA, on the other hand, was 0.22 in 2011 and increased to 1.78 by 2023, a remarkable increase, even after an initial decline. This suggests that China has consistently maintained a substantial competitive edge in this commodity, even with a slight decrease in recent years

4.4 India's Imports Dependency on China

India's reliance on Chinese imports is attributed to several factors, including China's competitive pricing, cost advantages, its wide array of products, and the integration of Chinese components into global supply chains. Despite efforts to reduce imports of goods like toys and plastics, India is expected to remain dependent on China shortly, especially in sectors such as electronics and machinery (N**air & Pandey, 2020**). Their complementary positions in the classical and manufacturing industries—China being a leader in the mass export of cheaply priced goods—fuel this dependence **(Beretta & Lenti, 2012)**. In addition, the dominance of China in the electronic goods industry can be attributed to its superior infrastructure for ports, higher intensity of development and research, and greater number of students **(Fung et al., 2013).** Furthermore, India's import dependence is reinforced by China's rapid industrialization and the reorganization of the global supply chain **(Wang et al., 2018).**

4.5 Boosting India's Domestic Production to Reduce Dependence on China

The "Make in India" and "Atmanirbhar Bharat" initiatives are central to India's strategy to boost local

manufacturing and reduce import dependence. These initiatives have been supported by policy measures aimed at promoting export-led growth, especially during the COVID-19 pandemic (Annachhatre and Gore; 2021, Pulicherla,2022). India should work towards import substitution via Make-in-India, prioritizing domestic productions of HS Code 85,84 to reduce its trade deficit with China (Bijoy,2022). India needs to draw lessons from China, particularly in high technology-incentive-vised products. The Chinese manufacturing- success in high-tech sectors, including cell phones, laptops, etc, are driven by a range of policies, such as the setting up of "science parks" that encouraged vertical foreign direct investment, incentivized research and development expenditure through various tax sops, and providing a favorable business environment, quality infrastructure, flexible labor laws, which jointly enabled China to emerge as a manufacturing factory of the world (Sahoo and Bishnoi,2023). India can explore alternative sources of imports from the ASEAN countries, especially Korea, Singapore, Malaysia, Thailand, and Vietnam. These countries are actively facilitating China's capital-intensive value-added exports. For instance, China exports almost one-fifth of its electrical machinery and electronics equipment to the ASEAN-5 countries, which amounts to more than 4% of the world's exports of this sector. Not only this, China is massively importing such products from these countries as is evidenced from the lower values of the intra-industry trade in the sector.

5. CONCLUSION AND POLICY IMPLICATIONS

India's electronics industry heavily depends on Chinese imports due to trade and investment policy liberalization, and a lack of robust industrial policies to boost local production. In 2011, India exported $16,717.8 million to China while importing $55,483 million, resulting in a trade deficit of $38,765.2 million. By 2023, exports to China decreased to $16,266.5 million, while imports surged to $101,338.8 million, peaking at $102,249.2 million in 2022. Exports under HS Code 84 rose from $373.2 million in 2011 to a peak of $1,036.5 million in 2021, then fell to $942.7 million in 2023, while HS Code 85 exports increased from $327.3 million in 2011 to $986.9 million in 2021, ending at $677.4 million in 2023. Imports under HS Code 84 grew from $9,791.6 million in 2011 to $22,109 million in 2023, and HS Code 85 imports rose from $13,240 million to $30,606 million. In 2023, the USA received 20% of HS Code 84 exports, while China accounted for 39% of imports and 2% of HS Code 85 exports, indicating India's increasing reliance on Chinese goods despite its comparative advantages in service trade.The findings stress the need for robust trade and industrial policies to reduce India's dependence on Chinese imports by boosting domestic manufacturing and improving the competitiveness of Indian firms, especially in the electronics sector. Supporting SMEs with capital, education, and infrastructure can enhance productivity and innovation. Prioritizing R&D investments, fostering industry-academia collaboration for technological self-sufficiency, and diversifying trade partnerships are key, alongside strengthening high-tech manufacturing through targeted policies and FDI incentives. Efforts to boost India's self-reliance, such as the "Make in India" initiative, aim to reduce this dependency by encouraging local production and attracting foreign investment in the electronics sector.

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Microfinance Women Empowerment Vision 2047 Aligning SDGS with India's Development Aspirations

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Sarbananda Sahoo[**]

Abstract

This study explores the role of microfinance in empowering women and its alignment with the "Sustainable Development Goals (SDGs), particularly Gender Equality (SDG 5) and Decent Work and Economic Growth (SDG 8)", within the context of India's Vision 2047. Using data from 485 participants across India, with a focused analysis on 135 women from the Delhi NCR region, the study employs rigorous statistical techniques, including Chi-Square tests, hypothesis testing, ANOVA, and correlation analysis, to assess microfinance's impact on women's income, employment status, and empowerment levels. The findings reveal a significant increase in income, employment, and empowerment among women post-microfinance interventions. Average income increased from ₹15,000 to ₹22,000, employment levels rose from 50 to 95 participants, and empowerment scores significantly improved from 3.5 to 4.6. These outcomes highlight microfinance as a critical tool for promoting gender equality and economic growth, aligning closely with India's development aspirations under Vision 2047. Policy recommendations include expanding access to microfinance, especially in underserved regions, integrating financial literacy and business training into programs, and leveraging digital financial services to reach more women. This research underscores microfinance's transformative potential for advancing women's economic and social empowerment, contributing to national development goals and global sustainable development priorities.

Keywords: Microfinance, Women Empowerment, Sustainable Development Vision 2047.

1. INTRODUCTION

A potent instrument for economic growth and poverty reduction, microfinance involves lending money to those with low incomes or who lack access to conventional banking services. By providing services like modest loans, savings accounts, and insurance, this financial inclusion approach helps connect the unbanked population to mainstream financial institutions (Armendáriz & Morduch, 2010). Microfinance institutions promote economic self-sufficiency and community development by providing access to these services, which enable people to participate in income-generating businesses (Banerjee et al., 2015). According to Cull et al. (2009), microfinance has the potential to revolutionise society by providing economically disadvantaged groups with chances for entrepreneurship and financial stability.

One way in which microfinance contributes to women's empowerment is by giving them access to the capital they need to launch or grow their own small enterprises (Kabeer, 2001). Customised microfinance initiatives greatly assist women, who often encounter structural obstacles to accessing financial services. Training and mentorship are additional components of these programs that aim to improve business acumen and financial literacy in addition to providing financial assistance (Pitt & Khandker, 1998). This leads to women having more control over their lives, higher family incomes, and more opportunities to be involved in the economy and community (Swain & Wallentin, 2009). Family health and educational results are two of the many societal advantages that result from this empowerment (Zaman, 2001).

Within the context of the Sustainable Development Goals (SDGs), this research examines how

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microfinance has contributed to women's empowerment. Adopted by the UN in 2015, the SDGs lay out a worldwide plan to improve and sustainably create a brighter future for everyone by 2030 (United Nations, 2015). The significance of empowering women and encouraging inclusive economic development is highlighted in Goal 8 (Decent Work and Economic development) and Goal 5 (Gender Equality) (Hermes & Lensink, 2011). By helping women become more financially included and economically active, microfinance programs are in line with these objectives and help alleviate poverty and promote long-term sustainability (Khandker, 2005). The importance of microfinance as a vehicle for achieving global development goals is highlighted by this alignment (Littlefield et al., 2003).

1.1 "Research question

This study seeks to answer the following key questions:

- How does microfinance contribute to the empowerment of women in India?
- To what extent do microfinance initiatives align with Sustainable Development Goals, particularly Gender Equality (SDG 5) and Decent Work and Economic Growth (SDG 8)?
- What is the specific impact of microfinance on women in the Delhi NCR region?
- What policy recommendations can be made to enhance the effectiveness of microfinance in empowering women and supporting India's Vision 2047?

1.2 Significance

The significance of microfinance in achieving these development goals underscores its transformative potential for advancing global equity (Littlefield et al., 2003).

1.3 Objectives

- To analyze the role of microfinance in empowering women in India.
- To examine how microfinance initiatives align with Sustainable Development Goals (SDGs), particularly Gender Equality (Goal 5) and Decent Work and Economic Growth (Goal 8).
- To explore the regional impact of microfinance, with a specific focus on the Delhi NCR region as a case study.
- To offer recommendations for enhancing the effectiveness of microfinance in achieving women's empowerment and advancing India's Vision 2047."

2. LITERATURE REVIEW

2.1 Small Loans and Empowering Women

Microfinance has been shown to empower women, according to several studies. This is especially true when it comes to women's economic independence, decision-making capacity, and social standing. Swain and Wallentin (2009) found that when families have access to microfinance, women are more likely to engage in income-generating activities, which in turn increases household incomes and improves family health and education. Microfinance institutions assist women to establish or develop their enterprises by offering modest loans and financial services suited to their requirements. This promotes their confidence and social position (Kabeer, 2001). "Microfinance not only helps women become financially independent, but it also empowers them to take an active part in decision-making at home and in the community, hence enhancing their social role (Pitt & Khandker, 1998)." A person's sense of agency has far-reaching consequences that help their loved ones and the society at large (Zaman, 2001).

2.2 Partnership between Microfinance Institutions and the SDGs

The significance of empowering women and encouraging inclusive economic development is

emphasised in the "Sustainable Development Goals (SDGs), namely in Goal 5 (Gender Equality) and Goal 8 (Decent Work and Economic development). With the help of microfinance, women are able to start their own businesses, which boosts the economy and helps close the gender gap (United Nations, 2015)." Microfinance helps close the gender gap in financial inclusion by expanding women's access to savings, loans, and insurance, which in turn allows them to start businesses, grow their incomes, and become economically independent (Hermes & Lensink, 2011). This congruence with the SDGs highlights the importance of microfinance in accomplishing larger development goals, such as reducing gender inequality and increasing women's access to economic opportunities (Littlefield et al., 2003).

2.3 Vision 2047 for India

India's long-term goals for societal and economic progress are laid forth in its Vision 2047 document. Part of this plan aims to reduce poverty, increase economic development, and level the playing field for women (Government of India, 2021). With the help of microfinance, women may gain economic independence and participate fully in society, two key components in achieving these aims. Microfinance organisations have the power to empower women and unleash their full economic potential by meeting their specific financial requirements (Simanowitz & Walter, 2002). Accelerating progress towards these ambitious objectives, leveraging the economic contributions of empowered women to create a more equitable and prosperous society, is projected to be achieved via the integration of microfinance within the larger development framework of Vision 2047 (Wright, 2000). The significance of attaining sustainable development via promoting gender equality and financial inclusion is emphasised by this strategic approach, which is in line with global development priorities.

3. METHODOLOGY

3.1 Research Design

The research employs a cross-sectional survey design, with quantitative analysis techniques such as ANOVA, Chi-Square tests, and correlation analysis. The data comes from 485 participants across India, with a focused subset of 135 women from the Delhi NCR region to capture regional dynamics.

3.2 Formulas for Statistical Tools

The study employs the following statistical techniques:

- **Chi-Square Test**: Used to assess the association between categorical variables, such as employment status before and after receiving microfinance.

$$\chi^2 = \sum (O-E)^2 / E$$

Where OOO is the observed frequency and EEE is the expected frequency under the null hypothesis.

- **Hypothesis Testing**: To evaluate the significance of changes in income levels and empowerment, the standard formula for t-tests and F-tests is applied.

3.3 Data Collection Techniques

Data was collected through structured **interviews** and **surveys** targeting participants from varied socioeconomic backgrounds across India. Special attention was given to participants from the Delhi NCR region to explore specific urban and semi-urban impacts.

3.4 Variables Analyzed

- **Income Levels**: Changes in income before and after receiving microfinance.

- **Employment Status**: Pre- and post-microfinance employment data, analyzed using the Chi-Square Test.

- **Empowerment Levels**: Decision-making power, social status, and financial autonomy as measured by changes in empowerment scores.

4. RESULTS

4.1 Demographic Analysis

The analysis is structured around the key hypotheses tested during the research, focusing on the impact of microfinance on women's income, employment, economic activity, and empowerment levels. Each hypothesis has been statistically evaluated, and the findings are connected to the Sustainable Development Goals (SDGs) and India's Vision 2047.

4.1 Demographic Analysis

Before delving into hypothesis testing, it is essential to understand the demographic profile of the participants, as it shapes the broader analysis. The sample comprises 135 women from the Delhi NCR region, selected to represent various socioeconomic backgrounds. The majority of participants (56%) live in medium-sized households (4-6 individuals), while 70% of participants are married, highlighting their varied social contexts.

Table 1. Demographic Characteristics of Participants

Demographic Variable	Frequency	Percentage (%)
Age		
20-30 years	40	30%
31-40 years	50	37%
41-50 years	25	19%
51 and above	20	14%
Education		
Primary	35	26%
Secondary	55	41%
Tertiary	45	33%
Marital Status		
Married	95	70%
Single	40	30%
Household Size		
1-3	30	22%
4-6	75	56%
7+	30	22%

These demographic details provide a crucial foundation for understanding how microfinance interventions impact the social and economic status of women in the Delhi NCR region. The diversity in education and age reflects the broader population this study aims to impact, supporting India's **Vision 2047** goals for inclusive economic development.

4.2 Hypothesis Testing

Hypothesis 1: Microfinance significantly impacts women's income levels

To test the impact of microfinance on income levels, we conducted a hypothesis test comparing average income before and after microfinance interventions. The results are summarized in the table below:

Table 2. Income Levels (Before and After Microfinance)

Group	N	Mean Income (`)	Standard Deviation	F-value	p-value
Before Microfinance	135	15,000	3,500	9.12	< 0.01
After Microfinance	135	22,000	4,800		

The analysis reveals a statistically significant increase in income levels after microfinance interventions. The mean income rose from `15,000 to `22,000, indicating a significant improvement in women's financial well-being. This aligns with SDG 8 (Decent Work and Economic Growth), as the income increase reflects enhanced economic participation and productivity among women. Further, this finding directly contributes to India's Vision 2047, as the increase in income through microfinance helps alleviate poverty and promotes sustainable economic growth. The emphasis on financial inclusion through microfinance serves as a key driver for economic upliftment, particularly for women, which is crucial to achieving India's long-term development goals.

Hypothesis 2: Microfinance significantly impacts women's employment status

A Chi-Square Test was conducted to examine changes in employment status before and after receiving microfinance. The results are as follows:

Table 3. Chi-Square Test for Employment Status Before and After Microfinance

Group	Employed	Unemployed	Chi-Square	p-value
Before Microfinance	50	85	38.2	< 0.01
After Microfinance	95	40		

The findings show a significant improvement in employment status post-microfinance, with the number of employed women increasing from 50 to 95. The Chi-Square value of 38.2 and a p-value of less than 0.01 confirm that this change is statistically significant. This shift not only enhances economic security for women but also aligns with SDG 5 (Gender Equality) and SDG 8 by enabling women to secure better employment opportunities, thereby narrowing the gender gap in the labor market. The increased employment opportunities among women, supported by microfinance, also help India progress toward its Vision 2047 goals of inclusive economic development.

Hypothesis 3: "There is a significant relationship between access to financial services and economic activity

A Pearson correlation test was conducted to explore the relationship between access to financial services and women's economic activity. The results are summarized below:

Table 4. Correlation Between Access to Financial Services and Economic Activity

Variable	Pearson Correlation	p-value
Financial Access	0.54	< 0.01
Economic Activity	0.54	< 0.01

The results show a strong positive correlation (r = 0.54) between access to financial services and economic activity, with a p-value of less than 0.01. This indicates that as access to financial services increases, women's participation in income-generating activities also rises. This finding underscores the role of microfinance in enabling women to engage more actively in economic ventures, furthering their empowerment. This aligns with SDG 8, emphasizing the role of financial inclusion in driving economic growth and development. Moreover, increased economic activity through microfinance strengthens India's Vision 2047 goals, as it contributes to building a more inclusive and prosperous economy where women play a central role.

Hypothesis 4: Microfinance significantly impacts women's empowerment levels"

The impact of microfinance on women's empowerment was assessed by comparing empowerment levels before and after microfinance interventions. The results are shown below:

Table 5. Empowerment Levels (Before and After Microfinance)

Group	Empowerment Level	Standard Deviation	F-value	p-value
Before Microfinance	3.5	0.7	8.45	< 0.01
After Microfinance	4.6	0.8		

The analysis indicates a significant increase in empowerment levels post-microfinance, with average scores rising from 3.5 to 4.6. The F-value of 8.45 and a p-value of less than 0.01 suggest that this increase is statistically significant. This increase in empowerment aligns with SDG 5 (Gender Equality), as it reflects women gaining more control over their financial decisions, improving their social status, and having greater agency in both their households and communities. As India progresses toward Vision 2047, microfinance plays a pivotal role in empowering women to contribute more effectively to social and economic development, ultimately leading to a more equitable and inclusive society.

5. DISCUSSION

This study aimed to examine the role of microfinance in empowering women, aligning its findings with India's Vision 2047 and the Sustainable Development Goals (SDGs), specifically Goal 5 (Gender Equality) and Goal 8 (Decent Work and Economic Growth). The results demonstrate that microfinance

plays a pivotal role in improving women's income, employment status, and overall empowerment. These outcomes underscore the importance of microfinance as a tool for sustainable development and advancing India's long-term goals (Government of India, 2021; United Nations, 2015).

Examining how microfinance has helped women in India gain economic independence was the primary goal of this research. According to the results, microfinance greatly increases women's economic autonomy and decision-making capacity. Microfinance recipients had an average income rise of `22,000, from an initial `15,000, according to the hypothesis testing. Microfinance has a good effect on women's economic status, which is shown in this income increase, which allows them to make more significant contributions to their homes and communities (Sharma, 2017). Microfinance had a significant impact on women's empowerment, as their empowerment ratings increased from 3.5 to 4.6. This indicates that microfinance has helped women gain control over their own finances and improve their social standing (Swain & Wallentin, 2009). Increasing women's voice in decision-making is in line with the larger objective of empowering women socially and economically so that they have more control over their own lives and the lives of their communities (Kabeer, 2001).

Our second goal was to look at the Sustainable Development Goals (SDGs) and how microfinance programs fit into them, namely SDG 5 (Gender Equality) and SDG 8 (Decent Work and Economic Growth). This alignment is backed up by the results. The growth in employed participants from 50 to 95 following microfinance intervention demonstrates that microfinance is improving women's economic stability, which in turn increases employment among women (Banerjee et al., 2015). By assisting in the reduction of the gender wage gap, this promotes gender equality and so contributes to SDG 5 (United Nations, 2015). Aligning with SDG 8, microfinance plays a role in promoting sustainable economic development, as shown by the association between increasing economic activity and access to financial services (Hermes & Lensink, 2011; Pitt & Khandker, 1998). Microfinance programs help women become more economically independent, which in turn helps the economy as a whole and moves us closer to our stated goals of universal access to quality employment and long-term economic development (Cull, Demirgüç-Kunt, & Morduch, 2009).

The research looked at the effects of microfinance on the Delhi NCR area, as well as its compatibility with the SDGs. Results from this area, where economic activity is more vibrant, demonstrate that women who were microfinance recipients had substantial increases in their income and employment rates. According to the demographic study, microfinance may reach a wide range of women in urban and semi-urban regions, regardless of their educational status or the size of their home (Swain & Wallentin, 2009). This geographical study highlights the importance of microfinance programs that are designed to address the unique needs and constraints of certain areas. By doing so, programs like Delhi NCR can have a greater effect and serve as a model for similar interventions throughout India. Connected to this is India's Vision 2047, a plan to promote inclusive economic growth via increasing women's economic agency and participation (Government of India, 2021).

In the end, the study's goal was to suggest ways to make microfinance work better to empower women and move India's Vision 2047 forward. The results provide credence to the idea that microfinance programs may help lift people out of poverty and boost economies, especially those headed by women. Microfinance helps India achieve its development objectives since it raises women's income, employment, and empowerment levels (Morduch, 1999; Yunus, 1999). Robertson (2001) and Sinha (2006) suggest that governments should prioritise increasing access to microfinance, especially in disadvantaged areas, and incorporating financial literacy and business training into microfinance programs in order to make these programs even more successful. To further guarantee that microfinance remains an essential tool in achieving India's Vision 2047 and the worldwide SDGs, it is possible to increase access to digital financial services, which might benefit women in rural regions in particular (Montgomery & Weiss, 2011).

The results of this research show that microfinance may be an effective means of achieving gender equality in India. Microfinance has the ability to propel sustainable development since it is in line with SDGs 5 and 8, and it contributes to India's Vision 2047 (United Nations, 2015). Microfinance helps women in India and also helps India's economy and society as a whole by giving them access to small loans and other forms of financial and social empowerment (Sengupta & Aubuchon, 2008).

6. CONCLUSION

6.1 Main Findings

Microfinance has been a game-changer for women's economic and social empowerment in India, according to this report. Results demonstrate that microfinance contributes to gender equality (SDG 5) and decent work and economic growth (SDG 8) by increasing women's income, employment, and decision-making power. Microfinance helps women become financially engaged and self-sufficient, which is a step in the right direction towards India's Vision 2047. Implementing microfinance programs effectively will help achieve this vision's goals of reducing poverty, increasing economic development, and promoting gender equality. The study emphasises the need of specific initiatives, such as making microfinance services available in underprivileged areas, combining business and financial education, and increasing access to digital financial services. Microfinance has been and will continue to be an important tool in India's fight for long-term objectives and sustainable development, and these suggestions are an effort to increase its effectiveness. In the end, microfinance helps achieve two main goals: empowering women and building a more fair society in India.

6.2 Implications

- Economic Empowerment: Microfinance significantly contributes to enhancing women's economic participation, resulting in increased income levels and employment opportunities, which in turn benefits families and communities.

- Social Impact: Empowering women through microfinance has broader social benefits, including improved family health, education, and community development, demonstrating a ripple effect beyond financial gains.

- Regional Adaptation: The success of microfinance programs in the Delhi NCR region highlights the need for context-specific interventions, as socioeconomic conditions vary across different regions of India, requiring tailored approaches to maximize impact.

6.3 Recommendations

- Inclusive Financial Ecosystems: Policymakers should focus on creating financial products and services that are tailored to women's specific needs, helping them overcome barriers to accessing traditional financial services.

- Capacity Building: Implement training and mentorship programs to improve women's financial literacy and business skills, enabling them to make the most of the financial resources provided.

- Monitoring and Evaluation: Establish robust frameworks to track the effectiveness and impact of microfinance programs, ensuring continuous improvement and scalability.

- Stakeholder Collaboration: Foster cooperation between financial institutions, non-profits, and government agencies to streamline efforts and ensure more comprehensive support for microfinance initiatives.

- Future Research: Investigate long-term impacts, explore regional differences, and integrate digital financial services to increase access and effectiveness across diverse socioeconomic groups.

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An Assessment of Expansion of Irrigation and Sdgs Attainment through Sustainable Practices in Haryana

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Abstract:

This paper analyzes the expansion of irrigation practices, and evaluates the extent to which these practices are consistent with the Sustainable Development Goals (SDGs). Haryana, a state that is predominantly agrarian, has experienced substantial agricultural development, primarily as a result of the expansion of irrigation. Nevertheless, this expansion presents sustainability challenges, particularly in the arena of environmental conservation, water resource management, and socio-economic equity. This study assesses the sustainability of current irrigation practices, their affect on agricultural productivity, and their relevance to the SDGs. The paper concludes with suggestions for achieving a harmonious balance between sustainable development and agricultural expansion in Haryana.

Keywords: Agricultural Expansion, Irrigation Practices, Sustainable Development Goals (SDGs)

Introduction:

The agricultural landscape of India is significantly influenced by Haryana, a state situated in the northern region. Haryana, which is frequently referred to as the "breadbasket of India," has made substantial contributions to the nation's food security, particularly through the production of maize and wheat. The state's agricultural success is primarily due to the extensive use of irrigation, a critical component that has revolutionized its agricultural practices in the past few decades. However, the rapid expansion of irrigated agriculture has raised concerns about the sustainability of such practices, particularly when viewed through the lens of the UN Sustainable Development Goals (SDGs), despite the fact that it has boosted productivity. The Green Revolution of the 1960s and 1970s marked the initial phase of agricultural expansion in Haryana, which was characterized by the widespread adoption of high-yield variety (HYV) seedlings, chemical fertilizers, and intensive irrigation practices. Haryana became one of the most agriculturally productive states in India as a result of this agricultural practice revolution. Significantly increasing crop yields, the introduction of canal irrigation systems and the proliferation of tubewells facilitated a transition from rain-fed to irrigated agriculture. The state's agricultural success was significantly bolstered by the extensive groundwater extraction and the network of irrigation canals, which were supplied by rivers such as the Yamuna and the Sutlej.

The sustainability of Haryana's agricultural model has been the subject of scrutiny, despite these accomplishments. The state has experienced a significant decrease in water tables as a result of the overexploitation of groundwater, particularly in the rice-wheat agricultural tract. The long-term sustainability of current irrigation practices has been called into question by the significant decreases in groundwater levels that have occurred in districts such as Kurukshetra, Karnal, and Sonipat. Furthermore, the dependence on monoculture, particularly the cultivation of water-intensive crops (paddy), has resulted in enhanced vulnerability to climate change, reduced biodiversity, and soil degradation. These environmental challenges are further complicated by socio-economic factors, such as the unequal distribution of irrigation resources, which has disproportionately impacted small and marginal producers.

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The UN adopted the Sustainable Development Goals (SDGs) in 2015, which establish a comprehensive strategy for sustainable development. These goals encompass the following: the abolition of starvation, the protection of terrestrial ecosystems, the promotion of sustainable economic growth, and the delivery of pure water and sanitation. A critical evaluation of Haryana's existing agricultural practices is necessary in order to accomplish these objectives. The state's agricultural prosperity has unquestionably been bolstered by the expansion of irrigation; however, it has also presented substantial sustainability challenges. A transition to more sustainable practices that balance productivity with environmental conservation and socio-economic equity is necessary to align Haryana's agricultural expansion with the SDGs.

The goal of this paper is to evaluate the impact of irrigation-driven agricultural expansion in Haryana and its compatibility with sustainable development practices as delineated by the SDGs. This study endeavors to offer a comprehensive assessment of the sustainability of Haryana's agricultural model by analyzing the state's irrigation practices, their influence on agricultural productivity, and the resulting environmental and socio-economic repercussions. The paper also investigates the feasibility of incorporating sustainable practices into Haryana's agricultural framework, providing policymakers, farmers, and other stakeholders with suggestions to guarantee that the state's agricultural development is both sustainable and productive in the long term. Although Haryana's irrigation-driven agricultural expansion has been instrumental in improving food security and stimulating the economy, it is essential to confront the sustainability challenges that are closely linked to these practices. The objective of this study is to contribute in the ongoing discussion on sustainable agriculture in Haryana by offering a comprehensive understanding of the current state of agricultural practices and their alignment with the SDGs. Ultimately, the goal is to assist the state in achieving a more sustainable and equitable agricultural future.

Objectives:

1. To examine the expansion of irrigation system in Haryana.
2. To assess the sustainability of existing irrigation practices.

Structured Literature review:

Many academic publications have looked at the effects of increased irrigation on sustainable practices that contribute to the Sustainable Development Goals (SDGs). The shift from the Green Revolution—which aimed to increase agricultural yields by technical and genetic innovations—to the Gene Revolution—which places an emphasis on genetic modifications—is covered by Pingali (1997). These technological breakthroughs have raised concerns about environmental sustainability and have greatly enhanced agricultural output. Therefore, it is necessary to evaluate their long-term implications. This brings up an important point about the impact of technology on agricultural growth in Haryana: it might increase production, but it can also raise questions about sustainability.

The environmental impacts of intensifying agriculture, such as degraded soil and biodiversity loss, are examined by Tilman et al. (2001). The research supports the idea that sustainable measures should be put in place to lessen the impact of these negative consequences. Also, incorporating sustainability into agricultural policy is crucial, as highlighted by Garnett (2011), who pinpoints key areas for lowering GHG emissions in the agricultural sector. Both studies provide the groundwork for the theoretical framework of this research by highlighting the need of sustainable practices in balancing production with environmental preservation. The importance of efficient irrigation methods in raising crop yields, with an emphasis on China, is the subject of Gao and Zhang (2014). In areas like Haryana, where watering crops efficiently may increase harvests, their research has special relevance. Another study that deals with irrigation efficiency is Kijne et al. (2003). They look at how better irrigation methods

might increase water production and help with sustainability. Sustainable irrigation techniques are essential for long-term agricultural performance and environmental objectives, according to these research. Sustainable irrigation methods should be part of agricultural plans to address future food security concerns, according to Rosegrant et al. (2002). Martorillo et al. (2016) underscores the need of aligning agricultural practices with sustainability objectives. They claim that in order to achieve food security and environmental sustainability, agricultural growth must be in accordance with the SDGs. Beddington et al. (2012) also stresses the significance of changing farming methods to accommodate climate change and maintain food security, which is an essential aspect of agricultural growth in Haryana.

Sustainable irrigation methods are crucial for managing water resources and ensuring food security in the long term, according to Hanjra and Qureshi (2010), who examine these practices within the framework of global water shortage. To achieve sustainable agricultural growth, Cai et al. (2011) argue that food, water, and energy systems are interdependent and that these resources should be managed together. Because water shortage is a major obstacle to agricultural growth in Haryana, these ideas are especially pertinent there. In the context of Haryana, Jain (2017) and Singh and Sharma (2019) investigate irrigation methods, with an emphasis on water management techniques and how they affect agricultural yields. Their study sheds light on problems unique to certain regions and provides helpful information for improving irrigation methods to promote long-term agricultural expansion. In addition to tying sustainable agriculture methods in Haryana to the achievement of SDGs and long-term economic advantages, Bhan and Sharma (2020) place additional emphasis on the environmental and productivity implications of these practices.

Research gap:

While much may be learned from the current research on the topic of irrigation methods, agricultural output, and sustainability, there are still many unanswered questions, especially as they pertain to Haryana. Firstly, there is a dearth of in-depth research that explicitly links the growth of irrigation with the accomplishment of Sustainable Development Goals (SDGs), although studies have investigated irrigation methods in Haryana. Without considering sustainability and the attainment of the SDGs as a whole, the majority of studies isolate agricultural production or water management. Second, although several studies have looked at sustainable irrigation and farming methods, very few have offered a comprehensive framework that connects these methods to the SDGs. We don't fully grasp how expanding irrigation may help achieve sustainability objectives in the long run because of this knowledge gap.

Not enough attention was given to the policy consequences, which is another major oversight. There have been a number of studies looking at the effects of sustainable irrigation on productivity and the environment, but much less on the policies that would be required to bring irrigation growth in line with the SDGs. This is especially true for areas like Haryana that are already struggling with issues like water shortages and climate change. Furthermore, there is a dearth of scientific information that explicitly connects sustainable irrigation techniques to the achievement of the SDGs. While many studies provide theoretical frameworks, there is a dearth of empirical evidence about how these practices affect SDGs in a regional setting.

The absence of sustainability evaluations over extended periods of time is the last point. Given the region's susceptibility to climate change, it is particularly concerning because current research mostly looks at the immediate effects of better irrigation on production rather than the broader implications for water resource management, agricultural sustainability, and environmental objectives. In order to fill these gaps, this research will examine how additional irrigation in Haryana might match with SDG objectives via sustainable practices. It will be more comprehensive, empirical, and context-specific than previous analyses.

Research methodology:

Applying a quantitative descriptive methodology, this research will examine the net area under irrigation in Haryana using time-series data. Key SDG indicators, including those for agricultural production, food security, and water management, will be examined in relation to changes in irrigated area.

Collecting Data: To find the net irrigated area throughout various time periods, i look at historical and current statistics from official sources like the Haryana Irrigation Department or agricultural surveys.

Information on Sustainable Development Goals (SDGs): Look into secondary sources for Haryana statistics on SDG-related measures including food security, agricultural production, water-use efficiency, and poverty reduction. Reports from governments, NGOs, and SDG monitoring websites are some possible sources.

Analysing the Data, An Examination of Current Trends and Correlations: Looked at the net area under irrigation and see how it has changed over time to see if there's a pattern. Examine the connection between several SDG metrics and the increase of irrigated land using statistical tools like correlation analysis. Goals 2 (food security), 6 (water-use efficiency), and 1 (poor reduction) may be better understood in light of this data.

Theoretical framework:

The Agricultural Production Function and the Economics of Sustainable Development are used in this study to look at the role of irrigation development in Haryana in reaching the SDGs.

Economics of Sustainable Development: This theory stresses that natural sustainability must be balanced with economic growth, such as higher crop yields from more irrigation. Water is a type of natural capital that should be used wisely to increase crop production (SDG 2: Zero Hunger) and make sure that it is managed in a way that doesn't harm the environment (SDG 6: Clean Water and Sanitation). The goal is to get the most out of the resources that are available so that everyone gains in the long run (SDGs 1, 10).

Agricultural Production Function: Irrigation makes land more productive on a minor level. However, if sustainable methods are not used, benefits may decrease over time. In line with SDG 12 (Responsible Consumption and Production), the production function uses water efficiently and conserves it so that the environment doesn't get worse.

Policy and Institutional Economics: This area looks at how policies and government work affect long-term irrigation. This is related to SDG 16 (Peace, Justice, and Strong Institutions) because it makes sure that everyone has equal access to water and stops people from using too much of it.

Irrigation system in Haryana:

The agricultural sector of Haryana, a state in northern India, is significantly dependent on its irrigation resources, which are essential for the state's economy. To maintain agricultural productivity and guarantee food security, it is imperative to implement effective irrigation in the region, which is characterized by irregular rainfall and a semi-arid climate. The state has established a comprehensive irrigation infrastructure that encompasses modern irrigation technologies, groundwater resources, and canal systems.

The canal system is the primary element of Haryana's irrigation infrastructure. The Indira Gandhi Canal

Project, a significant component of this system, utilizes water from the Yamuna and Ganges rivers to irrigate the arid regions in the southern and western regions of the state. This canal network has been instrumental in the transformation of previously unproductive land into fertile agricultural areas. It facilitates the cultivation of commodities that would be impossible to grow in the region's arid conditions, thereby supporting a substantial portion of Haryana's agricultural activity.

Groundwater resources are indispensable to Haryana's agricultural sector, in addition to canal irrigation. Underground water sources are extensively tapped to provide irrigation throughout the year through the use of tube wells and bore wells. Farmers have been able to maintain crop yields and even cultivate water-intensive crops such as paddy by utilizing this irrigation method, which has been especially essential during drought seasons. The pervasive use of groundwater has considerably increased agricultural productivity, thereby contributing to Haryana's status as a top producer of staple commodities such as maize and wheat.

Modern irrigation techniques have also been implemented to enhance the efficacy of water consumption. Sprinkler and drip irrigation systems are increasingly prevalent, particularly for high-value commodities like fruits and vegetables. These techniques contribute to the improvement of overall productivity and sustainability by reducing water wastage and optimizing water delivery to crops. These technologies facilitate more effective water management by directing water directly to the plant roots and reducing evaporation and discharge. Haryana is confronted with numerous irrigation resource-related obstacles, despite these developments. The over-extraction of groundwater is a significant issue that has resulted in significant declines in water tables in numerous regions of the state. The long-term sustainability of groundwater-dependent irrigation systems is jeopardized by this depletion. Furthermore, there are apprehensions regarding water management inefficiencies, including the necessity for improved canal maintenance and waterlogging in certain regions.The efficacy of current irrigation systems is also being affected by altered rainfall patterns and rising temperatures, which is a developing challenge due to climate change. Investment in more resilient irrigation technologies and enhanced water management practices is necessary to accommodate these changes.

Haryana's agricultural productivity and food security are contingent upon its irrigation resources. The agricultural output of the state has been substantially increased as a result of the state's extensive canal systems, reliance on groundwater, and implementation of contemporary irrigation techniques. Nevertheless, it is imperative to address the sustainability of Haryana's irrigation infrastructure and maintain its agricultural success by addressing issues such as groundwater depletion, enhancing water management, and adapting to climate change.

Table: 1 Net area under irrigation in Haryana (000 ha.)

Year/ District	Net area irrigated						
	Tube-wells	Tanks	Govt. Canals	Wells	Other sources	Total	% of net sown sown
1966-67		4	991	289	9	1 ,293	37.8
1970-71		1	952	574	5	1 ,532	43.0
1980-81	941	@	1,161	26	6	2,134	59.2
1990-91	1 ,248	1	1 ,337	@	14	2,600	72.7

2000-01	1 ,467	1	1 ,476	@	14	2,958	83.9
2010-11	1 ,650		1 ,236	@	1	2,887	82.1
2018-19	2,067		1,215			3,282	91.1
2019-20	2,156		1 ,232			3,388	94.9
2020-21 P	2,128		1 ,232			3,360	93.0

Source: "Department of Land Records, Haryana"

@ Less than 500 Hc.

P: Provisional data

The table offers a comprehensive account of the net area under irrigation in Haryana, India, from the agricultural year 1966-67 to 2020-21. The data is categorized by the various sources of irrigation, including government canals, reservoirs, wells, tubewells, and other sources. It displays the total area that has been irrigated, as well as the percentage of the net sown area that has been irrigated.The primary source of irrigation in Haryana was government canals, which irrigated 991,000 hectares, and the total net area irrigated was 1,293,000 hectares beginning in 1966-67. Tubewells and wells were also employed to irrigate 289,000 and 9,000 hectares, respectively. The total percentage of the net cultivated area that was irrigated was 37.8%. This suggests that canal irrigation was the primary method during the initial period, and irrigation infrastructure was still in the process of being developed. The total irrigated area increased marginally to 1,532,000 hectares by 1970-71, and the percentage of irrigated net sown area increased to 43.0%. The area irrigated by wells experienced a substantial increase, more than doubling to 574,000 hectares. Nevertheless, the area irrigated by government canals experienced a minor decrease, which is indicative of the initial changes in irrigation patterns. The total irrigated area increased to 2,134,000 hectares in 1980-81, which accounted for 59.2% of the net sown area, a decade later. Tubewells began to play a more significant role in irrigation, irrigating 941,000 hectares, while government canals irrigated 1,161,000 hectares. The utilization of containers experienced a significant decrease, with less than 500 hectares being utilized, suggesting a departure from conventional water storage methods. The total irrigated area in 1990-91 was 2,600,000 hectares, which accounted for 72.7% of the net sown area. In this period, the utilization of tubewells increased significantly, resulting in the irrigation of 1,248,000 hectares, surpassing the 1,337,000 hectares irrigated by government canals. This trend suggests that there is a growing dependence on tubewells, which is likely the result of improvements in drilling technology and the availability of groundwater. The total irrigated area increased to 2,958,000 hectares by 2000-01, and the percentage of the net sown area under irrigation increased to 83.9%. Tubewells maintained their dominance, irrigation 1,467,000 hectares, which is nearly equivalent to the area irrigated by government canals (1,476,000 hectares). The increasing significance of more contemporary and efficient irrigation methods was demonstrated by the continued decrease in dependence on alternative sources, such as wells and containers. The total irrigated area in 2010-11 was marginally lower at 2,887,000 hectares, which accounted for 82.1% of the net sown area. Nevertheless, tubewells emerged as the primary source of irrigation, irrigating 1,650,000 hectares, while the area served by government canals decreased to 1,236,000 hectares. It is possible that the limitations or degradation of canal infrastructure are the cause of the growing reliance on groundwater for irrigation, as this shift underscores. The total irrigated area had increased to 3,282,000 hectares by 2018-19, which accounted for 91.1% of the net sown area. Government canals irrigated 1,215,000 hectares, while tubewells were responsible for a substantially larger area of 2,067,000 hectares. This trend persisted in 2019-20, during which time the total irrigated area increased to 3,388,000 hectares,

with 94.9% of the net sown area being irrigated. The sustained dominance of tubewells as the primary source of irrigation was demonstrated by their irrigation of 2,156,000 hectares. The total irrigated area for 2020-21 decreased marginally to 3,360,000 hectares, with 93.0% of the net sown area being irrigated, according to the provisional data. Tubewells continued to be the largest contributor, with 2,128,000 hectares, while government canals irrigated 1,232,000 hectares. This data illustrates the continued significance of tubewells in Haryana's irrigation system, as the function of conventional sources such as wells and containers has nearly vanished. In general, the data indicates a distinct trend of increasing irrigation coverage in Haryana, with the total irrigated area more than doubling over the course of several decades. The proportion of the net sown area that is under irrigation has also increased significantly, from 37.8% in 1966-67 to 93.0% in 2020-21. This expansion is substantially driven by the pervasive implementation of tubewells, which have emerged as the most significant irrigation source, surpassing government canals. The transition to more modern, efficient, and dependable irrigation methods, as evidenced by the decrease in the utilization of wells, tanks, and other conventional sources, is indicative of the region's agricultural sector's technological advancements and infrastructural developments.

Sustainable Practices for the Achievement of SDGs and Irrigation in Haryana

The UN drawn the Sustainable Development Goals (SDGs) in 2015 as a world-wide framework for the implementation of a more sustainable and improved future for all by 2030. A wide range of social, economic, and environmental challenges are addressed by these 17 objectives. Haryana, one of the most agriculturally productive states in India, is essential in the country's pursuit of these global objectives. Haryana's strategy to achieve the SDGs, particularly those connected to clean water & sanitation (SDG 6), zero starvation (SDG 2), climate action (SDG 13), and life on land (SDG 15), is fundamentally rooted in sustainable irrigation practices, given the state's dependence on agriculture.

1. Sustainable Water Management or Clean Water & Sanitation in SDG 6

The objective of SDG 6 is to guarantee the sustainable management and availability of water & sanitation for all. Water management is a critical issue in Haryana, where agriculture sector is the primary method of income. The state's irrigation practices have undergone a substantial transformation over the years, with an emphasis on the sustainable utilization of water resources, the enhancement of water use efficiency, and the reduction of water wastage. Haryana's substantial dependence on groundwater for irrigation has resulted in a depletion of aquifers that is cause for concern. In order to resolve this issue, the state has implemented a variety of initiatives to encourage sustainable irrigation and water conservation. Mera Pani Meri Virasat (My Water, My Heritage) is a flagship program that motivates farmers to decrease their dependence on water-intensive crops, such as paddy. The program provides financial incentives to producers who diversify their crops, thereby transitioning to less water-intensive alternatives like oilseeds, pulses, and maize. This initiative contributes to food security and sustainable agriculture (SDG 2) by promoting agricultural diversification and conserving water (SDG 2).Furthermore, Haryana has been proactive in implementing micro-irrigation techniques, such as sprinkler and trickle irrigation systems. These systems enable the direct application of water to the plant bases, thereby reducing water waste and enhancing crop yields via precise application. Subsidies and training programs for farmers are provided to facilitate the widespread adoption of these water-saving technologies, which are supported by the government's initiative to promote micro-irrigation. This method is consistent with SDG 6, as it guarantees that water is utilized more sustainably and efficiently in agriculture, thereby safeguarding water resources for future generations. Another critical component of Haryana's water management strategy is the harvesting of rainwater. The state has made significant investments in the development of rainwater catchment structures, reservoirs, and check dams to capture and store rainfall. This not only replenishes groundwater levels but also ensures a consistent

source of water for irrigation during droughts. In recognition of the significance of these structures in the sustainable management of water resources, the rejuvenation of traditional water bodies, such as johads and baolis, is also being promoted.

2. Guaranteeing Sustainable Agriculture and Food Security (SDG 2)

SDG 2 is dedicated to the elimination of poverty, the establishment of food security, the enhancement of nutrition, and the promotion of sustainable agriculture. These objectives are significantly influenced by Haryana's irrigation strategy. In order to guarantee the resilience and productivity of food production systems, the state has implemented contemporary agricultural practices that combine sustainable farming methods with efficient irrigation techniques.The promotion of precision cultivation has been one of the primary strategies. This entails the utilization of sophisticated technologies, including satellite imaging, soil moisture sensors, and weather forecasts, to optimize the application of pesticides, fertilizers, and water. Precision farming minimizes resource wastage, increases crop productivity, and reduces environmental impact by administering the appropriate quantity of water at the appropriate time. This directly contributes to the sustainable intensification of agriculture in Haryana and to food security.Additionally, the state government has implemented initiatives to encourage the use of organic cultivation and decrease the dependence on chemical inputs. In addition to being environmentally favorable, organic farming practices necessitate significantly less water than conventional farming methods. Haryana is ensuring that agricultural practices are more sustainable and aligned with environmental objectives by encouraging farmers to employ organic farming, thereby contributing to the sustainable management of water resources.Additionally, the state has been developing integrated water management strategies that incorporate surface and groundwater resources to guarantee that the water requirements of agriculture are satisfied in a sustainable manner. In order to improve the availability of water for agriculture, particularly during the critical growing seasons, the construction of water reservoir structures and the development of canal irrigation systems have been prioritized. These measures are crucial for the preservation of agricultural productivity and the guarantee of food security, particularly in the presence of water scarcity and climate variability.

3. SDG 13: Climate Action and Resilience Building

SDG 13 mandates immediate action to curtail the effects of climate change. Climate change in Haryana poses a substantial hazard to agriculture, as it impacts agricultural yields and water availability through erratic rainfall patterns, increasing temperatures, and frequent droughts. Consequently, it is vital to implement sustainable irrigation practices in order to establish resilience in the face of climate change. Haryana's initiatives to foster water-efficient irrigation methods, including drip and sprinkler systems, directly contribute to the reduction of agriculture's carbon footprint. These systems not only conserve water but also decrease the energy necessary for water extraction, thereby decreasing GHGs emissions. In addition, these practices contribute to the preservation of the natural equilibrium of ecosystems, which is essential for climate resilience, by minimizing the over-extraction of groundwater. Additionally, the state is investigating the potential of solar-powered irrigation systems to encourage the use of sustainable energy in agriculture. Solar pumps are being implemented to supplant diesel-powered pumps, thereby reducing the dependence on fossil fuels and reducing carbon emissions. This initiative is consistent with both Climate Action in SDG 13 and Affordable and Clean Energy in SDG 7 encourages the utilization of renewable energy in agriculture, thereby fostering a more resilient and sustainable agricultural system. Haryana is also emphasizing climate-smart agriculture practices, which incorporate climate change adaptation and mitigation measures into cultivation. This encompasses the promotion of agroforestry practices that increase carbon sequestration and biodiversity, the development of drought-resistant crop varieties, and the adaptation of irrigation scheduling to weather forecasts. Haryana is striving to implement a more resilient agricultural system that can withstand the

effects of climate change and contribute in the global effort to address it by implementing these practices.

4. Preservation of Terrestrial Ecosystems and Biodiversity (SDG 15)

SDG 15 underscores the necessity of safeguarding, rehabilitating, and fostering the sustainable utilisation of subastral ecosystems, sustainable forest management, desertification mitigation, and the reversal and prevention of land degradation and biodiversity loss. The health of terrestrial ecosystems and biodiversity in Haryana is inextricably linked to sustainable irrigation practices. In certain regions of Haryana, the over-extraction of groundwater for irrigation has resulted in a decrease in soil quality and land degradation. In order to resolve this issue, the state has been advocating for the implementation of sustainable land management practices by the use organic fertilizers, conservation tillage, and crop rotation. These practices contribute to the sustainable utilization of land resources by preserving soil fertility and preventing land degradation.Furthermore, Haryana has acknowledged the significance of preserving the ecological health of wetlands and the natural flow of rivers, which are essential habitats for biodiversity. The state has implemented measures to safeguard and revitalize these ecosystems, such as the restoration of wetlands that function as natural water storage and filtration systems. These endeavors guarantee the resilience and health of ecosystems by promoting the sustainable management of water resources and the conservation of biodiversity. Haryana's strategy for irrigation is a critical component of its endeavors to realize the SDGs. The state is making substantial progress in the arena of food security, water conservation, biodiversity protection, and climate change by advocating for sustainable water management, efficient irrigation practices, and climate-smart agriculture. In addition to contributing to the long-term sustainability of the state's natural resources, these sustainable practices not only support the livelihoods of farmers but also guarantee that Haryana can continue to flourish in an increasingly challenging global environment. Haryana is a potent example for other regions in India and around the globe in terms of how to achieve the SDGs through integrated and sustainable approaches to agriculture and water management as it continues to innovate and implement sustainable irrigation practices.

Strategies for Implementing Sustainable Irrigation in Haryana to Achieve SDGs

Haryana places a significant emphasis on sustainable irrigation practices in its pursuit of the Sustainable Development Goals (SDGs). The adoption of innovative and sustainable irrigation methods is essential for the state to ensure water security, improve agricultural productivity, and promote environmental sustainability, given its dependence on agriculture. Haryana is implementing the following important practices to achieve the SDGs through sustainable irrigation:

1. Encouragement of Micro-Irrigation Methods: The pervasive implementation of micro-irrigation techniques, including sprinkler and trickle systems, is one of the most influential practices in Haryana. This method enables the precise delivery of water to the plant roots, thereby reducing water waste and guaranteeing that crops receive the requisite moisture without over-irrigation. The evaporation losses that are typical of traditional flood irrigation methods are also reduced by micro-irrigation. The state government has been actively promoting the adoption of these systems by offering technical assistance and subsidies to farmers. This practice is consistent with SDG 6 (Clean Water & Sanitation) in that it promote the cautious use of water resources in agriculture, reduces the depletion of groundwater reserves, and promotes the efficient use of water resources.

2. Water Conservation through Crop Diversification: Another critical practice that contributes to the attainment of SDGs, specifically SDG 2 (Zero Hunger) and SDG 6, is Haryana's emphasis on crop diversification. Mera Pani Meri Virasat (My Water, My Heritage) is a state action plan that target to motivate farmers to transition from water-intensive crops like paddy to less water-demanding

alternatives like maize, pulses, and oilseeds. By reducing the burden on groundwater resources, this practice not only conserves water but also contributes to the preservation of ecological equilibrium. Thus, crop diversification contributes to sustainable agricultural practices by improving soil health and resilience to climate variability.

3. Groundwater Recharge and Rainwater Harvesting: Haryana has been advocating for the implementation of groundwater recharge and precipitation harvesting practices in order to resolve the critical issue of groundwater depletion. In order to capture precipitation and recharge groundwater aquifers, the state has made significant investments in infrastructure development, including check dams, reservoirs, and percolation tanks. Furthermore, farmers are encouraged to implement on-farm rainwater harvesting methods to capture and store rainwater for irrigation purposes. These practices contribute to the long-term availability of water for agricultural and domestic use by ensuring that water resources are sustainably managed and replenished, thereby supporting SDG 6.

4. Implementation of Solar-Powered Irrigation Systems: Haryana is advocating for the implementation of solar-powered irrigation systems in accordance with SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action). The ecological burden associated with irrigation is being reduced by the introduction of solar pumps as an alternative to diesel-powered pumps. Solar energy is a renewable, pure source of power that not only reduces greenhouse gas emissions but also offers producers a sustainable and cost-effective irrigation solution. The utilization of solar turbines decreases farmers' dependence on fossil fuels, thereby enhancing their economic resilience and environmental sustainability.

5. Resource Efficiency through Precision Farming: To optimize the utilization of water, fertilizers, and other inputs, precision agricultural techniques are becoming more prevalent in Haryana. Farmers can more accurately apply water and nutrients and monitor crop requirements in real-time by utilizing technologies such as GPS, satellite imagery, and soil moisture sensors. This method decreases water waste, improves crop yields, and mitigates the environmental impact of agriculture. Precision farming contributes to SDG 6 by ensuring the sustainable management of water resources, while also supporting SDG 2 by enhancing agricultural productivity and ensuring food security.

6. Encouragement of Organic Farming: This is being advocated as a sustainable agricultural practice that conserves water and reduces the necessity for chemical inputs. Organic farming practices are generally more resilient to drought conditions and necessitate less water than conventional farming methods. Organic cultivation contributes to SDG 15 (Life on Land) by reducing the dependence on synthetic fertilizers and pesticides, thereby preserving soil health and biodiversity. Furthermore, organic farming is consistent with SDG 2 by ensuring the production of secure, nutritious food, and it is in accordance with SDG 12 (Responsible Consumption and Production) by promoting sustainable agricultural practices.

7. The Rebirth of Traditional Water Bodies: The revival and restoration of traditional water bodies, including johads, baolis, and ponds, are essential components of Haryana's strategy to achieve the SDGs. Throughout history, these bodies of water have been instrumental in the administration of local water resources, providing irrigation and groundwater recharge. Haryana is not only increasing water availability for agriculture but also preserving cultural heritage by revitalizing these traditional structures, which also enhance water storage capacity. This practice contributes to SDG 15 by preserving the ecological health of local ecosystems and supports SDG 6 by assuring sustainable water management.

8. Integrated Water Resource Management: This practices are being implemented in Haryana to facilitate the coordination of the development and management of water, land, and associated resources.

IWRM aims to ensure that water resources are distributed equitably, thereby harmonizing the requirements of agriculture, industry, and domestic use. Haryana is striving to ensure the sustainable use of water resources, minimize conflicts, and guarantee that water is accessible to all sectors by integrating surface water and groundwater management. IWRM is a comprehensive strategy that encourages the sustainable management of water and sanitation services, thereby supporting SDG 6.

9. Agriculture that is Climate-Smart: Haryana is also emphasizing climate-smart agriculture (CSA) practices, which are intended to enhance agricultural productivity, decrease GHGs emissions, and increase resilience to climate change. Conservation agriculture, agroforestry, enhanced irrigation scheduling, and the adoption of drought-resistant crop varieties are all components of CSA practices. These methods assist farmers in adapting to evolving climate conditions while simultaneously guaranteeing the sustainability and productivity of agriculture. Climate-smart agriculture directly contributes to SDG 13 (Climate Action) and SDG 2 by assuring food security in the face of climate variability and creating resilience in the agricultural sector.

10. Farmer Education and Capacity Building: The widespread adoption of these techniques is contingent upon the education of farmers regarding sustainable irrigation practices. In order to increase farmers' awareness of the advantages of sustainable irrigation methods, Haryana has implemented workshops, training programs, and field demonstrations. These educational initiatives provide the necessary knowledge and skills to implement water-saving technologies and practices on their properties. Haryana is guaranteeing the extensive and effective adoption of sustainable practices by enhancing capacity at the grassroots level. This practice promotes sustainable water management and supports SDG 4 (Quality Education) by offering lifelong learning opportunities. Also, it is consistent with SDG 6.

Haryana's sustainable irrigation practices are a critical component of the state's endeavors to realize the Sustainable Development Goals. Haryana is mitigating critical challenges associated with water management, food security, and climate change by promoting micro-irrigation, crop diversification, rainfall harvesting, and the use of renewable energy in irrigation. These practices are not only ensuring that the state's agricultural sector remains productive and resilient in the face of emergent global challenges, but they are also assisting to conserve water and reduce the environmental impact of agriculture.Haryana is establishing a powerful precedent for other regions in India and around the world by combining traditional knowledge with modern technologies. The state's dedication to sustainable irrigation practices serves as an illustration that it is feasible to reconcile environmental sustainability with agricultural productivity, thereby contributing to the worldwide endeavor to accomplish the SDGs by 2030.

Theoretical framework achievement:

Sr. no.	Theoretical Concept	Findings/Results
1.	Sustainable Development Economics	Expansion of irrigation has boosted agricultural productivity in Haryana. However, long-term sustainability is at risk due to inefficient water use, highlighting the need for sustainable practices to prevent resource depletion.
2.	Agricultural Production Function	Irrigation has increased crop yields, validating the theory of enhanced marginal productivity. However, diminishing returns are evident in areas with over-irrigation,

		reinforcing the need for efficiency in water usage.
3.	Policy and Institutional Economics	Government policies have expanded irrigation infrastructure, but lack strong regulatory measures to ensure sustainable water use. More comprehensive policies and governance are needed to manage water resources efficiently.
4.	Integration of Irrigation and Sustainability	The study confirms that irrigation expansion must be balanced with sustainable practices and policy interventions to achieve long-term agricultural and environmental benefits, supporting the theory of sustainable development.

Conclusion:

The objective of this research paper was to evaluate the sustainability of current irrigation practices in Haryana and assess the expansion of the irrigation system in accordance with the Sustainable Development Goals (SDGs). The results underscore Haryana's substantial progress in the expansion of its irrigation infrastructure, which has been instrumental in improving agricultural productivity and food security in the state. Nevertheless, this expansion has also presented obstacles, particularly in the areas of water resource sustainability and the environmental consequences of intensive irrigation practices.The examination of Haryana's irrigation system exposes a comprehensive network of canals, tubewells, and micro-irrigation systems that have facilitated the state's agricultural development. However, the state's irrigation practices have been at risk of long-term sustainability due to the critical depletion of aquifers as a result of its dependence on groundwater. This highlights the necessity of a paradigm shift toward more sustainable water management and irrigation practices to guarantee the ongoing prosperity of Haryana's agriculture.Several key initiatives and strategies are highlighted in the evaluation of sustainable practices for accomplishing SDGs through irrigation in Haryana. The adoption of renewable energy sources, such as solar-powered pumps, the promotion of micro-irrigation techniques, crop diversification, and rainfall harvesting are among these. These practices are essential for the conservation of water and the preservation of soil health, as well as for the reduction of the carbon footprint of agricultural activities. Consequently, they contribute to the overall attainment of the SDGs and the resilience of the climate.Lastly, the strategies for the implementation of sustainable irrigation in Haryana indicate that, despite the substantial progress that has been achieved, there is still a significant amount of work to be done. The successful execution of these strategies necessitates ongoing investments in infrastructure, farmer education, and policy support. Additionally, it will be imperative to cultivate collaboration among stakeholders and integrate traditional knowledge with modern technologies in order to expand sustainable irrigation practices throughout the state.Haryana has made significant strides in the expansion of its irrigation system; however, the sustainability of these practices must be meticulously monitored in order to achieve the SDGs. Haryana can guarantee the long-term sustainability of its water resources, support the livelihoods of its farmers, and contribute to the global endeavor to achieve a more equitable and sustainable future by prioritizing sustainable irrigation methods.

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Investigating Interstate Disparities of Resource Optimization in Organized Manufacturing Sector: A Case Study of Indian States

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Abstract

This paper is an attempt to analyse the total factor productivity and technical efficiency of organised manufacturing sector of the 32 states and U.T.s of India using ASI data at three-digit level from 2009-10 to 2019-20 through Data Envelopment Analysis (DEA) and Malmquist productivity index. The findings reveal that technical change has led to regional growth in TFP, with most states aiming for isoquant. Technical efficiency is high at 64 percent, but resources are not fully utilized. The investigation of disparities of the performance of the industrial sector among all states of India have been guide the policy regarding to achieve the SDG 9.2 i.e., inclusive and sustainable industrialization which in terms leads to enhance output & employment in underdeveloped states. The study also strives to find the determinants to uplift the Indian states and U.T.s on the next growth trajectory in the coming years.

Keywords: Organised Manufacturing Sector, Total factor productivity Growth, Technical Efficiency, Data Envelopment Analysis, Malmquist productivity index,

JEL Codes: D24, L60, P27, R11

INTRODUCTION

To achieve the target of developed India @ 2047 and SDG 9.2 by 2030, there is a need to focus on industrial sector in the present economic scenario of India where agriculture sector is facing multifaceted problems and service sector led growth raising the inflation. The industrial sector in this regard can play a vital as it has forward and backward linkages with both sectors. However, in India, there are regional disparities in the growth of the industrial sector. Southern states outperform northern states in terms of net state domestic product and per capita income, while eastern and central India is significantly behind in overall development (RBI, Handbook of Statistics on Indian States, 2022). Economic development is reflected in the advancement of social and physical infrastructure, which raises a society's standard of living. However, the pace of development varies widely throughout the regions, leading to regional disparities. These disparities result from selective development in a small number of regions and negligence in other parts, which can be man-made or naturally endowed. Regional disparities in India are influenced by locational advantages, economic overheads, and inadequate planning. However, the government has made some impressive efforts towards industrial reforms in the post-independence era. The government adhering to its decentralized policy, established large industries in underdeveloped areas; but, in spite of significant public investment, these places remained behind due to the absence of supporting industries. States like Tamil Nadu, Gujarat, Maharashtra, Karnataka, Andhra Pradesh, and Uttar Pradesh outperform others in terms of fixed capital, factories, output, persons engaged, gross value added, and net state domestic product (MOSPI, 2021-22). These states are ahead of other states due to their historical and infrastructure (ports, roads & power supply) development, business friendly policies of states government, attractive investment, skilled workforce (Karnataka, is known for its strong IT sector due to its skilled professionals), developed SEZs etc. Industrial backwardness in regions is influenced by topography, economic issues

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like poverty, sociocultural factors like low literacy, demographics, political will, insecurities, corruption, and infrastructure deficiencies (Saroha, 2017). The present study explores disparities in the resource optimization across 32 Indian states and U.T.s where policy makers can endeavour to provide special support in deprived states to bring inclusiveness. The next section envelops the review of literature related to regional disparities in India.

LITERATURE REVIEW

There is a plethora of literature available on interstate disparities among Indian states over the years. (Hirschman, 1958) used his well-known "Inverted - U shape theory" to notice and analysed the regional disparity image for the first time. (Kuznets, 1958); (Williamson, 1965) found that regional disparities initially diverge but eventually converge as an economy grows. (Dhar and Sastry, l969) estimated the degree of industrial development in 15 states including Delhi, during the period of 1951–61 using power consumption data and found the tendency of reduction in disparities. (Sekhar, 1982) in his study found that Maharashtra, West Bengal, Gujarat, and Tamil Nadu were the industrial leaders in India during 1961-75 and observed a significant reduction in interstate imbalances in industrial development. (Tewari, 1985) confirmed the increasing the gap across the states. The focus of (Mathur, 2005) on the 1980s and 1990s demonstrated that there was a noticeable acceleration in the per capita income's coefficient of variation from the reform period to 1996. (Bhattacharya and Sakthivel, 2004) analysed that industrialized states were shown to be expanding faster than backward states and suggesting tendency toward larger divergence in industrial growth. (Kumar, 2006) assessed TFPG of organised manufacturing sector using MPI and discovered regional variation in TFP. (Krishna, 2004) and (Nair, 2004) stated that the relative positions of states haven't changed significantly over time and the pattern was entirely different from the pre-reform period. (Nayyar, 2008) evaluated the income and growth disparities among the Indian states and not found any convergence among the states. Several studies (Baddeley et al., 2006); (Ghosh et al., 1998); (Kar & Sakthivel, 2007); (Cashin & Sahay, 1996) ;(Ahluwalia, 2000);(Trivedi, 2002) ;(Sodsriwiboon & Kalra, 2010)) analysed the regional economic growth and disparities in India and found no convergence among the states. (M. Ghosh, 2012);(Singh, 2012); (Deb & Ray, 2014) analysed the regional economic growth of the Indian states and discovered variance in productivity growth also an improvement has been observed after the reform. (Cherodian & Thirlwall, 2015) found weak evidence of conditional convergence in per capita income differences among Indian States, accounting for changes in male literacy, credit expansion, population growth, and state spending. (Pal, 2023) examined the differences across Indian States's regions and industries, discovering underutilization of resources and unfair labour distribution. The above-mentioned literature review provides the snapshot of different disparities among Indian states and induced to get in-depth picture of resource optimization disparities.

RESEARCH METHODOLOGY

The study has used DEA (Data Envelopment Analysis) to evaluate the TE and TFPG of the Indian manufacturing sector using a non-parametric method which was developed by Charnes et al., (1978), further extended by Banker et al., (1984). DEA provides a point-wise production function estimate using mathematical programming techniques, unlike the parametric approach that requires explicit functional forms. The Malmquist Productivity Index (MPI) is chosen for the TFP analysis of Indian states and U.T.s due to its attractive qualities (Caves et al., 2008). It is based on the quantities of input and output and for calculating this, distance function is used. It can be divided into technical efficiency change, scale efficiency changes and technical change. TECH is then further divided into pure technical efficiency change and scale efficiency change. The analysis calculates the TFP of the organized manufacturing sector in Indian states and U.T.s using output-maximizing criteria, illustrating the MPI. For technology set, consider N manufacturing firms using $x^t \in M^{P}_{+}$ inputs for the production of $y^t \in$

M^J_+ output in t years, t = 1…….., T. Hence, technology set ($\mathbb{R}$) is possible to write as in single input and single output:

$\mathbb{R}^t = \{(x^t , y^t), x^t \text{ can produce } y^t\}$, t = 1,….., T ……. eq. (1)

Comparably, it can be implemented using several sets of inputs and outputs that show up $\mathbb{R}^t$ as

$\mathbb{Z}^t (x^t) = \{y^t : (y^t , x^t) \in \mathbb{R}^t\}$, t = 1,….., T …...eq. (2)

The output-oriented distance function, as per Shephard (1970), is defined as

$K_0^t (x^t , y^t) = \min_{\Theta\, \theta} : \frac{yt}{\theta} \in \mathbb{Z}^t (x^t)$, $\theta > 0$ …..eq. (3)

where $K_0^t (x^t, y^t)$ estimates the maximum possible contraction of x^t. The difference in TFP for two consecutive time periods t_1 and t_2 has been measured using MPI. The MPI designed using technology seeking output orientation for the t_1 period is characterized as

$P_0^{t1} (x^t_{2,} y^t_2 , x^t_1, y^t_1) = \frac{K_{0c}^{t1} (xt_{2,}\ yt_2)}{K_{0c}^{t1} (xt_{1\,,}\, yt_1)}$ ……eq. (4)

In the equation (4), the subscripts o and c stand for the output orientation and CRS, respectively. Therefore, the MPI for technology from period t_2 is shown as

$P_0^{t2} (x^t_{2,} y^t_2, x^t_1, y^t_1) = \frac{K_{0c}^{t2}\ (xt_2,yt_2)}{K_{0c}^{t2} (xt_1,yt_1)}$ …… eq. (5)

It was suggested by Fare et al. (1994) to compute MPI using geometric mean of equations (4) and (5). Therefore,

$P_0^{t1} (x^t_2 , y^t_2 , x^t_1 , y^t_1) = \sqrt{\frac{K_{0c}^{t1} (xt_2 ,yt_2)\ K_{0c}^{t1} (xt_2 ,yt_2)}{K_{0c}^{t1} (xt_1,\ yt_1)\ K_{0c}^{t2} (xt_1 ,yt_1)}}$ …… eq. (6)

ECH $= \frac{K_{0c}^{t1}\ (xt_2\,,\ yt_2)}{K_{0c}^{t1}\ (xt_1 ,yt_1\ )}$ ……eq. (7)

TECH $= \sqrt{\frac{K_{0c}^{t1}\ (xt_2\,,\ yt_2)}{K_{0c}^{t2} (xt_2 ,yt_2\ )} \times \frac{K_{0c}^{t1}\ (xt_1,\ yt_1)}{K_{0c}^{t2} (xt_1,y\, t_1)}}$ ……eq. (8)

To calculate TFP for firm n between t_1 and t_2, using MPI under CRS assumption, an index of four different distance functions is required i.e. $K_{0c}^{t1} (x^{n\,,\,t}_1 , y^{n\,,\,t}_1)$; $K_{0c}^{t2} (x^{n\,,\,t}_2 , y^{n\,,\,t}_2)$; $K_{0c}^{t1} (x^{n\,,\,t}_2 , y^{n\,,\,t}_2)$; $K_{0c}^{t2} (x^{n\,,\,t}_1 , y^{n\,,\,t}_1)$. LP equations are used to derive these distance functions:

$K_{0c}^{t+i} (x^{n\,,t+i}, y^{n\,,t+i})^{-1} = \max \theta^n$ ……eq. (9)

subject to

$\theta^n\ y_q^{n\,,t+i} \le \sum_{n=1}^{N} z^{n\,,t+v}\ y_q^{n\,,t+v}$, q = 1, ……., Q

$\sum_{n=1}^{N} w^{n\,,t+v}\ x_s^{n\,,t+v} \le x_s^{n\,,t+i}$, s = 1, ……., S

$w^{n\,,t+v} \ge 0$, n = 1, ……..N

Where, (i, v) = (0,0) for solving ($K_0^{t1}(x^{n,t1}, y^{n,t1})$)$^{-1}$;

(i, v) = (1,1) for solving ($K_0^{t2}(x^{n,t2}, y^{n,t2})$)$^{-1}$;

(i, v) = (0,1) for solving ($K_0^{t1}(x^{n,t2}, y^{n,t2})$)$^{-1}$;

(i, v) = (1,0) for solving ($K_0^{t2}(x^{n,t1}, y^{n,t1})$)$^{-1}$;

The LP equation uses intensity variable $w^{n,t}$ and efficiency scores θ to define a firm's effort in pushing technology boundaries.

$$ECH = \left(\frac{K_{0u}^{t2}(x^{t2},y^{t2})}{K_{0u}^{t1}(x^{t1},y^{t1})}\right) \times \left(\frac{K_{0u}^{t2}(x^{t2},y^{t2}) / K_{0u}^{t2}(x^{t2},y^{t2})}{K_{0u}^{t1}(x^{t1},y^{t1}) / K_{0u}^{t1}(x^{t1},y^{t1})}\right) \quad \text{…… eq. (11)}$$

The above equation shows PECH and SECH. In addition, Simar & Wilson, (1998), decomposed MPI into PECH, SECH, PTECH and STECH.

$$TECH = \left(\sqrt{\frac{K_{0u}^{t1}(x^{t2},y^{t2})}{K_{0u}^{t2}(x^{t2},y^{t2})} \times \frac{K_{0u}^{t1}(x^{t1},y^{t1})}{K_{0u}^{t2}(x^{t1},y^{t1})}}\right) \times \left(\sqrt{\frac{K_{0u}^{t1}(x^{t2},y^{t2})}{K_{0u}^{t2}(x^{t2},y^{t2})} \times \frac{K_{0u}^{t1}(x^{t1},y^{t1})}{K_{0u}^{t2}(x^{t1},y^{t1})}}\right) \times \left(\sqrt{\frac{K_{0c}^{t1}(x^{t1},y^{t1}) / K_{0u}^{t1}(x^{t1},y^{t1})}{K_{0c}^{t2}(x^{t1},y^{t1}) \; K_{0u}^{t2}(x^{t1},y^{t1})}}\right) \quad \text{…..…… eq. (12)}$$

So,

$$MPI = PECH \times SECH \times PTECH \times STECH \quad \text{…….. eq. (13)}$$

The DEA model converts inputs and outputs to produce an efficiency scalar, while the CCR model ensures proportional increases in outputs. The BCC model determines VRS for DMUs. TE ranges from 0 to 100 percent, with state/U.T. s manufacturing sector scoring 1 as efficient. The study uses net value added, invested capital, and total number of persons engaged as output and input variables. For each DMU i.e., State/U.T.s manufacturing sector in this study, there is need to get the measure of ratio of all outputs over all inputs such as $u' y_i / v'x_i$, where u is an M×1 vector of output weights and v is a M×1 vector of input weights in the equation 14. The optimal weights have been obtained with the solution of following mathematical programming problem:

$$\max_{u,v} (u' y_i / v'x_i)$$

$$\text{St. } u'y_j / v'x_j < 1, \; j = 1, 2 \ldots N, \; N = 32 \text{ in this study}$$

$$u, v \geq 0 \quad \text{…..eq. (15)}$$

To avoid this problem one constraint can be imposed i.e., $v'x_i = 1$, which gives:

$$\max_{\mu,v} (\mu' y_i),$$

$$\text{st. } v'x_i = 1$$

$$\text{st. } \mu'y_j - v'x_j \leq 0, \; j = 1,2,\ldots N, \; N = 32 \text{ in this study}$$

$$u, v \geq 0 \quad \text{….. eq. (16)}$$

is the transformed equation. This is called multiplier form of LPP. The envelop form can be obtained with the use of duality which is as follows:

$$\min_{\Theta, \alpha} \Theta,$$

$$\text{st. } -y_i + Y\alpha \geq 0,$$

$$\Theta x_i - X\alpha \geq 0,$$

$$\alpha \geq 0, \qquad \text{.....eq. (17)}$$

This LPP can be modified to account for VRS by adding convexity constraint which is known as BCC model.

$$\min_{\Theta, \alpha} \Theta,$$

$$\text{st. } -y_i + Y\alpha \geq 0,$$

$$\Theta x_i - X\alpha \geq 0,$$

$$N1 \text{ `} \alpha = 1$$

$$\alpha \geq 0, \qquad \text{....eq. (18)}$$

Thus, the study compares CCR and BCC models to determine a firm's own inefficiency and those caused by others, calculating scale efficiency as the ratio of technical efficiency and pure technical efficiency (Coeli, et al.,1996).

RESULTS AND DISCUSSIONS

This section contains the empirical findings from the two main analyses that were carried out to evaluate the interstate disparities in resource optimization among the Indian states and U.T.s from 2009-10 to 2019-20.

Total Factor Productivity Estimates

The Table.1. shows the total factor productivity growth of remaining 18 states except the north-east states and UTs (Due to small size of the manufacturing sector of these states & UTs). In MPI, value might be equal to one indicates no change, greater than one means positive change and less than one indicates a negative change. The results shows that productivity declined by 20 percent among the 18 states during these years.

Table. 1 Total Factor Productivity Growth from 2009-10 to 2019-20

States	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**Mean**
Andhra Pradesh	0.5	0.67	0.76	0.82	0.83	0.86	0.88	0.88	0.92	0.90	**0.80**
Bihar	0.5	0.67	0.77	0.79	0.84	0.86	0.88	0.89	0.90	0.91	**0.80**
Chhattisgarh	0.52	0.69	0.76	0.79	0.85	0.90	0.87	0.89	0.89	0.91	**0.81**
Gujarat	0.5	0.67	0.75	0.8	0.83	0.86	0.88	0.89	0.9	0.91	**0.80**
Haryana	0.51	0.67	0.75	0.8	0.83	0.86	0.88	0.89	0.9	0.91	**0.80**
Himachal Pradesh	0.51	0.67	0.76	0.81	0.83	0.86	0.88	0.89	0.91	0.92	**0.80**

Jharkhand	0.51	0.69	0.75	0.81	0.84	0.89	0.86	0.89	0.89	0.94	**0.81**
Karnataka	0.5	0.71	0.72	0.8	0.83	0.86	0.88	0.89	0.9	0.91	**0.80**
Kerala	0.51	0.68	0.75	0.80	0.85	0.85	0.87	0.90	0.90	0.92	**0.80**
Madhya Pradesh	0.51	0.68	0.76	0.81	0.84	0.86	0.88	0.89	0.9	0.93	**0.80**
Maharashtra	0.5	0.67	0.75	0.8	0.83	0.86	0.88	0.89	0.9	0.91	**0.80**
Odisha	0.51	0.68	0.77	0.80	0.85	0.88	0.87	0.87	0.89	0.93	**0.80**
Punjab	0.51	0.67	0.76	0.81	0.84	0.86	0.88	0.89	0.90	0.92	**0.80**
Rajasthan	0.52	0.66	0.75	0.80	0.83	0.86	0.88	0.89	0.9	0.91	**0.80**
Tamil Nadu	0.5	0.67	0.75	0.8	0.83	0.86	0.88	0.89	0.9	0.91	**0.80**
Uttar Pradesh	0.5	0.67	0.75	0.8	0.83	0.86	0.88	0.89	0.9	0.91	**0.80**
Uttarakhand	0.51	0.67	0.75	0.8	0.83	0.86	0.88	0.89	0.9	0.91	**0.80**
West Bengal	0.51	0.68	0.76	0.81	0.85	0.86	0.87	0.88	0.90	0.92	**0.80**
Mean	**0.51**	**0.67**	**0.75**	**0.80**	**0.84**	**0.86**	**0.87**	**0.89**	**0.90**	**0.91**	**0.80**

Source: Computed by researcher using ASI data (2009-10 to 2019-20) [Note* the states of north-east and UTs are not included]

For the year 2010-11, the average total factor productivity change is 49 percent (1-0.51=0.49*100 = 49 %). Chhattisgarh and Rajasthan experienced a 52 percent productivity decreases, while Andhra Pradesh, Bihar, Maharashtra, and Tamil Nadu experienced a 49 percent reduction in productivity in the same year. The TFPCH value in most of states experienced a moderate productivity reduction of 23 to 25 percent in 2012-13, 18 to 20 percent in 2013-14, 17 to 13 percent in the year 2014-15, no change in 2018-19, and 9 percent in 2019-20. The analysis shows a significant increase in productivity over the specified period, despite initial decline and potential technological advancements.

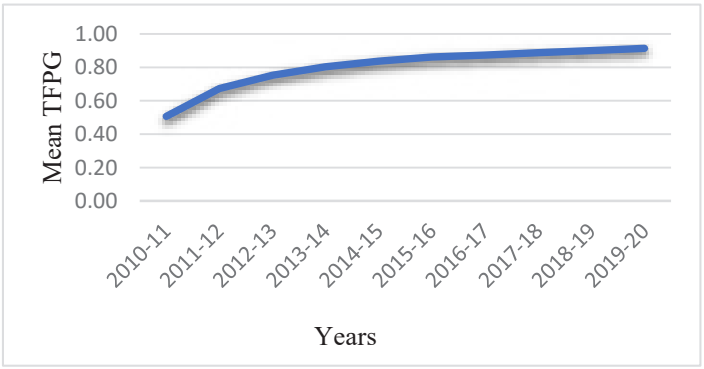

Figure 1: Total Factor Productivity (compiled by the researcher using Table.1 data)

The figure shows that productivity declined rapidly by 49 percent in the initial year but thereafter a significant improvement has been observed. In the last period, only 9 percent reduction was observed in the productivity of all states.

Estimates of Input-Oriented Technical Efficiency (CRS)

Table. 2 shows the results of technical efficiency of the manufacturing sector of 18 Indian states. A DMU is considered efficient when its score is 1, whereas inefficiency is indicated by a value below 1.

Over the past 11 years, no state has been found fully efficient, with Andhra Pradesh operating at 13 percent of its potential, and Uttarakhand and Himachal Pradesh being less inefficient with TE scores of 42 percent and 40 percent respectively. In other states efficiency score has been observed less to mean efficiency score. During the study period, states achieved a 24 percent mean efficiency score, indicating they only produce 24 percent of their maximum production despite their resources.

Table.2 Input-Oriented TE-CRS

States	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	Mean
Andhra Pradesh	0.17	0.15	0.13	0.13	0.11	0.16	0.14	0.10	0.12	0.11	0.14	**0.13**
Bihar	0.23	0.30	0.24	0.07	0.24	0.23	0.29	0.20	0.20	0.17	0.27	**0.22**
Chhattisgarh	0.33	0.18	0.18	0.25	0.40	0.31	0.13	0.11	0.14	0.18	0.21	**0.22**
Gujarat	0.30	0.17	0.17	0.25	0.29	0.36	0.28	0.18	0.19	0.20	0.22	**0.24**
Haryana	0.33	0.17	0.17	0.21	0.22	0.22	0.28	0.33	0.28	0.32	0.31	**0.26**
Himachal Pradesh	0.41	0.29	0.35	0.34	0.36	0.46	0.40	0.46	0.42	0.43	0.47	**0.40**
Jharkhand	0.41	0.26	0.23	0.31	0.33	0.36	0.18	0.20	0.23	0.27	0.26	**0.28**
Karnataka	0.22	0.16	0.31	0.18	0.19	0.18	0.22	0.30	0.27	0.27	0.29	**0.23**
Kerala	0.24	0.19	0.17	0.22	0.23	0.17	0.24	0.29	0.26	0.26	0.25	**0.23**
Madhya Pradesh	0.26	0.15	0.16	0.20	0.20	0.19	0.18	0.15	0.20	0.24	0.20	**0.19**
Maharashtra	0.31	0.25	0.22	0.28	0.33	0.34	0.34	0.37	0.35	0.28	0.29	**0.31**
Odisha	0.25	0.15	0.17	0.19	0.25	0.20	0.13	0.12	0.18	0.28	0.24	**0.20**
Punjab	0.23	0.19	0.25	0.18	0.17	0.15	0.22	0.29	0.26	0.29	0.31	**0.23**
Rajasthan	0.28	0.14	0.26	0.22	0.18	0.21	0.25	0.27	0.23	0.25	0.30	**0.23**
Tamil Nadu	0.23	0.18	0.15	0.20	0.15	0.16	0.26	0.27	0.28	0.30	0.30	**0.23**
Uttar Pradesh	0.22	0.21	0.13	0.16	0.20	0.15	0.23	0.39	0.28	0.27	0.30	**0.23**
Uttarakhand	0.30	0.30	0.24	0.31	0.33	0.36	0.59	0.55	0.46	0.56	0.60	**0.42**
West Bengal	0.17	0.13	0.10	0.12	0.12	0.09	0.14	0.16	0.18	0.21	0.19	**0.15**
Mean	**0.27**	**0.20**	**0.20**	**0.21**	**0.24**	**0.24**	**0.25**	**0.26**	**0.25**	**0.27**	**0.29**	**0.24**

Source: Computed by researcher using ASI data (2009-10 to 2019-20) [Note* the states of north-east and UTs are not included]

Estimates of Input-Oriented Pure Technical Efficiency (VRS)

Table.2.1 displays Indian states pure technical efficiency (TE-VRS) for each year, showing higher efficiency scores across all DMUs and a greater number of efficient units compared to CRS. During these 11 years, Maharashtra has been observed as a fully efficient state with 100 percent efficiency

score and remained constantly efficient. If looked at the average TE-VRS of the states in these eleven years, Bihar was the most inefficient state with 29 percent score while Gujarat, Himachal Pradesh, Uttarakhand, and Jharkhand are the most efficient states (see. Table.2.1.). Apart from these states, the remaining states are on average technical efficient in VRS. Gujarat and Uttarakhand improved TE-VRS scores from 90 percent to 100 percent, while Chhattisgarh experienced high fluctuations and inconsistent deterioration in efficiency from 76 percent to 70 percent over eleven years.

Table.2.1 Input-Oriented Pure Technical Efficiency (VRS)

States	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	Mean
Andhra Pradesh	0.54	0.57	0.42	0.38	0.28	0.35	0.37	0.31	0.42	0.35	0.49	**0.41**
Bihar	0.32	0.59	0.44	0.07	0.36	0.29	0.29	0.20	0.20	0.17	0.27	**0.29**
Chhattisgarh	0.80	0.61	0.40	0.60	1.00	0.57	0.22	0.18	0.30	0.47	0.56	**0.52**
Gujarat	0.99	0.77	0.55	0.86	0.87	1.00	1.00	0.92	0.89	1.00	1.00	**0.90**
Haryana	1.00	0.57	0.52	0.70	0.66	0.67	0.49	0.71	0.67	0.85	0.72	**0.69**
Himachal Pradesh	1.00	1.00	0.96	0.95	0.96	1.00	1.00	0.99	0.96	0.90	0.98	**0.97**
Jharkhand	1.00	0.91	0.57	0.86	0.82	0.70	0.34	0.68	0.72	0.94	0.76	**0.76**
Karnataka	0.69	0.58	1.00	0.60	0.55	0.50	0.47	0.69	0.72	0.78	0.85	**0.68**
Kerala	0.60	0.54	0.39	0.44	0.60	0.30	0.30	0.44	0.43	0.38	0.35	**0.43**
Madhya Pradesh	0.75	0.54	0.42	0.55	0.53	0.38	0.45	0.58	0.78	0.93	0.66	**0.60**
Maharashtra	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**
Odisha	0.61	0.51	0.44	0.50	0.64	0.34	0.26	0.37	0.62	1.00	0.75	**0.55**
Punjab	0.66	0.62	0.80	0.48	0.49	0.35	0.31	0.47	0.50	0.48	0.48	**0.51**
Rajasthan	0.84	0.45	0.83	0.67	0.53	0.53	0.46	0.48	0.57	0.64	0.78	**0.62**
Tamil Nadu	0.73	0.71	0.52	0.81	0.53	0.58	0.65	0.65	0.78	0.99	0.96	**0.72**
Uttar Pradesh	0.67	0.78	0.42	0.54	0.66	0.44	0.41	0.91	0.71	0.68	0.74	**0.63**
Uttarakhand	0.90	1.00	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**0.96**
West Bengal	0.52	0.44	0.29	0.33	0.34	0.19	0.20	0.33	0.43	0.47	0.31	**0.35**
Mean	**0.76**	**0.68**	**0.59**	**0.63**	**0.66**	**0.57**	**0.51**	**0.61**	**0.65**	**0.72**	**0.70**	**0.64**

Source: Computed by researcher using ASI data (2009-10 to 2019-20) [Note* the states of north-east and UTs are not included]

Estimates of Scale Efficiency

The study analysed Indian states and U.T.s scale efficiency using CRS and VRS, finding none were optimal. Bihar was the most efficient, with 84 percent efficiency, while Kerala, Punjab, Chhattisgarh,

and West Bengal showed increased efficiency from 2009-10 to 2019-2020 (see. Table.2.2). In 2010-11, 30 percent average scale efficiency has been observed which is very low as compared to other years. Bihar, Kerala, Punjab and Rajasthan have been noticed above the average of scale efficiency in the same period, rest of other states. States like Jharkhand, Madhya Pradesh, and Odisha experienced a 41 percent to 31 percent decline in efficiency score from 2009-10 to 2019-20, while Haryana remained stagnant and reduced post in 2015-16. Fluctuations has been observed in the mean of scale efficiency over the period.

Table.2.2. Scale Efficiency

States	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**Mean**
Andhra Pradesh	0.32	0.27	0.31	0.35	0.39	0.47	0.40	0.32	0.29	0.31	0.29	**0.34**
Bihar	0.74	0.51	0.55	0.97	0.68	0.78	1.00	1.00	1.00	1.00	1.00	**0.84**
Chhattisgarh	0.41	0.29	0.46	0.42	0.40	0.55	0.61	0.60	0.48	0.39	0.37	**0.45**
Gujarat	0.30	0.22	0.31	0.29	0.33	0.36	0.28	0.20	0.21	0.20	0.22	**0.27**
Haryana	0.33	0.30	0.32	0.30	0.33	0.33	0.56	0.47	0.42	0.38	0.44	**0.38**
Himachal Pradesh	0.41	0.29	0.37	0.36	0.38	0.46	0.40	0.46	0.44	0.48	0.48	**0.41**
Jharkhand	0.41	0.28	0.40	0.36	0.40	0.51	0.53	0.30	0.31	0.29	0.34	**0.38**
Karnataka	0.32	0.27	0.31	0.29	0.34	0.36	0.47	0.43	0.38	0.35	0.34	**0.35**
Kerala	0.41	0.36	0.44	0.51	0.38	0.57	0.80	0.66	0.60	0.69	0.71	**0.56**
Madhya Pradesh	0.34	0.27	0.39	0.36	0.38	0.51	0.41	0.26	0.25	0.26	0.30	**0.34**
Maharashtra	0.31	0.25	0.22	0.28	0.33	0.34	0.34	0.37	0.35	0.28	0.29	**0.31**
Odisha	0.41	0.29	0.39	0.38	0.40	0.57	0.52	0.32	0.29	0.28	0.31	**0.38**
Punjab	0.35	0.31	0.32	0.37	0.35	0.43	0.71	0.62	0.52	0.61	0.64	**0.47**
Rajasthan	0.33	0.31	0.31	0.33	0.33	0.39	0.54	0.56	0.41	0.39	0.38	**0.39**
Tamil Nadu	0.31	0.26	0.30	0.25	0.29	0.29	0.39	0.41	0.36	0.30	0.31	**0.31**
Uttar Pradesh	0.32	0.27	0.31	0.30	0.31	0.35	0.57	0.43	0.40	0.40	0.41	**0.37**
Uttarakhand	0.33	0.30	0.34	0.31	0.33	0.36	0.59	0.55	0.46	0.56	0.60	**0.43**
West Bengal	0.33	0.30	0.34	0.36	0.35	0.48	0.68	0.51	0.43	0.45	0.62	**0.44**
Mean	**0.37**	**0.30**	**0.35**	**0.38**	**0.37**	**0.45**	**0.54**	**0.47**	**0.42**	**0.42**	**0.45**	**0.41**

Source: Computed by researcher using ASI data (2009-10 to 2019-20) [Note* the states of north-east and UTs are not included]

Graphical Presentation of Mean TE-CRS, PTE-VRS and Scale Efficiency

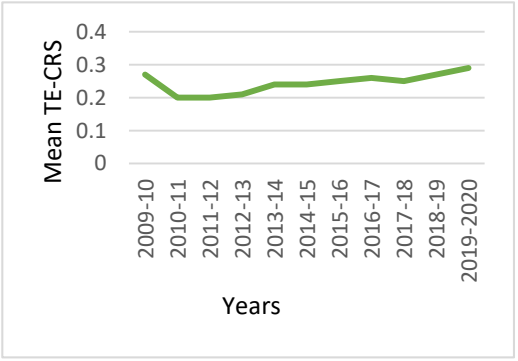

Figure 2: Mean Technical Efficiency (CRS) (Compiled by the researcher using Table.2. data) data)

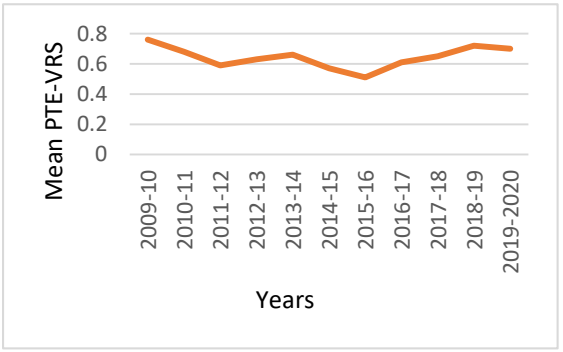

Figure 3: Mean Pure Technical Efficiency (VRS) (compiled by the researcher using Table. 2.1.

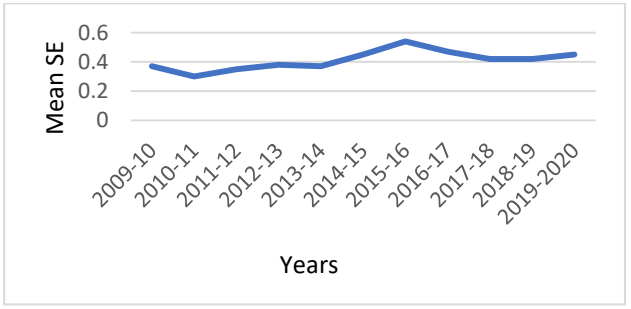

Figure 4: Mean Scale Efficiency

(compiled by the researcher using Table.2.2 data)

Figure 2,3 and 4 shows the mean TE, PTE and SE. The figure 2 depicts that the average technical efficiency fluctuated from 27 percent in 2009-10 to 29 percent by the end of the period. The figure 3 shows the mean PTE which higher from mean technical efficiency. The figure reveals a 64 percent mean PTE in selected Indian states from 2009-10 to 2019-2020, with the highest decline in 2015-16 at 51 percent. Figure 4 shows a mean SE of 30 percent to 54 percent during the study period, with the largest decline occurring in 2010-11 and peaking in 2015-16.

CONCLUSION AND POLICY IMPLICATION

The present study explores disparities in the resource optimization across 32 Indian states and U.T.s using ASI state level data through DEA and Malmquist productivity index. The study reveals that technical change has led to growth in TFP with regional variations. While there is still regional variation in TFPG, it seems that these have been decreased and the majority of states attempted to get closer to the isoquant. 24 percent mean technical efficiency has been observed among the selected Indian states from 2009-10 to 2019-20 which shows that productivity has been increased but somewhere the states are still not able to fully utilise their resources. The complete exercise of this study suggests that it is necessary for the policy makers to get equality in resource optimization among all states and U.T.s of India which can generate snowball effect to catch the next growth trajectory in Indian economy. To

improve technical efficiency of deprived states, the public sector investment should focus on research and innovation, effective management, operational scale improvement, efficient information systems, and quality infrastructure. On the other hand, the efficiency and productivity of leading states can be sustained with better private investment and spillover effects from other emerging/ improving states.

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Improving India's Performance in SDG-4: Some Observations and Policy Lessons for Addressing Education Inequality

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Abstract

The study traces the progress of states and union territories of India in the Goal 4 of SDG, ensuring quality education for all, for the years 2018 to 2023-24 and focusses on NFHS-5 period for further analysis. It uses database from secondary sources- NITI Aayog's SDG India Index Reports, National Family Health Survey (NFHS) Reports; Annual Status of Education Report (Rural) 2022, and UDISE Plus Report (GoI, 2021). It is found that there are huge disparities in schooling outcomes, in terms of literacy, enrolment, dropout and grade-adequate learning proficiency, across states and UTs. Economic status, social background, physical and human infrastructure in schools together with child health and women empowerment are found to impact education outcomes. The policy must focus on quality of education as measured by achievement of desired learning proficiency and years of completed education as objectives and not mere literacy; and make use of public campaigns and community engagement programmes to overcome the barriers related to mindsets that generate any biases related to gender, caste, and religion. Since economic status is an important factor and lack of adequate financial resources are found to dampen schooling outcomes, policies for improving household income and reduced costs of education will be needed to uplift education outcomes.

Keywords: SDG-4, Education, Literacy, Learning outcomes, Dropout, School Quality, India

1. INTRODUCTION

Education, a crucial component of human capital, is indispensable for economic growth, economic development as well as social progress. The importance of education is highlighted in the global policy sphere by its inclusion as one of the seventeen Sustainable Development goals (SDG), Goal 4 - "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all"[4].

The vision of 'Viksit Bharat 2047', transforming India into a developed country within a century after its independence, encompasses development in its truly comprehensive and sustainable sense with its path converging with the 17 SDGs adopted by UN member nations under 'The 2030 Agenda for Sustainable Development' in 2015. Alongside the focus on faster economic growth, India aims to ensure adequate nutrition, health, education, and work opportunities for all sections of people without any discrimination and prejudices. In addition to providing a decent and dignified life to its people, the environmental issues are also on the priority list. Finland, Sweden, and Denmark are among the top three countries in terms of overall SDG score that measures the progress of nations towards achieving SDGs. India's overall SDG index score is 63.99 with a rank of 109 among 166 countries. Among South Asian countries, India lags behind all countries - Bhutan (rank 61), Maldives (rank 67), Sri Lanka (rank 93), Nepal (rank 95), Bangladesh (rank 107), except Pakistan (rank 137). China is ahead of India with a rank of 68 and SDG index score 70.85.[5]

There are several studies using unit record data and for specific states but there is a limited literature

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[4] https://sdgs.un.org/goals/goal4
[5] https://dashboards.sdgindex.org/rankings

that analyses the state of education at the level of all states and union territories of India. The objectives of the study are to examine the progress in schooling outcomes of SDG-4 for states and union territories (UTs) of India for the years 2018 to 2023-24 and explore the role of socio-economic correlates and school infrastructure in school education outcomes, namely literacy rate, enrolment, dropout, and attainment of learning proficiency for 2019-21. The observations are used to formulate policy prescriptions that aim at not just improving India's ranking in world SDG index scores but also providing a dignified and a meaningful way of life to its people.

2. REVIEW OF LITERATURE

Several reasons contribute to the low literacy rate such as low economic status of households, discrimination based on social identities and inadequate physical infrastructure and trained teachers in educational institutions. Greater dropout rate is observed among adolescent girls due to gender disparity, inadequate sanitation facilities and lack of hygienic methods of menstrual protection.

Dreze and Kingdon (2001) find the factors influencing school participation in rural north India to be parents' education, social background, dependency ratio, work opportunities, village development, teachers, mid-day meals and school infrastructure. Kingdon (2007) points out the low ranking of India among BRIC countries, especially China, in literacy levels and that low enrolment in secondary schools could be due to insufficient schools, household economic status and gender bias. The study also elaborates on the rise in private schools and the resultant equity concern. In the setting of a rural Uttar Pradesh, Siddhu (2011) finds cost factor, proximity to the closest secondary school, social background, and gender to be important factors affecting parents' decision to send the child for secondary schooling. Das and Das (2023), using NSSO data, find distance to school as a significant barrier in achieving school as well as higher education. Sivakami et al., (2019) finds, using survey data in Maharashtra, Chhattisgarh and Tamil Nadu, higher absenteeism in schools among females if there are inadequate sanitation facilities and lack of hygienic methods of menstrual protection.

Gouda and Sekhar (2014) use NFHS-3 survey results and examine the factors affecting school dropouts in India. The study finds the dropout to be high among children who belonged to Muslim, Scheduled Caste, and Scheduled Tribe households; whose parents were illiterate and had a weaker economic status. Kumar et al (2023) use longitudinal survey data for Bihar and Uttar Pradesh for 2015-16 and 2018-19 to find the determinants of school dropout among adolescents in the age group 10–19 years. They find dropout to be higher among children belonging to lower social and economic status and those who are engaged in paid work. Gender bias and substance abuse were found to be important factors affecting girls and boys respectively.

The issue of efficacy of midday meal scheme to attract children to school and positively impact enrolment is far from settled. Afridi (2011), using a school, household, and village survey in a district of Madhya Pradesh, finds a positive impact of midday meals provided in schools on increasing school participation rates, particularly for girls. The report by CAG on Performance Audit of Mid-Day Meal scheme (2015) points out a decline in the enrolment of children in the schools under the scheme and a rising enrolment in private schools that are seen as an option providing better quality education and that the scheme is not sufficient to retain children in schools.

Govinda and Bandyopadhyay (2010) observe gender bias, social background, poverty, and location of schools to be major challenges in improving schooling outcomes in India. Johnson and Parrado (2021) compare the ASER and NAS databases that are conducted to ascertain the learning outcomes of school children and conclude that ASER database is much more reliable and is correlated with other socio-economic indicators.

3. METHODOLOGY

This study uses official secondary data sources. The SDG India Index Reports published by NITI Aayog for the years 2018, 2019-20, 2020-21 and 2023-24 are used to extract data related to overall SDG-4 scores for states and UTs. The data on the four constituent parameters of SDG-4 index that are output indicators in nature, namely percentage of persons (15 years and above) who are literate, average annual dropout rate at secondary level (class 9-10), Gross Enrolment Ratio (GER) in higher secondary (class 11-12) and percentage of students in grade VIII achieving at least a minimum proficiency level in terms of nationally defined learning outcomes to be attained by the pupils at the end of the grade- is taken from SDG India Index Report 2020-21. This report is also the source for data on three constituent parameters that are essentially inputs in education, namely, percentage of trained teachers at secondary level, pupil-teacher ratio at secondary level and percentage of schools with electricity & drinking water. In addition, we also use scores of School Education Quality Index (SEQI) 2019 computed by NITI Aayog. This index uses thirty indicators covering outcomes, namely learning outcomes, access outcomes, equity outcomes, infrastructure & facilities for outcomes; and governance processes aiding outcomes that include student and teacher attendance, teacher availability, administrative adequacy, training, accountability, and transparency.[6] All statistics mentioned are considered at state/UT level and hence include all types of schools- public as well as private.

National Family Health Survey Reports (NFHS) for the Rounds 2-5, corresponding to years 1998-99, 2005-06, 2015-16 and 2019-21, are used as data sources for reasons why children do not attend school. The data on male and female literacy rates, median years of schooling and variables pertaining to socio-economic status- percentage of households in lowest wealth quintile, religion, and caste - are taken from NFHS-5 corresponding to period 2019-21. NFHS-5 India Report is also used to obtain data on women using hygienic methods of menstrual protection, participation of women in household decisions, female workforce participation rate as well as prevalence of stunting of children. The data on percentage of schools with computer facilities is extracted from Report on UDISE Plus 2020-21 (GoI, 2021). The data on schools with mid-day meal scheme, enrolment of children age 6-14 in government schools and prevalence of paid tuition classes in rural areas are sourced from Annual Status of Education Report (ASER) Rural 2022 (Pratham, 2023).

The methods of analysis include tabulation, graphs, and cross-section bivariate and multivariate cross-sectional regressions.

4. RESULTS

NITI Aayog, the nodal institution for SDGs in India, is entrusted with the task of monitoring the progress towards the goals and has been publishing the reports and statistics since 2018. It considers following parameters in computing the SDG-4 index scores for states and union territories[7]:

- Adjusted Net Enrolment Ratio (ANER) in elementary education (class 1-8)
- Average annual dropout rate at secondary level (class 9-10)
- Gross Enrolment Ratio (GER) in higher secondary (class 11-12)
- Percentage of students in grade VIII achieving at least a minimum proficiency level in terms of

[6] For details, please refer to https://www.niti.gov.in/sites/default/files/2019-09/seqi_document_0.pdf
[7] https://sdgindiaindex.niti.gov.in/assets/Files/SDG3.0_Final_04.03.2021_Web_Spreads.pdf

nationally defined learning outcomes to be attained by the pupils at the end of the grade

- Gross Enrolment Ratio (GER) in higher education (18-23 years)
- Percentage of persons with disability (15 years and above) who have completed at least secondary education
- Gender Parity Index (GPI) for higher education (18-23 years)
- Percentage of persons (15 years and above) who are literate
- Percentage of schools with access to basic infrastructure (electricity and drinking water)
- Percentage of trained teachers at secondary level (class 9-10)
- Pupil Teacher Ratio (PTR) at secondary level (class 9-10)

The indicator 'pre-primary organized learning' is so far not included for calculation of SDG score.

4.1 Performance on SDG Index Scores

The progress of states and UTs in SDG-4 over the period 2018 to 2023-24, ranked by 2020-21 scores is presented in Table 1. While India's SDG-4 score has increased from 58 to 61 from 2018 to 2023-24, a fall in the score is observed in fifteen states/UTs. In 2020-21, Kerala tops the list followed by Chandigarh, Delhi, Himachal Pradesh, and Goa. Bihar is at the bottom among all states and UTs followed by Nagaland, Arunachal Pradesh, Tripura, Assam, Odisha, Madhya Pradesh, and Jharkhand.

The performance of states and UTs in the four schooling outcomes - literacy rate, GER in higher secondary, dropout rate at secondary level, and learning outcome/proficiency- along with ranking for 2020-21 is presented for states and UTs in Table 2(a). The ranks for literacy rates, enrolment, and learning outcomes are taken in descending order, while the rank for dropout rate, a negative indicator, is taken in ascending order so that a higher rank implies a lower dropout. The performance of states and UTs is not found to be consistent across the four indicators. For example, Rajasthan ranks first in achieving learning outcomes, whereas its rank is quite low in literacy rate. Kerala is a state with approximately similar rank in all four indicators. Except for GER and dropout rate, the correlation between all other pairs of ranking on schooling indicators are quite low. The correlation between ranking for literacy rate and learning outcome turns out negative but low (Table 2(b)).

Table 1: SDG-4 Index Scores of States and UTs, ranked by 2020-21 index scores

AREA	2018	2019-20	2020-21	2023-24
India	**58**	**58**	**57**	**61**
Kerala	87	74	80	82
Chandigarh	85	80	79	84
Delhi	58	64	75	85
Himachal Pradesh	82	81	74	77
Goa	71	71	71	72
Puducherry	69	67	70	76

Uttarakhand	68	66	70	73
Tamil Nadu	75	70	69	76
Haryana	65	68	64	77
Karnataka	76	67	64	63
Maharashtra	74	65	64	67
Manipur	65	70	63	65
Telangana	66	64	63	64
Lakshadweep	62	62	62	67
Mizoram	54	61	60	65
Punjab	63	67	60	75
Rajasthan	73	51	60	63
Sikkim	47	58	58	67
India	58	58	57	61
Andaman and Nicobar Islands	69	61	57	63
Dadra and Nagar Haveli	77	53	56	67[#]
Daman and Diu	46	43	56	NA
Chhattisgarh	53	52	55	63
West Bengal	51	50	54	60
Gujarat	67	47	52	58
Uttar Pradesh	53	48	51	54
Andhra Pradesh	77	52	50	52
Jammu and Kashmir	51*	54*	49	56
Ladakh	NA	NA	49	53
Meghalaya	38	55	48	40
Jharkhand	58	42	45	61
Madhya Pradesh	49	54	45	49
Odisha	46	40	45	40
Assam	54	44	43	41
Tripura	56	55	42	52
Arunachal Pradesh	44	58	41	52
Nagaland	45	47	39	46
Bihar	36	19	29	32

includes Daman and Diu, includes Ladakh

Source: Author's compilation using SDG India Index Reports 2018, 2019-20, 2020-21, 2023-24 available at https://sdgindiaindex.niti.gov.in/#/ranking

Table 2(a): Schooling outcomes by states and UTs, 2020-21

State/ UT	Persons 15 years and above who are literate		Average annual dropout rate at secondary level (class 9-10)		GER in higher secondary (class 11-12)		Attainment of Learning Outcomes	
	%	Rank	%	Rank	%	Rank	%	Rank
Chandigarh	89.1	8	4.52	1	83.43	1	81.55	5
Lakshadweep	95.7	2	4.56	2	73.5	4	65.25	28
Himachal Pradesh	84.2	15	7.81	3	81.79	2	72.75	12
Kerala	94.6	3	9.14	4	80.26	3	86.75	2
Goa	88.9	9	9.4	5	71.95	6	71.65	16
Odisha	72.5	29	9.52	6	65.86	12	71.85	15
Mizoram	98.5	1	10.64	7	51.87	20	70.5	21
Uttarakhand	79	22	10.95	8	66.2	11	74.95	11
Punjab	79.4	21	11.52	9	68.14	10	61.55	31
Rajasthan	67.1	34	12.69	10	56.51	14	88.1	1
Puducherry	89.5	7	12.73	11	69.78	8	61.3	32
Tamil Nadu	80.7	18	13.02	12	72.32	5	69.8	22
Manipur	85.6	13	13.03	13	54.82	18	68.25	24
Maharashtra	80.3	19	13.29	14	68.93	9	64.5	29
Telangana	67.4	32	13.47	15	56.49	15	71.3	18
Haryana	77.3	24	14.79	16	56.05	17	71.6	17
Delhi	86.4	11	14.93	17	70.07	7	67.35	25
Uttar Pradesh	68.2	31	15.51	18	46.12	23	67.35	26
Andhra Pradesh	65.6	35	16.37	19	46.84	22	80.15	7
Jammu & Kashmir	76.4	25	17.81	20	42.31	26	84	3
Ladakh	76.4	26	17.81	21	42.31	27	59.75	35
Chhattisgarh	74.1	28	18.29	22	52.08	19	68.9	23

Meghalaya	91.4	5	19.47	23	41.64	29	72.3	13
West Bengal	79	23	19.49	24	51.73	21	70.55	20
Dadra and Nagar Haveli and Daman and Diu	82.83	16	21.08	25	42.14	28	72.02	14
Andaman & Nicobar Islands	88.3	10	22.22	26	56.44	16	65.5	27
Jharkhand	67.3	33	22.26	27	38.89	31	59.75	36
Karnataka	75.7	27	23.43	28	44.4	24	83.5	4
Sikkim	86.2	12	23.67	29	58.22	13	64.4	30
Gujarat	80.7	17	23.84	30	41.2	30	81.05	6
Nagaland	93.8	4	24.08	31	33.92	34	60.95	33
Madhya Pradesh	70.5	30	24.85	32	43.73	25	76.3	10
Bihar	64.7	36	28.46	33	26.39	36	78.3	9
Tripura	89.9	6	29.55	34	38.62	32	71.3	19
Assam	84.9	14	31.47	35	30.94	35	79.55	8
Arunachal Pradesh	79.9	20	35.98	36	38.48	33	59.95	34
India	74.6	--	17.87	--	50.14	--	71.88	--

Table 2(b): Correlation matrix for ranks in various schooling outcomes

	Literacy rate	**Dropout rate**	**GER**	**Learning Outcome**
Literacy rate	1			
Dropout rate	0.2216	1		
GER	0.2739	0.8605	1	
Learning Outcome	-0.1676	0.1122	0.0208	1

Source: Authors computation using SDG data, NITI Aayog

Figure 1 shows the ranks for all four indicators along with the aggregate. Lower the height of the bar, better the ranking and hence better performance on various parameters of school education. Based on aggregation of ranks in four parameters, Kerala, Chandigarh, Himachal Pradesh, and Lakshadweep are the top four performers. Jharkhand, Arunachal Pradesh, Bihar and Ladakh are among the bottom-most performers.

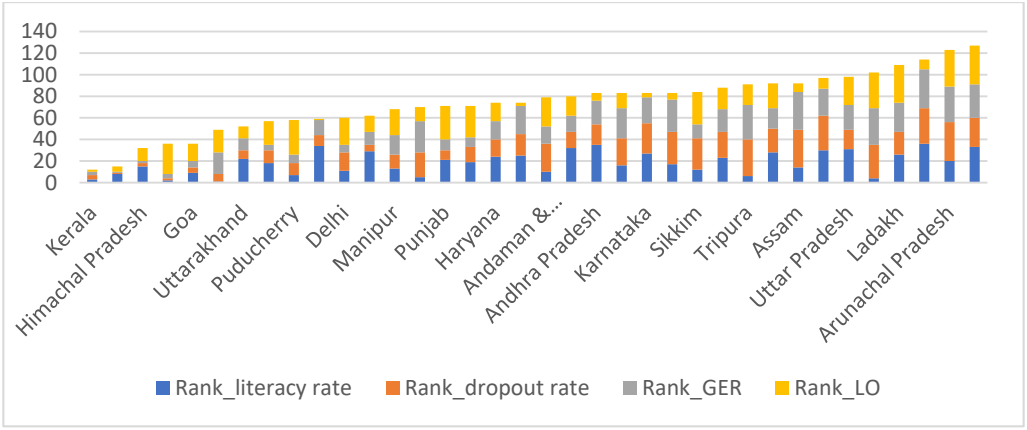


Figure 1: Ranking of states in various schooling indicators, 2020-21

Source: Authors compilation using SDG data, NITI Aayog

4.2 Performance on literacy rate, median years of schooling and achievement of learning outcomes

To gain further insights into the literacy rates by gender, median years of schooling and other correlates, NFHS-5 data is used. The literacy rates for states and UTs, arranged in descending order of male literacy rate, are presented in Figure 2. Among all states and UTs, Lakshadweep, Kerala, and Mizoram have highest male literacy rates of 98.6%, 97.1% and 97% respectively, whereas Bihar (76.4%) has the lowest male literacy rate followed by Andhra Pradesh (76.5%) and West Bengal (80.2%). The states with highest female literacy rates include Kerala (97.4%), Lakshadweep (95.2%) and Mizoram (94%), and the states with lowest female literacy rates are Bihar (55%), Jharkhand (61.7%) and Rajasthan (64.7%). Clearly the disparities in literacy rates are much sharper for females as compared to males.

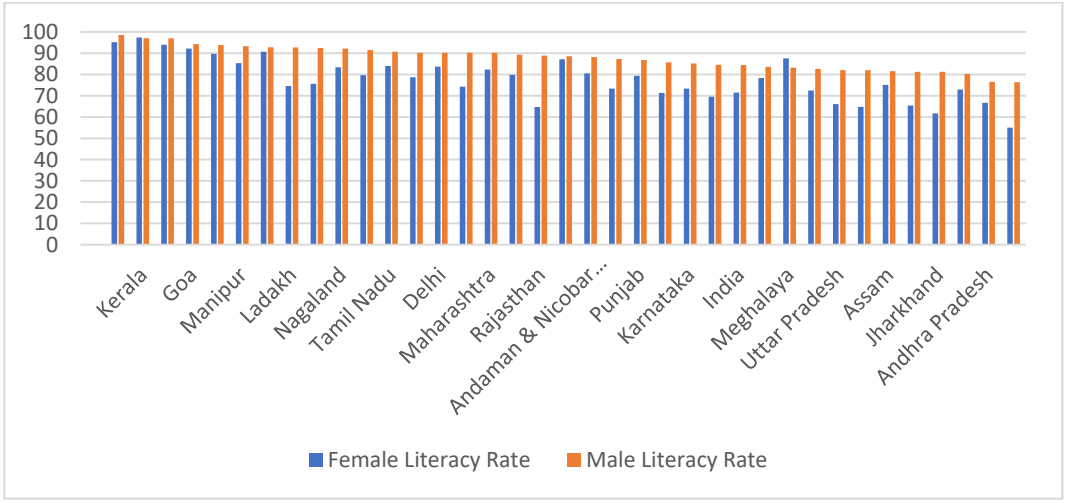


Figure 2: State/UT wise literacy rates by sex, 2019-21 arranged in descending order of male literacy rate

Source: Authors compilation from NFHS-5, 2019-21

Along with literacy rate, it is also important to see how many years of education people are attaining, as mere literacy will not attain the true purpose of education. Table 3 presents some relevant insights based on literacy, gender gap and median years of schooling attained in states and UTs using NFHS-5 data corresponding to 2019-21.

- At all-India level, median years of schooling are 7.3 for males and 4.9 for females, the lowest being 5 years and a mere 2 years for males and females respectively in Bihar.

- Largest gender gap is observed in Rajasthan, both for literacy rates as well as median years of schooling.

- Sixteen states show ranking in female literacy higher than male literacy indicating relatively higher levels of social progress and less prevalence of gender bias.

Table 3: Top and bottom performing States and UTs in literacy rate, NFHS-5 (2019-21)

Top 5 states/UTs	Top 5 states/UTs	States with male literacy rate less than national average	States with female literacy rate less than national average	States with gender gap greater than national average	States/UTS with higher ranking in female than male literacy outcome
Literacy Rate					
Male literacy rate	Female literacy rate	Male literacy rate	Female literacy rate	For Literacy rate	For Literacy rate
Lakshadweep (98.6%), Kerala (97.1%), Mizoram (97%), Goa (94%), Puducherry (89.7%)	Kerala (95.2%), Lakshadweep (95.2%), Mizoram (94%), Goa (92.2%), Himachal Pradesh (90.7%)	Bihar (76.4%), Andhra Pradesh (76.5%), West Bengal (80.2%), Jharkhand (81.3%), Madhya Pradesh (81.3%), Assam (81.6%), Telangana (82%), Uttar Pradesh (82%), Chhattisgarh (82.6%), Meghalaya (83.2%), Tripura (83.6%) India: 84.4%	Bihar (55%), Jharkhand (61.7%), Rajasthan (64.7%), Telangana (64.8%), Madhya Pradesh 65.4%), Uttar Pradesh (66.1%), Andhra Pradesh (66.7), Odisha (69.5%), Arunachal Pradesh (71.3%) India: 71.5%	Rajasthan (24.2), Bihar (21.4), Jharkhand (19.6), Ladakh (18.1), Telangana (17.2), Dadra and Nagar Haveli and Daman and Diu (16.9), J&K (15.9), Uttar Pradesh (15.9), Madhya Pradesh (15.9), Odisha (15.1), Arunachal Pradesh (14.4), Gujarat (13.9) India: 12.9	Kerala, Himachal Pradesh, Meghalaya, Sikkim, Tamil Nadu, Delhi, Nagaland, Maharashtra, Andaman & Nicobar Islands, Uttarakhand, Punjab, Tripura, Assam, West Bengal, Chhattisgarh, Andhra Pradesh
Median years of schooling					
Male median years of schooling	Female median years of schooling	Male median years of schooling	Female median years of schooling	For median years of schooling	For median years of schooling
Chandigarh (9.5), Goa (9.3), Delhi (9.2), Lakshadweep	Chandigarh (9.1), Goa (9.1), Kerala (9), Lakshadweep (8),	Bihar (5), Meghalaya (5), Andhra Pradesh (6.1),	Bihar (2), Jharkhand (3.4), Telangana	Rajasthan (3.3), Telangana (3.2), Bihar (3), Uttar Pradesh (2.9),	NIL

(9.1), Puducherry (9.1), Himachal Pradesh (9.1), Kerala (9)	Puducherry (7.9), Delhi (7.8), Himachal Pradesh (7.4)	Jharkhand (6.3), Assam (6.3), West Bengal (6.3), Arunachal Pradesh (6.5), Odisha (6.6), Madhya Pradesh (7), Tripura (7), Telangana (7.1), Chhattisgarh (7.1) India:7.3	(3.9), Rajasthan (4), Andhra Pradesh (4.3), Madhya Pradesh (4.3), Uttar Pradesh (4.3), Odisha (4.5), Chhattisgarh (4.6), Arunachal Pradesh (4.8) India: 4.9	Jharkhand (2.9), Madhya Pradesh (2.7), Chhattisgarh (2.5) India:2.4	

Source: Authors compilation from NFHS-5 data for 2019-21

4.3: Reasons for not attending school

At this point, it is worthwhile to look at reasons for not attending school as stated in NFHS- Rounds 2, 3, 4 and 5. The surveys asked a set of reasons which have been categorized for our present purposes into four categories- reasons related to child (repeated failure, got married), reasons related to household (cost too much, required for household work, further education not considered necessary, required for work on farm/family business, required for care of sibling, required for outside work for payment in cash or kind), reasons related to school (school too far, did not get admission, transport not available, not safe to send girls, no proper school facilities for girls, no female teacher) and child not interested in studies (Figure 3).

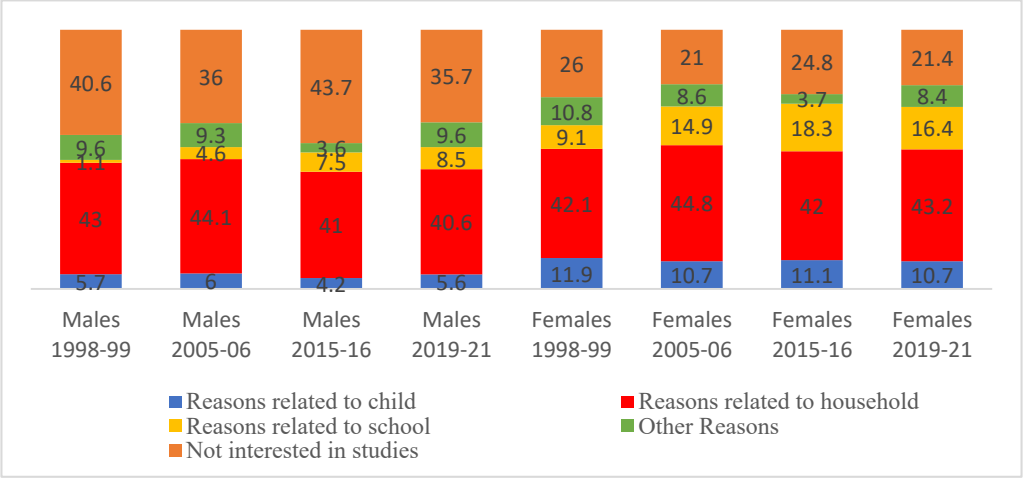


Figure 3: Reasons for not attending school by gender and NFHS Round

Source: Authors compilation from NFHS surveys for Rounds 2-5

Some observations are in order here. One, the household-related factors, the dominant reason for not attending school, are intrinsically the indicators of economic status. Two, the second dominant reason

is non-interest in studies, with the percentage being larger for males than females, although a downward trend is observed over the years for both sexes. It could hint at the poor learning environment in schools that fails to generate and retain the interest of young minds. Three, girls face another important issue of safety implying the role of law and order in education outcomes. In addition, several studies have pointed out that lack of adequate menstrual protection acts as a discouraging factor forcing young girls to drop out of school.

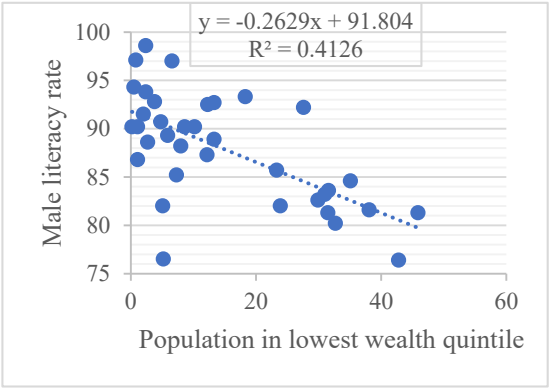
4.4 Socio-economic correlates of school education outcomes

We now explore the role of economic status and social identities on schooling outcomes. The NFHS provides information on percentage of households in different quintiles as per wealth score constructed based on asset ownership. For our purposes, we consider population percentage in the lowest wealth quintile. The social backgrounds considered here are religion and caste. The role of religion is examined using percentage of Hindu population and percentage of Muslim population in a state/UT. For caste, percentage of scheduled caste and percentage of scheduled tribe population are examined for literacy outcomes.

4.4.1 Economic Status

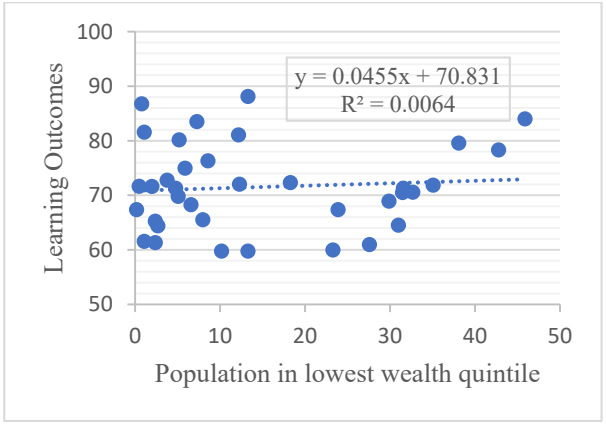
The percentage of population in lowest wealth quintile is observed to be inversely related with male literacy rate, female literacy rate and enrolment rate; positively related to dropout rate and has no significant correlation with learning outcomes (Figure 4).

Panel (a)



Panel (b)

Panel (c) Panel (d)



Panel (e)

Figure 4: Literacy rates, GER, Dropout rate and learning outcomes by household wealth

The economic factors seem to play an important role with literacy rates being lower in states with higher percentage of population in the lowest wealth quintile. This is also reflected in the household-level reasons stated for dropping out in various rounds of NFHS. There is a sizeable presence of private schools in many states/UTs that entail schooling fee. Large prevalence of paid tuition classes is observed in several states (Kingdon, 2017). Also, if school is far away, transport costs need to be incurred. In some states, free cycles are distributed to cut down on the costs. To illustrate further, according to ASER (Rural) 2022, enrolment of children age 6-14 years in government schools is observed to be highest in rural areas of West Bengal, Odisha, and Gujarat; and lowest in Manipur, Meghalaya, and Nagaland. The rural West Bengal, Bihar and Tripura have the largest percentage of children going for paid tuition classes (Table 4).

Table 4: Prevalence of government schools and paid tuition classes in rural areas, 2022 (arranged in descending order of former)

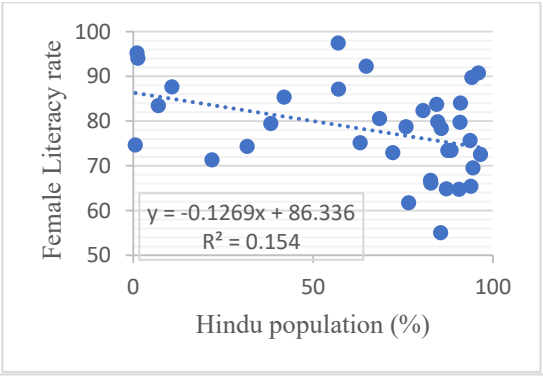
State	Percentage of children enrolled in government schools (age 6-14)	Percentage of children taking paid tuition classes
West Bengal	92.2	74.2
Odisha	92.1	53.6
Gujarat	90.9	9.6
Tripura	86.1	68.9
Jharkhand	83.3	45.3
Bihar	82.2	71.7
Chhattisgarh	81.6	5.2
Karnataka	76.3	9.2
Tamil Nadu	75.7	9.5
Sikkim	75.2	27.4
Assam	71.9	25.3
Andhra Pradesh	70.8	17.9
Telangana	70.1	6.3
Madhya Pradesh	70	15
Rajasthan	68.5	4.6
Maharashtra	67.4	15.1
Himachal Pradesh	66.3	9.7
Mizoram	64.6	9.2
Kerala	64.5	21.6
Arunachal Pradesh	62.2	26.6
Uttarakhand	61.5	21.1
Uttar Pradesh	59.6	23.7
Punjab	58.8	30.6

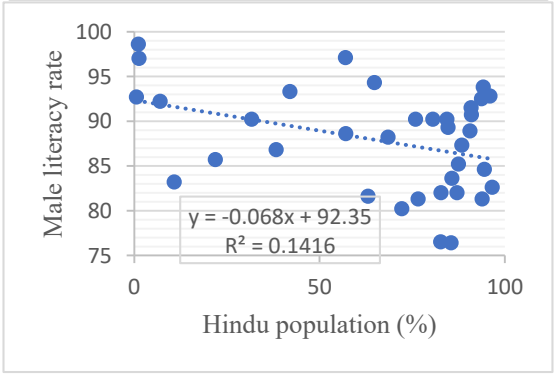
Jammu & Kashmir	55.5	13.8
Haryana	51.9	19.5
Nagaland	50.8	34.9
Meghalaya	43.7	20
Manipur	32.8	53.4

Source: ASER (Rural) 2022

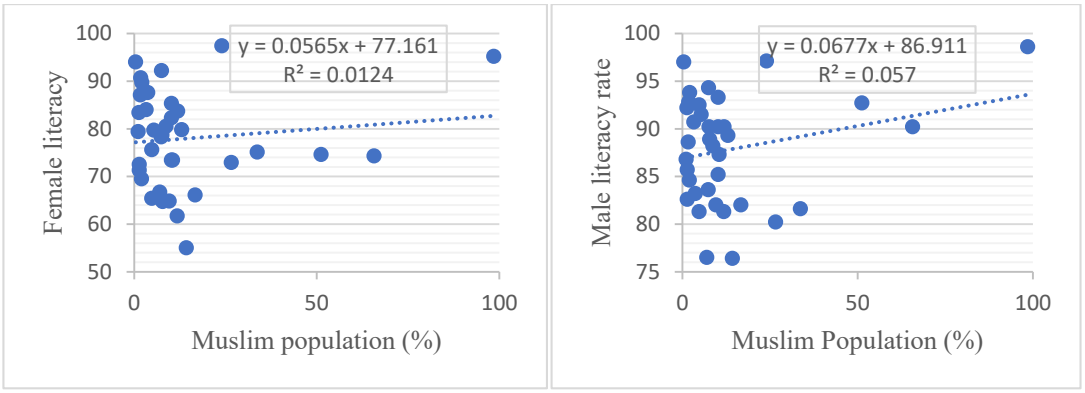
4.4.2 Religion

We now examine the relationship between religion and literacy rates by gender. Figure 5 shows the scatter plot of male and female literacy rates by percentage of Hindu population (Panels (a) and (b)) and Muslim population (Panels (c) and (d)). While percentage of Hindu population is found to be inversely related with literacy rates, presence of Muslim population is positively related with literacy rates of both males and females. Neither of the relationship is statistically significant as indicated by low R-squared. Several Muslim-dominated states/UTs such as Kerala, Assam, Jammu & Kashmir are doing well in literacy rates. Lakshadweep, that ranks first in male literacy and second in female literacy, has 97% of Muslim in its total population.





Panel (a) Panel (b)



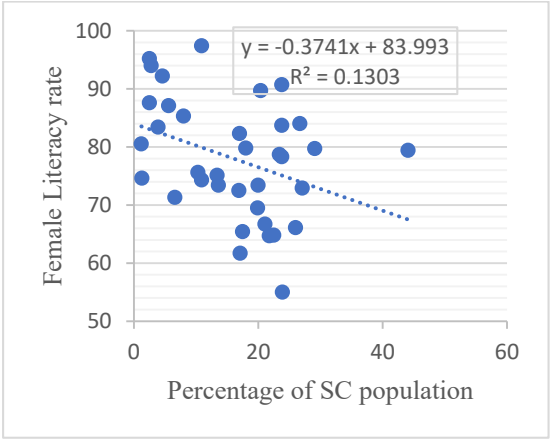
Panel (c) Panel (d)

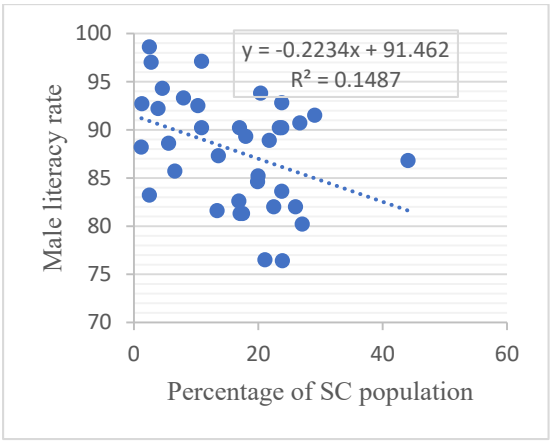
Figure 5: Male and Female Literacy rates by religion, NFHS-5

Source: Authors construction using NFHS-5 data

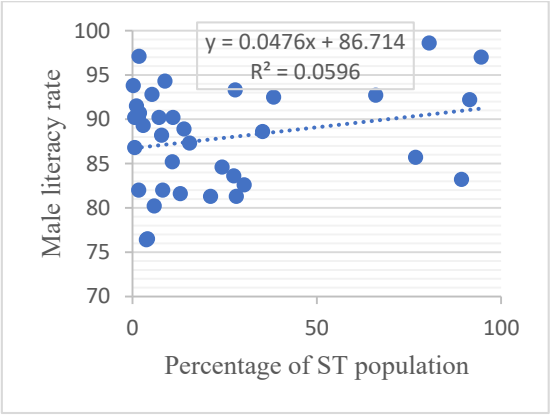
4.4.3 Caste

The percentage of scheduled caste (SC) population in the state/UT is inversely correlated with male as well as female literacy rates; whereas the percentage of scheduled tribe (ST) population is positively correlated with literacy rates. Neither of the castes have a significant association with literacy as indicated by low values of R-squared.

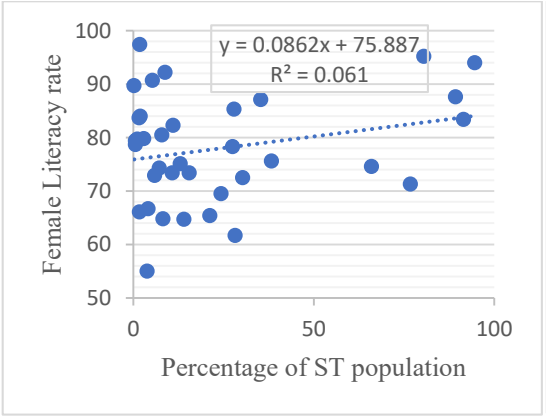




Panel (a)



Panel (b)



Panel (c)

Panel (d)

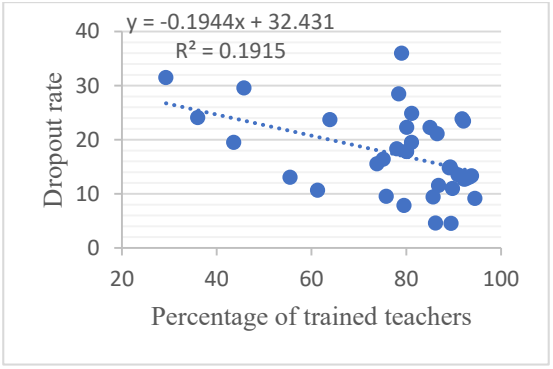
Figure 6: Male and Female Literacy rates by caste, NFHS-5

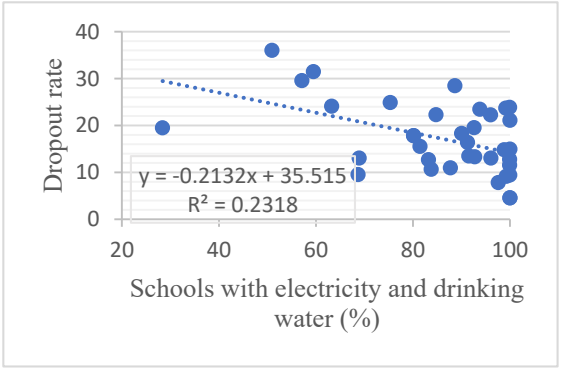
Source: Authors construction using NFHS-5 data

4.5 School infrastructure and learning environment as correlates of schooling outcomes

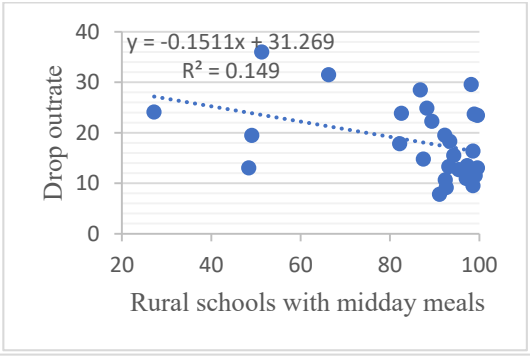
School facilities form an integral part of learning environment and impact dropout rate and learning proficiency. Higher the percentage of trained teachers, larger the percentage of schools with electricity & drinking water, and midday meals[8], lower is the observed dropout rate in the state/UT (Figure 7, Panel (a) to (c)). Panel (d) shows an inverse relationship between School Education Quality Index constructed by NITI Aayog (2019) and dropout rate. On the other hand, pupil teacher ratio has very low correlation with learning outcomes attainment (Figure 7, Panel (e)).

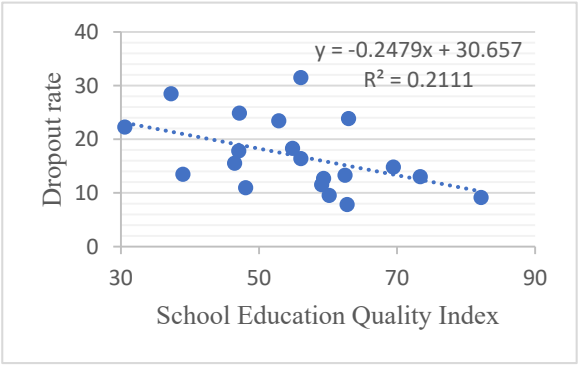
[8] The percentage of schools with mid-day meals pertains to rural schools only.



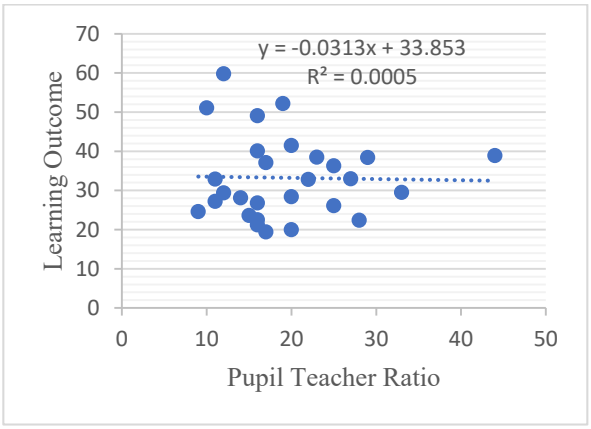


Panel (a) Panel (b)





Panel (c) Panel (d)



Panel (e)

Figure 7: Dropout rate and learning outcomes by school infrastructure and quality

Source: Authors construction using SDG data, NITI Aayog (Panel a-b and e); ASER (Rural) 2022 (Panel c); NITI Aayog (2019) (Panel d)

It is important to note that the use of ICT in education is still a distant dream in many states. The use of Computer-Aided Learning is found to be highest in Goa and Maharashtra followed by Chhattisgarh and Rajasthan; whereas lowest ICT use is observed in Bihar followed by Chandigarh and Mizoram.

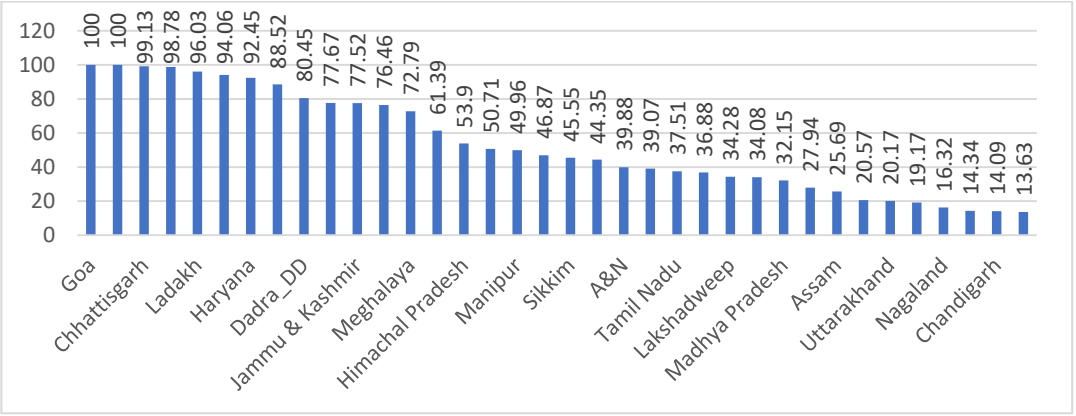


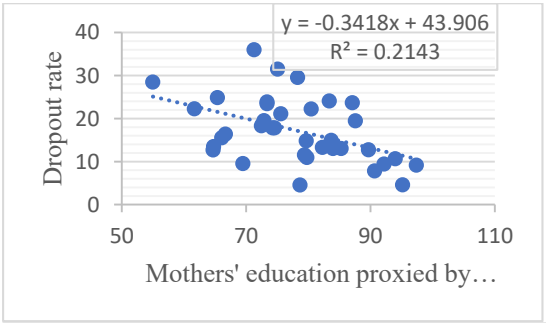
Figure 8: Percentage of schools with computer facilities

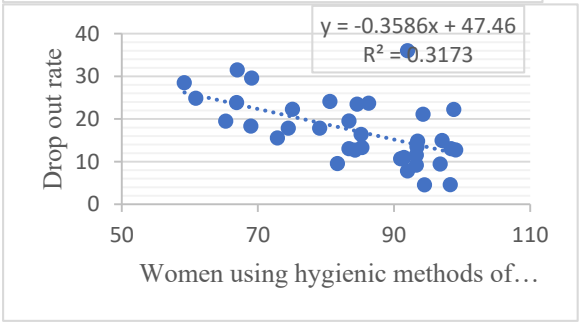
Source: Report on UDISE Plus 2020-21, GoI (2021)

4.6 Women empowerment

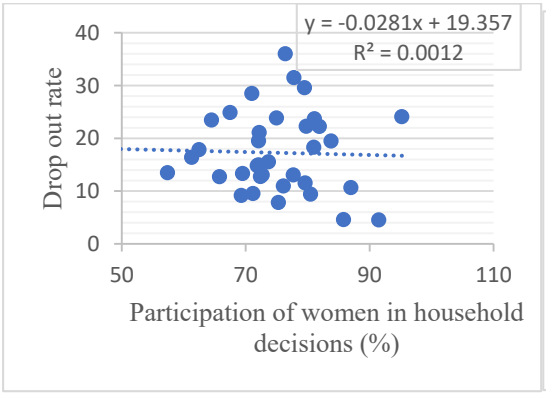
We take four indicators of women empowerment from NFHS-5 - mothers' education proxied by female literacy rate, percentage of young women age 15-24 using hygienic methods of menstrual protection, percentage of women participating in three household decisions (own health care, making major

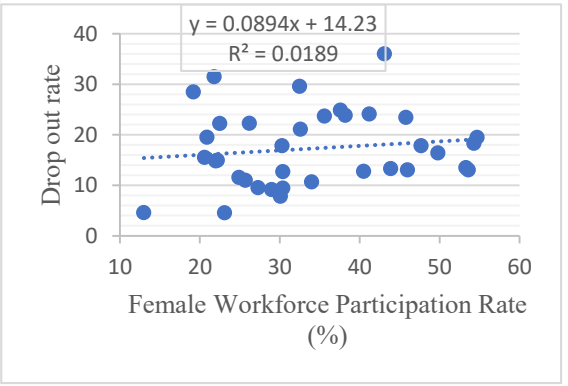
household purchases and visits to her family or relatives) and percentage of women who are working. Figure 9 shows that dropout rate is lower in states with higher mothers' literacy and higher use of hygienic methods of menstrual protection (Panel (a) and (b) respectively). However, women's participation in household decision-making and their work-status do not seem to have a significant impact on dropout rate (Panel (c) and (d) respectively).





Panel (a) Panel (b)





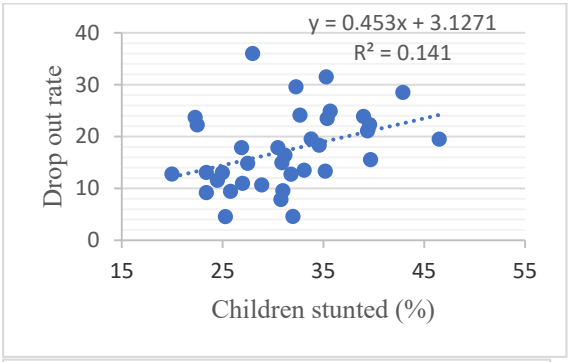
Panel (c) Panel (d)

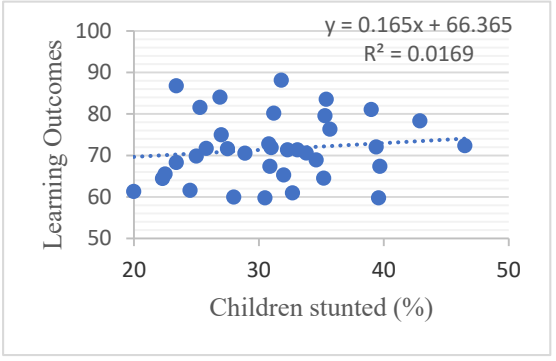
Figure 9: Dropout rate and Learning outcomes by women empowerment indicators

Source: Authors construction using NFHS-5 data and SDG data (NITI Aayog)

4.7 Child health

Child's health impacts cognitive abilities and hence the ability to perform well at school. We use the data from NFHS-5 on percentage of children (age under 5 years) categorized as malnourished if height-for-age lies below -2 standard deviation. Dropout rate is found to be lower in states/UTs with lower percentage of malnourished children, while malnourishment is not found to be correlated with achievement of learning outcomes (Figure 10, Panel (a) and (b) respectively).





Panel (a) Panel (b)

Figure 10: Dropout rate and Learning outcomes by percentage of children stunted

Source: Authors construction using NFHS-5 data and SDG data (NITI Aayog)

4.8 Regression results

The robust OLS regression results for the cross section of 36 states and UTs for the NFHS-5 period 2019-21 are presented in Table 5. The significant determinants of literacy rate are found to be economic status, SC population and women empowerment (Model A). Percentage of population in lowest wealth quintile turns out as a significant explanatory factor for gross enrolment ratio in all the three models, with a decrease of one percentage point contributing to an increase in GER in the range 0.52 to 0.75 percentage points. Additionally, school quality and women empowerment have a significant positive impact in Models B and C respectively. In Model D, child health has a positive but not significant impact on GER, its p-value being 0.104. The variables found significant are in line with existing literature (e.g. Narayanamoorthy and Kamble, 2003). However, unlike studies like Gouda and Sekher (2014), we do not find Muslim population as a significant determinant of school outcomes.

Table 5: Regression results

Dependent Variable	Literacy rate	GER at higher secondary		
	Model A	Model B	Model C	Model D
Percentage of population in lowest wealth quintile	-0.281*** (-3.503)	-0.523*** (-3.306)	-.725*** (-5.20)	-.559*** (-2.96)
Percentage of Scheduled Caste population	-0.250** (-2.299)	0.140 (0.718)	.180 (0.91)	.261 (1.21)
Percentage of Scheduled Tribes population	0.0344 (0.876)	-0.0321 (-0.459)	-.119* (-1.74)	-.028 (-0.34)
Percentage of Muslim population	0.0446 (1.010)	-0.0343 (-0.351)	.058 (0.61)	.0173 (0.13)
Participation of women in household decision-making	0.582*** (6.429)	--	.494*** (3.03)	--
School Education Quality Index	--	0.228* (2.017)	--	--
Percentage of children stunted	--	--	--	-.635 (-1.68)
Constant	44.42*** (5.552)	46.45*** (4.728)	27.857** (2.04)	79.014*** (8.02)
Observations	36	36	36	36
R-squared	0.681	0.569	0.596	0.5616
F	21.94	8.674	10.47	9.59
Prob > F	0.000	0.000	0.000	0.000

*** p<0.01, ** p<0.05, * p<0.1

5. DISCUSSION

India's literacy rate stands at 75% in 2020-21 with significant variation across states and union

territories. Economic status, social background, school infrastructure, and learning environment together with child health and women empowerment have an impact on school education outcomes. Important policy lessons that emerge from the above results are as follows.

One, there is a need to emphasize quality along with quantity. Policy must aim at not just improving enrolment rates and reducing dropouts thereby increasing literacy rates but also ensuring achievement of learning outcomes.

Two, economic stress seems to be an important barrier in getting an education. This issue requires two kinds of policies- uplifting household incomes and reducing education costs. Although government schools charge no fee and distribute free books and uniforms, there is still a cost involved in sending children to school. According to the Report on UDISE Plus (2020-21) (GoI, 2021), the number of government schools has been shrinking over the years. The reason largely is the union government's rationalization policy for schools that includes merger/closure policy of non-viable schools[9]. It should be taken care that rationalisation does not affect access and equity issues, particularly for females.

Three, policy must aim at inclusive education and reducing the role of social identities as a barrier to education.

Four, an improvement in education is difficult to achieve without addressing gender bias. To illustrate, Rajasthan with 17th rank in male literacy and 34th in female literacy among states/UTs of India shows the huge disadvantage young girls are in. Massive social campaigns and community talks need to be launched in states with sharp gender disparities to promote female education and helping it become the accepted social norm. The state of Bihar, on the other hand, occupies the lowest rank in male as well as female literacy implying systemic factors also at work. State-specific policies need to be designed considering the specific circumstances and challenges of the region.

Five, physical and human resources available in the schools play a very important role in achieving the desired goal of education. Good infrastructure ranging from library, playground, ICT, and science labs help well-trained teachers to engage students with academics better.

Six, women empowerment and child nourishment are important enabling factors in the process of improving schooling outcomes and can be strengthened through improved economic status as well as public campaigns.

These lessons offer valuable guidelines that can be used to formulate policies for improving school outcomes. State governments need to devise mechanisms to address these issues. A decentralised holistic approach with community outreach; regulation, and monitoring of both public and private schools by state governments; an increase in outlays for school education and specially targeted programmes for marginalised sections of society; the efficient operation of mid-day meals and Anganwadi schemes for women and children can improve the ecosystem for learning. The integration of vocational and skill development with general education at the school level is vital to enable skill building for students from an early age. Improving schooling outcomes also requires focus on the design of relevant curriculum and pedagogy that enables creativity and critical thinking in students. Greater funding for schools can enable the use of technology which is crucial to improving student learning outcomes and can help to enhance teacher development skills and make education more inclusive.

[9]https://www.education.gov.in/sites/upload_files/mhrd/files/Guidelines%20for%20Rationalization.pdf

6. CONCLUSION

The Right to Education Act was passed in India in 2009. Attainment of universal literacy levels is a target that needs to be prioritized on an urgent basis. Improvement of education outcomes begins with a positive environment at home and availability and access to well-functioning schools that parents can afford; and their ability and willingness to send their children to school. The willingness comes from the realization that education is important to lead a fulfilling life and the hope that it will help their children to lead better lives in their future. The ability requires financial resources as well as acceptability of diversity within the classroom as well as society. Educational institutions must have an enabling learning environment to promote attainment of desired proficiency. Women empowerment and child health need to be emphasized. Achieving India's development dream and upgrading our global ranking in education outcomes requires access to schools with good infrastructure, and a change in mindsets and social norms.

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An Analysis of the Role of UPI Payments in Advancing Financial Inclusion and Its Impact on Inflation in India

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Abstract

The UPI has revolutionized digital transactions in India, playing a crucial role in advancing financial inclusion and impacting India's economic growth. This study analyses the role of UPI in advancing financial inclusion in India and its impact on inflation. The research analyses the role of UPI payments in financial inclusion by analysing trends in online Payments over the period as well as analyses the impact of UPI transactions on Inflation using Multiple Linear Regression model. It is found that UPI is contributing positively towards financial inclusion in India, but it also has a positive impact on inflation. The findings highlight how digital payment systems like UPI are shaping the economic conditions of the country, suggesting that policymakers should consider these dynamics when formulating strategies to enhance financial inclusion and economic stability.

JEL Classification: E42, G21, E31, O33

Keywords: Financial Inclusion, UPI, Digital Payments, Mobile Banking, Inflation

INTRODUCTION

India launched the Digital India initiative in 2015, a transformative vision aimed at harnessing the power of technology to drive the country's economic growth, improve governance, and enhance the quality of life for its citizens. Digital India, as an umbrella scheme, provided the framework within which UPI was introduced in 2016, significantly contributing to the shift towards digital payment methods. Following the implementation of the Digital India initiative and the UPI, there has been a notable shift in India's Payment system. With the help of these initiatives, India has entered a period of unparalleled technological progress in the financial industry, resulting in a notable transition from traditional cash-based transactions to digital payment methods. The UPI technology unifies various banking functions, smooth fund routing, and merchant payments under one roof by enabling numerous bank accounts into a single mobile application (of any participating bank). Additionally, it supports "Peer to Peer" collection requests, which can be planned and funded according to convenience and necessity. The shift to cashless transactions is more than simply a convenience; it's a fundamental change in how economic transactions are conducted within the country.

This shift will have a significant effect on the Indian economy, impacting growth, stability, and financial inclusion. Some research indicates that mobile transactions may have a major impact on financial inclusion and inflation, even if the consequences of cashless transactions on the economy have not yet been thoroughly investigated. These studies demonstrate how the growth of mobile payments has the potential to influence inflation and enhance access to financial services, therefore influencing economic circumstances. The UPI revolution in India may have comparable impacts, increasing financial inclusion and affecting inflation.

The present study investigates the impact of the increase in UPI transactions, which is a crucial aspect of India's digital payment revolution, on financial inclusion and inflation. This research holds particular

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relevance in India because of its distinct economic conditions and its aggressive push towards a cashless society. Our objective is to offer significant perspectives on the continuous transformations in India's payment system by analysing the effects of UPI transactions on inflation and financial inclusion in the Indian setting. In order to help businesses, policymakers, and the public understand the consequences of UPI transactions for financial services accessibility and economic stability, this research aims to provide a comprehensive examination of how these two significant components of the economy are impacted by these transactions.

LITERATURE REVIEW

Recent studies highlight the significant influence of electronic payment systems on various economic variables across different countries. Reddy and Kumarasamy (2015) demonstrated that electronic payments impact inflation and economic growth in India, posing a concern for policymakers. Franciska and Sahayaselvi (2017) noted the rising trend of cashless transactions in India, predicting a future dominated by digital payments. Chaudhari et al. (2019) stressed the importance of rapid growth in digital payments to stabilize India's money supply and counteract inflation. Oyelami et al. (2020) finds that e-payments affect consumer spending in Nigeria, potentially boosting aggregate demand and economic growth. Titalessy (2020) provided evidence linking digital transactions with inflation fluctuations, indicating their crucial role in the economic landscape. Patnam and Yao (2020) suggested that the adoption of mobile payment technology can increase sales for micro and small enterprises by reducing transaction costs in India. Rahim (2021) found that electronic payments increase money circulation and impact inflation, particularly during the COVID-19 pandemic. Ghaith and Ghaith (2022) emphasized the necessity of e-payment systems for integrating into the global financial network and enhancing consumer behavior in Jordan. Carrière-Swallow et al. (2022) noted that mobile finance in India, akin to Kenya's financial inclusion, plays a very significant role in broadening financial access. Prabheesh et al. (2023) explored the effects of public debt and cashless transactions on inflation in emerging markets during the pandemic, finding significant impacts in specific sectors like energy and transport. Jain (2023) confirmed the link between cashless transactions and money supply, suggesting their potential to influence price levels. Mathur (2023) examined the UPI system, highlighting its rapid growth and substantial impact on India's GDP, further accelerated by the COVID-19 pandemic. Gbawae and Tonye (2023) observed a positive correlation between mobile banking and inflation, noting that cashless transactions could increase money velocity and prices. These findings underscore the complex interplay between digital transactions, money supply, and inflation across various economic contexts.

International organizations, including the IMF, World Bank, UNDP[10], and the World Economic Forum, have recognized the potential of mobile payment technology. Studies in Kenya by (Morawczynski and Pickens 2009) highlighted mobile finance's role in financial inclusion. Research by Vodafone Group, Vodacom Group, Safaricom, and the UNDP indicated that mobile financial services could positively impact GDP growth in developing markets by lowering costs and improving credit access. The World Economic Forum reported significant productivity and income growth in Kenya following mobile payment adoption. These insights from international studies further emphasize the transformative potential of digital and mobile payment systems in enhancing economic performance and financial inclusion globally.

RESEARCH GAPS

Despite the extensive research on electronic payment systems and their economic impact, there is a

[10] United Nations Development Programme. (2022, October 27). New research shows mobile finance can increase national GDP.

notable gap in understanding the specific effects of UPI transactions on inflation in India. Most studies have broadly focused on digital payments and their influence on economic variables like growth and consumer spending, but the direct relationship between UPI usage and inflation trends remains underexplored. Additionally, while some research highlights the impact of mobile payments on financial inclusion and economic performance, there is limited analysis of how UPI, as a unique and rapidly growing system, specifically affects inflationary pressures and Financial Inclusion in the Indian context. This study aims to fill these gaps by providing a focused examination of UPI transactions and their potential influence on inflation in India.

OBJECTIVE OF THE STUDY

I. Analyse UPI's impact on financial inclusion in India.

II. Accessing the role of UPI in financial Inclusion of various demographic groups in India.

III. Examine the relationship between UPI transactions and inflation in India, determining the strength and implications of this correlation using Multiple Linear Regression model.

RESEARCH METHODOLOGY

This study examines the impact of UPI transactions on financial inclusion and their subsequent influence on inflation in India using a quantitative research approach. Data were sourced from the Reserve Bank of India (RBI) and the National Payments Corporation of India (NPCI).

To capture the changing role of UPI in the Indian financial environment, data covering the period from April 2016 to March 2023 is analysed using a longitudinal research design. The study uses quarterly data, which results in a sample size of 28 quarters because monthly GDP data are not available. This timeline spans UPI's creation to its rise to prominence as a payment method. To match the GDP data, monthly UPI transaction data were transformed into quarterly data throughout the data cleaning procedure. Additionally, data on the bank rate from the RBI was used as a proxy in place of the interest rate.

The study investigates the relationship between UPI transactions and inflation using a multiple linear regression model (MLRM). The model is specified as follows:

$$Inflation_t = \beta_0 + \beta_1(\text{UPI Transactions})_t + \beta_2(\text{Interest Rate})_t + \beta_3(\text{GDP})_t + \varepsilon_t$$

Data were meticulously collected from authoritative and reliable sources, and the analysis was conducted using SPSS 16 software to ensure accuracy and precision. SPSS 16 was employed for regression analysis and descriptive statistics, enabling a detailed examination of the relationships between variables. The analysis includes diagnostic tests to verify the assumptions of the regression model and to ensure the validity and reliability of the results.

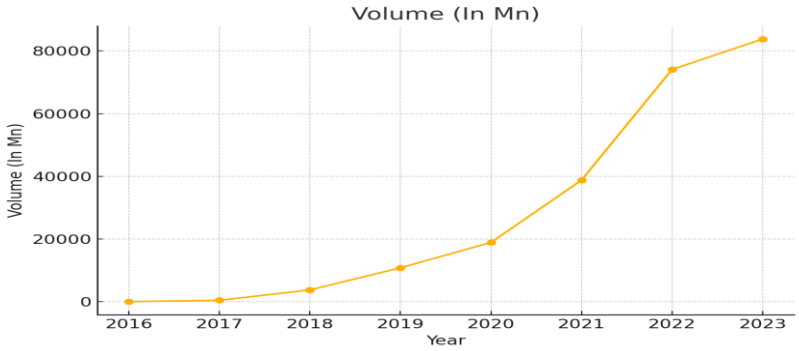
To measure financial inclusion in India, the study utilized The Global Findex database developed by the World Bank, providing a comprehensive assessment of trends and patterns in financial inclusion. This quantitative methodological framework allows the study to derive meaningful insights into the impact of UPI transactions on financial inclusion and inflation, contributing to the broader understanding of digital payments' role in shaping India's economic landscape.

UPI and Financial inclusion

National Informatics Center claims that UPI has grown significantly since its launch in 2016, largely

due to the National Payments Corporation of India (NPCI). This expansion is a result of UPI's growing contribution to improving financial inclusion in India by increasing accessibility to digital payments and encouraging greater economic engagement. The UPI journey in India is summarized here, along with YoY (year-over-year) growth data through January 2023:

Figure 1: Volume of UPI transactions in India



Source: National Informatics Centre

From 2017 to 2023, UPI transactions are expanding day by day, by the end of 2022 the total transaction value reached INR 125.95 trillion, comprising nearly 86% of India's GDP. The platform continued to expand in 2023 processing 83.75 billion transactions.

In India, there are over 70 UPI apps, with every bank integrating UPI transfers into their mobile applications. As of September 2023, 24 third-party UPI apps operate in India, with the most widely used ones having up to 100 million users.

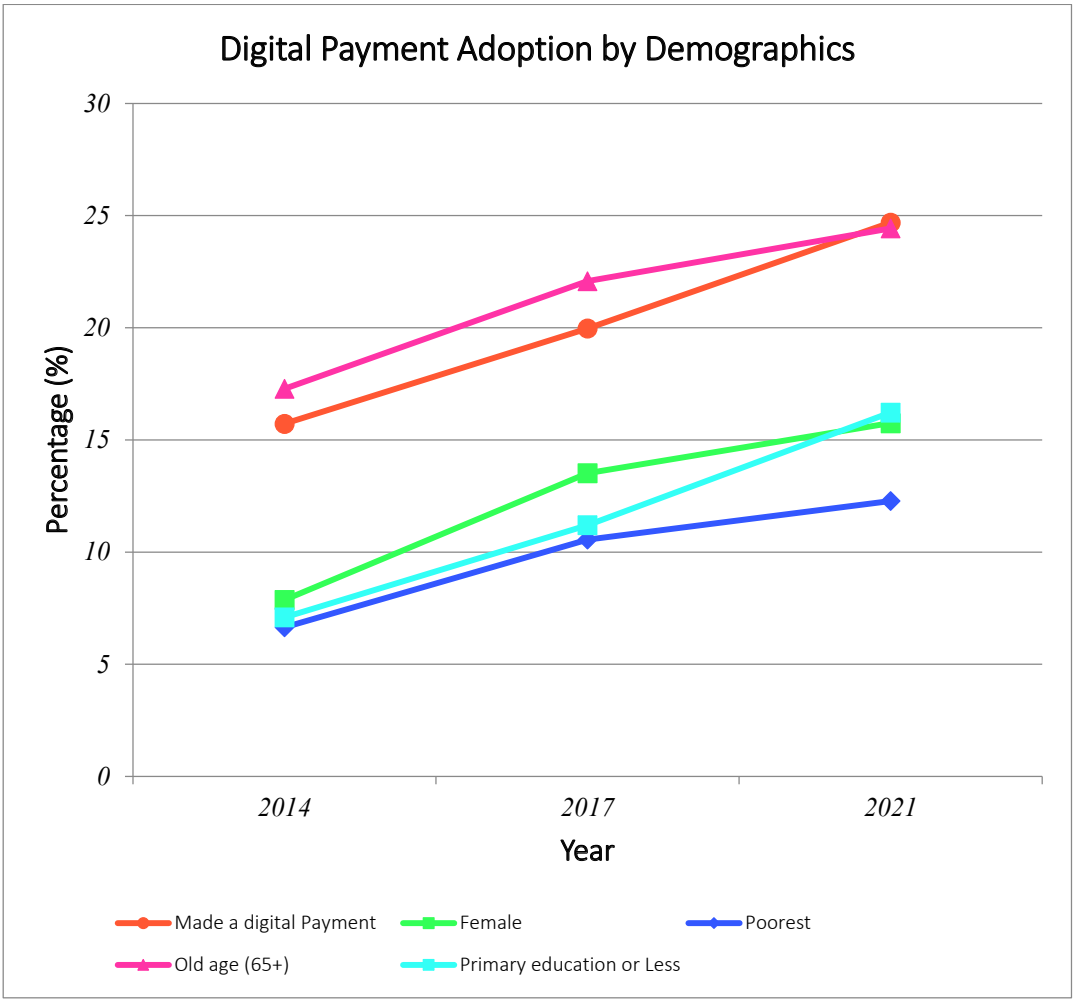
Table 1: Popular UPI apps and their transactions

UPI Apps	PSP banks	Total Transactions (Cr.)
PhonePe	ICICI, YES, AXIS	774,845.98
Google Pay	HDFC, SBI, AXIS, YES	541,624.06
Paytm	Paytm Payments Bank	176,865.46
BHIM UPI	NPCI	8,005.18

Source: NPCI

These figures demonstrate how UPI is being more and more widely used in India as a practical and safe digital transaction platform.

Figure 3: The Global Findex indicating Financial Inclusion in India



Source: World Bank

To measure financial inclusion in India, we utilized the World Bank's Global Findex database. The Global Findex is a comprehensive index that provides data on how adults make their financial decisions, offering a clear view of financial inclusion globally. It is considered one of the best indicators for measuring financial inclusion. The data presented below demonstrates the substantial increase in the adoption of digital payments from 2014 to 2021, highlighting the role of UPI in transforming the financial landscape for diverse demographic groups. Figure 3 above is derived from this index, providing a reliable representation of financial inclusion trends in India.

Role of UPI in Financial Inclusion of various demographic groups

I. **Overall Increase in Digital Payments:** The percentage of individuals making digital payments has increased from 15.72% in 2014 to 24.69% in 2021. This growth signifies a broad acceptance and integration of digital payments in daily transactions.

II. **Female Participation:** Female participation in digital payments has nearly doubled, from 7.87% in 2014 to 15.75% in 2021. This growth reflects improved access to financial services and digital literacy among women, contributing to greater financial empowerment.

III. **Poorest Sections:** Digital payment adoption among the poorest sections of society increased from 6.65% in 2014 to 12.28% in 2021. This increase demonstrates how digital payment platforms, including UPI, have made financial services more accessible to economically disadvantaged groups.

IV. **Elderly (65+ years):** The percentage of elderly individuals using digital payments rose from 17.28% in 2014 to 24.43% in 2021. This growth indicates that digital payment solutions have become more user-friendly and accessible, even for older populations who may have initially been resistant to adopting new technologies.

V. **Primary Education or Less:** Individuals with primary education or less have also shown a significant increase in digital payment usage, from 7.09% in 2014 to 16.22% in 2021. This rise highlights the role of digital payment initiatives in bridging the financial inclusion gap for less-educated individuals.

The data unequivocally shows that the adoption of digital payments by all segments of Indian society has been greatly impacted by the advent of UPI. The widespread nature of this financial revolution is highlighted by the notable rise in the use of digital payments among women, the lowest-income groups, the elderly, and those with low levels of education. The increasing prevalence of digital transactions in India has reinforced the overall financial inclusion, hence enhancing access to financial services for diverse societal sectors and fostering an inclusive economy.

UPI and Inflation

Based on the multiple linear regression analysis, the model constructed to analyze the relationship between inflation (dependent variable) and UPI transactions, interest rate, and GDP (independent variables) is presented as follows:

$$\text{Inflation}_t = \beta_0 + \beta_1(\text{UPI Transactions})_t + \beta_2(\text{Interest Rate})_t + \beta_3(\text{GDP})_t + \varepsilon_t$$

Furthermore, great care was taken to guarantee that the fundamental presumptions of multiple linear regression were fulfilled during the model's execution. To guarantee a linear relationship between the dependent and independent variables, linearity was verified. Tolerance and VIF values were used to test for multicollinearity; all values fell within acceptable bounds, suggesting that multicollinearity was not an issue for this model. Upon assessment, heteroscedasticity was determined to be negligible, implying that the variance of the errors remained consistent for all values of the independent variables. The thorough verification of assumptions improves the validity and dependability of the model's output.

Table 2: Correlations					
		INFLATION	**UPI**	**INTEREST_RATE**	**GDP**
Pearson Correlation	INFLATION	1.000	.607	-.539	.308
	UPI	.607	1.000	-.387	.758
	INTEREST_RATE	-.539	-.387	1.000	-.306
	GDP	.308	.758	-.306	1.000
Sig. (1-tailed)	INFLATION	.	.000	.002	.055
	UPI	.000	.	.021	.000
	INTEREST_RATE	.002	.021	.	.057
	GDP	.055	.000	.057	.
N	INFLATION	28	28	28	28
	UPI	28	28	28	28
	INTEREST_RATE	28	28	28	28
	GDP	28	28	28	28

Source: Compiled by author

The Pearson correlation matrix (Table 2) reveals significant relationships between the variables. UPI transactions ($r = 0.607$, $p < 0.001$) and GDP ($r = 0.308$, $p = 0.055$) are positively correlated with inflation, indicating that as UPI transactions and GDP increase, inflation tends to rise. Conversely, the interest rate shows a negative correlation with inflation ($r = -0.539$, $p = 0.002$), suggesting that higher interest rate is associated with lower inflation.

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.731[a]	.535	.477	1.092076435119E0	.535	9.203	3	24	.000

Source: Compiled by author

The model summary (Table 3) indicates that regression model explains 53.5% of the variance in inflation ($R^2 = 0.535$), which is statistically significant ($F(3, 24) = 9.203$, $p < 0.001$). The Adjusted R^2 value of 0.477 accounts for the number of predictors in the model, reinforcing the robustness of the findings. The standard error of the estimate is 1.092, reflecting the model's accuracy in predicting inflation values.

Table 4: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	32.928	3	10.976	9.203	.000
	Residual	28.623	24	1.193		
	Total	61.551	27			

Source: Compiled by author

The ANOVA results (Table 4) further support the model's significance, with the regression sum of squares (32.928) substantially higher than the residual sum of squares (28.623), leading to a significant F-statistic ($F = 9.203$, $p < 0.001$). This indicates that the model is a good fit for the data.

Table 5: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	11.522	3.072		3.750	.001	5.181	17.863					
	UPI	9.015 E-7	.000	.745	3.383	.002	.000	.000	.607	.568	.471	.399	2.505
	INTEREST_RATE	-.433	.180	-.363	-2.405	.024	-.804	-.061	-.539	-.441	-.335	.850	1.177
	GDP	-1.490 E-6	.000	-.368	-1.723	.098	.000	.000	.308	-.332	-.240	.426	2.350

Source: Compiled by author

The coefficients (Table 5) provide detailed insights into the impact of each predictor variable on inflation. The unstandardized coefficient for UPI transactions ($\beta 1 = 9.015E\text{-}7$, $p = 0.002$) is positive and statistically significant, suggesting that an increase in UPI transactions is associated with an increase in inflation. This finding is crucial as it highlights the inflationary pressure exerted by the growing usage of digital payments. The standardized coefficient (Beta = 0.745) further emphasizes the strong positive relationship between UPI transactions and inflation.

The interest rate ($\beta 2 = -0.433$, $p = 0.024$) shows a significant negative impact on inflation, indicating that higher rates of interest can help to curb inflation. GDP ($\beta 3 = -1.490E\text{-}6$, $p = 0.098$), although not statistically significant, shows a negative relationship with inflation in the model.

The analysis makes it very evident how UPI transactions affect inflation. The increasing prevalence of digital payment systems like UPI has brought about a greater significance for their impact on economic indicators like inflation. The strong and positive correlation between UPI transactions and inflation raises the possibility that the economy's inflationary pressures are a result of the quick uptake of digital payments. Money moves through the economy more swiftly as a result of UPI transactions, which is one of the main causes of this. An increase in the money supply as a result of this greater circulation may raise inflation. Therefore, while developing monetary policies and regulating digital payment networks, officials must take this into account.

CONCLUSION

Since its launch in 2016, the UPI has revolutionized digital payments in India, emerging as a key driver of financial inclusion. The exponential growth in UPI transactions reflects its role in making digital financial services accessible to diverse segments of society, including women, the economically disadvantaged, the elderly, and those with lower educational attainment. This widespread adoption demonstrates UPI's effectiveness in bridging financial gaps and fostering a more inclusive economy.

A significant correlation between UPI transactions and macroeconomic variables, specifically inflation, is also revealed by the investigation. According to the study, there is a strong and positive association between UPI transactions and inflation, suggesting that the explosive growth of digital payments could exacerbate inflationary pressures. This phenomenon can be linked to the higher money velocity made possible by UPI, which speeds up the flow of money throughout the economy and may increase the total money supply, which in turn fuels inflation.

Further, the regression analysis underscores the significance of GDP and interest rates alongside UPI transactions as determinants of inflation. The positive correlation between UPI transactions and inflation highlights the need for careful consideration by policymakers. While UPI's benefits in promoting financial inclusion and economic participation are substantial, its impact on inflation necessitates a balanced approach to regulation.

In summary, UPI has been instrumental in advancing financial inclusion in India, yet its influence on inflation requires careful monitoring. As digital payment systems continue to expand, policymakers must craft regulatory strategies that harness their benefits while safeguarding economic stability. Balancing the promotion of digital financial services with the need to manage inflationary pressures is crucial for sustaining economic growth and inclusivity.

Implications and Future Directions

This study reveals a significant impact of UPI transactions on inflation, highlighting the role of digital payments in shaping economic policies. For policymakers, UPI’s influence on money supply and inflation calls for integrating digital payment trends into monetary policy planning. For financial inclusion, targeted efforts are needed to ensure UPI benefits reach underserved populations, especially in rural areas.

Looking forward, further research can explore the long-term effects of UPI on inflation, particularly as digital payments grow. The impact on the informal sector and tax compliance needs deeper investigation. Additionally, comparative studies with other countries’ digital payment systems and analyzing UPI’s role in changing consumer behaviour and savings patterns would provide more insights into its broader economic consequences.

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Disaster Preparedness and Mitigation through Ham Radio; Opportunity and Scope, A Blueprint of India's Vision 2047: A Study in West Bengal

Suman Patra*

ABSTRACT

The world is becoming vulnerable day by day in different aspects, whether it is in the forms of natural disasters like floods, droughts, forest fires, Tsunami, cloudbursts, earthquakes, landslides, cyclones, heat waves and global warming etc. or it may be in the form of man-made disasters like carbon emission, atomic explosions and experiments of weapons and missiles etc. As a result, human life and civilisation become in danger whatever the disaster is. No matter how advanced our technology and science are, we are still helpless against the destructive forms of nature. So to cope with our nature we need to build infrastructure to survive natural calamities. As per Sustainable Development Goal (SDG) 13 'Climate Action', all countries need to strengthen their resilient and adaptive capacity to climate-related hazards and natural disasters. According to 'The National Policy on Disaster Management', disaster interrupts and destroys development progress which takes years to build up. A disaster is an event which hampers the normal activity of the world, as a result, loss of human as well as animal lives and damage to the infrastructure and environment. In terms of geographical dimensions of India, the Himalayan region is more prone to disasters like earthquakes, landslides and cloudbursts, while the coastal region and the plane lands are mostly affected by floods, cyclones and storms, droughts, heat waves etc.

That's why 'Crisis Communication' and 'Disaster Management Plan' become crucial. In disaster mitigation plans mass media plays an important role. But when all the front-line mainstream media and communication tools collapse in an emergency, HAM or amateur Radio gives oxygen to the communication system. Amateur Radio is emerging as a significant communication tool that establishes two-way communication with people. Amateur radio transmitters and receivers can be put temporarily in affected areas to use as they are wireless devices that can operate with a battery from anywhere. HAM radio has provided emergency and public service communication throughout its history. At times of crisis and natural disaster, amateur radio is used as a means of emergency communication when wireless systems, cell phone networks, and other traditional terrestrial means of communication fail. HAM radio is independent and it works smoothly when cellular telephone networks become overloaded. For example, RMS (Radio Mali Server) is used to send and receive emails with audio-video attachments and share GPS positioning reports with HAM call signs, even when the internet or mobile network is unavailable. In addition, amateur satellite radio services play an important role in disaster mitigation and relief support.

This research work is about crisis communication, disaster preparedness and risk management mitigation focusing on Sustainable Development Goal 13, 'Climate Action', and the use of HAM Radio communication during emergencies in West Bengal mostly in vulnerable places. The primary aim of this research work is to assess the usefulness of wireless amateur radio facilities as an alternative communication tool in the affected communities of disaster-affected areas and to get a detailed idea about the present status of Amateur Radio Communication in West Bengal.

Key Words: Crisis Communication, Disaster Mitigation Plan, Alternative Communication, HAM Radio, SDGs Goal 13 'Climate Action'

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1. INTRODUCTION

Sustainable Development Goal 13 states every country needs to take action to combat climate change and to develop a framework for disaster risk reduction. Communication plays an invaluable role in rescue, response and recovery activities. Media forges a bridge between the affected public and the rescuer organizations like 'National Disaster Response Force' (NDRF), 'State Disaster Response Force' (SDRF), Police Administrations, NGO's and other voluntary agencies to disseminate information to the public before, during and after crisis. HAM Radio has always been at the forefront whenever a disaster strikes, be it a flood, an earthquake, a cyclone or whatever kind of man-made or natural disaster it is. HAMs operate with the capabilities of modern equipment even in low battery powers from the fields where basic amenities do not exist. HAM Radio is internationally accepted as the 'Second line of emergency communication' and has proven its invaluable role in such crises. HAM Radio channelize emergency services to people all over the world by organizing 'on-the-air emergency medical traffic' and during natural calamities as well, when mainstream public or government communication fails.

1.1 HAM RADIO IN INDIA

The HAM radio started its journey in India as early as 1921. The pioneer Indian HAM late Amarendra Chandra Gooptu began his transmission in the year 1921. His call sign was 2JK. As no other HAM operator was there apart from him at that time, so his radio transmission was one-way traffic. In 1922 and 1924, two Indians joined the path, Mukul Bose and Loken Bose. After that two way of HAM radio contact among Indians started in 1922. Moreover, from 1923 onwards there were twenty British HAMs, operating from India. The first short-wave public broadcasting station was set up under the supervision of Dr. Matcalfe, (a leading radio amateur and was the Vice Chancellor of Mysore University). He with his team of radio amateurs set up an entertainment public broadcasting station in the year 1935 and became popular among the listeners from all over India. In 1939 Amateur radio licensing and operation was restricted and HAM radio equipment was banned by the authorities at the time of World War II. At the end of World War II. The authorities resumed issuing temporary amateur radio operator's licenses in 1946. In 1948, there were hardly fifty licensed HAMs, out of which few were active. In 1948, 'The Amateur Radio Club of India (ARCI)' was inaugurated in the School of Signals at Mhow. In May 1954, 'The Amateur Radio Society of India (ARSI)' was set up in New Delhi, moved from Mhow to Bombay and finally to Delhi. 'Indian Institute of HAMs (IIH)', was formed as a registered trust in the year 1993 for promoting Amateur radio in India and set another milestone. Since 1993, IIH has continuously conducted HAM radio training programmes for enthusiasts.

1.2 HAM RADIO IN WEST BENGAL

In West Bengal, HAM club radio started its journey at the beginning of the 1990s. West Bengal Radio Club was formed by Sri Ambarish Nag Biswas, a renowned licensed HAM operator and founder secretary of the club. It is a non-profit organization. The members of the club actively participate in Disaster Management as an Emergency Communication support for the Government. This club conduct various mock drills and helps to communicate in various disasters along with NDRF and SDRF teams. At present, there are near about 70 active members in the club. Every year a team of WBRC has taken part in Gangasagar Mela to help the West Bengal government since 1991. Apart from this club in West Bengal, there are near about 200 licensed HAM operators who are active individually or in groups.

1.3 PURPOSE OF USING HAM RADIO IN CRISIS COMMUNICATION

Amateur Radio or HAM radio is a wireless method of communication connecting individuals from every corner of the globe, irrespective of location or circumstances. Licensed operators use radios to

dashboard mounts and remote shacks to communicate with other HAMs across the globe and worldwide. HAM radio operators come from many backgrounds, professions, nationalities and income levels. HAM radio operators can use their equipment to talk to fellow enthusiasts worldwide, engage in emergency communications during disasters when other forms of communication are unavailable, provide assistance in public service broadcasting, participate in contests and experiments new technologies. In emergency communication, HAM radio plays a vital role by providing reliable communication when other networks stop. They assist during natural disasters, severe weather events and other emergencies, often serving as a lifeline for affected communities. HAM radio operators can communicate through amateur radio satellites orbiting the Earth. Satellite communications provide a unique and exciting aspect of the hobby, allowing contacts over long distances via these satellites.

2. OBJECTIVES

Any country in this world want to make sure of achieving economic development, ensuring a decent living for its people and to build a strong adaptability cum strategy to combat against the climate change and environmental degradation. According to SDG's goal 13 'Climate Action' all countries must strengthen resilience and adaptive capacity to climate related hazards and natural disasters. The countries need to improve their people's education, awareness-raising programmes, and institutional and human resource capacity on climate change mitigation, adaptation, impact reduction and early warning as well as monitoring systems. Communications at times of emergencies perform a wide range of measures and preparedness to manage risks to communities and the environment. Amateur radio possesses a vast potential to serve as an alternative communication channel when mainstream channels break down during a disaster. In this proposed research work, there are some important aims and objectives to understand the uses and impacts of HAMs during natural calamities and emergencies. The primary aims are the following-

i) To know the status and scope of HAM radio as the second line of communication in disaster mitigation plans in West Bengal.

ii) To study about the HAM operators in West Bengal and their infrastructure and communicational equipment.

iii) To know the status of SDGs one of the major goals is to ensure disaster risk management preparedness and strengthen resilience and adaptive capacity to climate-related disasters in the state.

iv) To understand the problems or obstacles of imparting HAM radio communication training to the people of vulnerable areas as well as for the common people as life skill education.

v) To suggest appropriate remedial measures to make effective use of HAM radio services in an emergency.

3. RESEARCH QUESTIONS

HAM radio has provided emergency and public service communication throughout its history. At times of crisis and natural disaster, amateur radio is used as a means of emergency communication when wireless systems, cell phone networks, and other traditional terrestrial means of communication fail. HAM radio is independent and it works smoothly when cellular telephone networks become overloaded. For example, RMS (Radio Mali Server) is used to send and receive emails with audio-video attachments and share GPS positioning reports with HAM call signs, even when the internet or mobile network is unavailable. In addition, amateur satellite radio services play an important role in disaster mitigation and relief support. So, in this proposed research work some important questions are

formulated to examine the existing scenario of HAM radio operators as well as their communication strategies during the crises in West Bengal. These questions are the following-

i) How many HAM radio operators exist in West Bengal and what type of work do they usually perform in any kind of crisis?

ii) Does HAM radio play an important role in disseminating the information to the affected people of crisis and how it works?

iii) What are the initiatives taken by both Central and State Governments financially to popularise the HAM radio operations?

iv) What are the difficulties still have that needs to improve for the betterment and popularization of HAM radio operation?

4. SIGNIFICANCE

This research is focusing on the alternative communication system as a needful requirement to communicate with the affected people in the disaster situation. As per the guidelines of SDG's Goal 13; Climate Action, all the countries should promote mechanisms for raising capacity for effective climate change-related planning, management and hazard mitigation. This research will show the effectiveness of the HAM radio as an alternative medium of communication in crisis conditions. Besides this observation, the research will show the awareness and knowledge of HAM radio utilization among the students as well as the common people. The research will also address the financial aspects of HAM radio operation by the NGOs and the different HAM radio clubs. The research will examine whether is there any communication gap that exists between the government and the HAM radio operators during hazard mitigation and rescue operations. The observations and suggestions of this research will help the academicians, policymakers and the government to analyse and understand the role and importance of HAM radio during crisis communication so that they can use this HAM communication system in disaster preparedness and mitigation plans as stated in one of SDGs goal on Climate Change.

5. LITERATURE REVIEW

Sudhakaran, C. (2020). A Novel Approach to Maximize Coverage and Re-Establish Connectivity in Cognitive Radio Ad-hoc Based Emergency Communication [Doctoral Dissertation, Anna University] Anna University Research Repository.

In this research paper researcher shows both the man-made and natural disasters are discussed. Disasters like fires, floods, droughts, earthquakes, tsunamis and cyclones are categorized here as natural disasters and war, terrorist attacks as well as chemical-biological-radiological and nuclear crises and aeroplane crashes have been shown as man-made disasters. Whatever the disaster is the significant impact comes usually as the form of the malfunction of the conventional communication network. Communication infrastructures became damaged by disasters or interruptions in connectivity.

Pandya, J. M. (2013). Decision Support System for Disaster Management [Doctoral Dissertation, Kadi Sarva Vishwavidyalaya, Gandhinagar] Kadi Sarva Vishwavidyalaya Research Repository.

In this research work the researcher presented different forms of natural hazards, their causes and their effects on civilization. Next, he vividly described Remote Sensing (RS) Technology and its uses to restrict disaster management functions. How RS can be used in different ways to alert before a natural disaster comes and with the pictures and relevant data he showed how it could be effective and

efficiently work in the disaster management plan. He vividly describes on Gama Ray Spectrometer, Aerial Camera, video camera, multi-spectral scanner etc. equipment to support disaster management plan.

Kaul, I. (2021). Disaster Management in India: A Case Study of Jammu & Kashmir [Doctoral Dissertation, Punjab University], Punjab University Research Repository.

In this paper, the researcher showed the policy structure and operational aspects of the disaster management plan in Jammu & Kashmir. In her work, he narrates different laws regarding disasters in India like, the 'Disaster Management Act, of 2005', 'The National Policy on Disaster Management, of 2009', 'The Jammu & Kashmir State Disaster Management Policy 2017' and 'The J&K State Disaster Management Plan, of 2017'. The role of stakeholders (Local Bodies, NGOs/CBOs, Media, and Police & Armed Forces) was also vividly discussed here in detail. The study revealed that 'there is a gap between the Disaster Management Act, 2005 and its implementation in J&K. The Act is not understood in its true spirit as it is poorly implemented due to lack of human & financial resources. Poor coordination, communication & attitudinal problems of Disaster Management Officials adversely affected the implementation of the Act.' (Kaul, I, 2021). Not only that, 'there is a lack of people's participation and stakeholders in policy making and implementation' (Kaul, I, 2021). In her research, he found, that the role of armed forces and police in relief operations is admirable but lack of specific training, specialized personnel and equipment hampers their role in disaster management. She suggested that 'effective disaster management needs holistic policy, institutional mechanism, coordination, involvement of civil society. Awareness among people and training to the communities in disaster management is a prime need to deal with the disasters in the State. Disaster Management in J&K can be made more efficient by effectively utilizing the ICT applications.' (Kaul, I, 2021).

Chanda, S. (2002) Management of Natural Disasters: A Case Study of Bangladesh [Doctoral Dissertation, Jawaharlal Nehru University], Jawaharlal Nehru University Research Repository.

In her research work, the researcher describes the geographical domain of Bangladesh and the related natural hazards faced by the country over the period, especially in the coastal region almost in every year super cyclonic storms destroy thousands of villages, homes agricultural lands, and civilization. The reasons behind those natural calamities have been discussed in detail by the researcher with data and supportive documents. The role of the disaster management department of Bangladesh and its communication gap, and collaborative mismanagement have come out of her research. She also suggested some remedial to cope with these hazards.

Giri, D. (2019) Analysing the Role of Mass Media in Disaster Management in India [Doctoral Dissertation, Amity University], Amity University Research Repository.

In this research paper the researcher firstly narrates different major natural disaster accidents happened in our country and the role of different stake holders of disaster mitigation plan. He then discussed different aspects of natural disaster. Its causes, factors and characteristics. Next he describes the role of different disaster mitigation and planning agencies, the role of mass media in disseminating information, and cooperation between govt. and state agencies. The role of media and its uses are vividly described with proper data and supportive documents.

Singla, A. (2022) Knowledge Management of Social Media Data for Disaster Management [Doctoral Dissertation, Indian Institute of Technology] Indian Institute of Technology Research Repository.

In this research work the researcher discussed the role of social media as an alternative way to

conventional media, the different natural hazards and their stages, preparedness planning and programme using social media platforms and web-based smart management systems for disaster mitigation plans in four parts of the thesis. The researcher describes and gives a few examples of natural disasters and shows the role of social media in awareness and preparedness programmes.

Mahalakshmi S. (2020) A Study on Media Use, Information Seeking Behaviour and Disaster Preparedness in Tamil Nadu [Doctoral Dissertation, Anna University] Anna University Research Repository.

In this research paper, the researcher showed the role of media in disseminating information before, during and after natural disasters. As Tamil Nadu covers a major portion of the coastal region, so calamities like floods, cyclones etc. usually happen in the state. So the role of media becomes very crucial to aware the people aware, give them proper information, alert them before hazards come and also to maintain good communication and cooperation with the state emergency agencies and national agencies. Overall she vividly describes the role of media with proper examples and data with graphical representation. The role of National and international agencies in reducing the devastating impact on the citizens and civilization is also discussed here with reference.

L, Brigitte. (2000). Disaster through a Different Lenses; Behind Every Effect, There is a Cause. United Nation Press

In this book, almost all the aspects of natural hazards are discussed with the cause and effects. The role of media before, during and after the crisis has described here with examples. How media could be used to give proper training and to aware people are vividly described here. The role of journalists and the source of information during the calamities have been discussed here. Here are four examples of natural hazards which caused huge destruction to civilization and caused a large number of life loss.

Spence, P., Edward, A., & Lachlan, K. (2022). 'We Interrupt This Programme, This is an Emergency; Revisiting the Role of Radio in a Crisis- 'Journal of Radio & Audio Media', Routledge Publication. January 2022. https://doi.org/10.1080/19376529. 2021.2023539

This research article shows that during crises and emergencies, radio stations mostly work in the public interest through the dissemination of critical information. The research was done to assess preparedness and perception-making in crises. This research has shown that radio is a preferred medium in instances characterized as disasters. Though the medium is underrepresented in many areas of research this research study highlights that radio plays an important role in disaster and crisis management and is a key platform for reaching at-risk audiences.

Edwards, L. (1994). The Utilization of Amateur Radio in Disaster Communications. Journal 'Digital Commons', University of Florida. USA, FMHI Publication. https://digitalcommons.usf.edu/fmhi_pub/59

According to this article, 'the use of amateur radio is inevitable as a provider of supplemental communications for disaster relief and disaster control agencies. Amateur radio operators, or hams are professionally skilled communicators willing and able to volunteer their time and equipment for emergencies.'(Edwards, L. (1994). They are professionally skilled and with additional frequencies, it makes sense to plan for and include them in disaster training and preparation and to use them when disaster strikes. This paper has a few segments where it has been shown how the HAM radio with the help of satellite systems and communication and wireless technology helps in disaster mitigation plans.

Apart from the above literature reviews some other journals on 'disaster management and mitigation

plan' have been studied, and different webinars on HAM radio and disaster management also helped to get the idea and information on crisis management plan and mitigation. These are-

i) 'Disaster & Development- Journal of the National Institute of Disaster Management', New Delhi

ii) A Study of Amateur Radio Innovations for Disaster Medicine- Journal of Emerging Technologies and Innovative Research.

iii) Webinar Report on 'Role of Radio in Disaster Communication and Information'- organized by 'National Institute of Disaster Management', 'West Bengal Radio Club' & 'Indian Academy of Communication and Disaster Management'.

iv) Webinar Report on 'Role of HAM Radio Communication during Emergencies'- organized by National Institute of Disaster Management, New Delhi.

6. RESEARCH METHODOLOGY

It is a Mixed-Method research, both qualitative and quantitative. This research work is based on both the primary and the secondary data. The primary data has been collected by the survey method (questionnaire) of seventy (70) respondents among the students, professionals and service persons to know their knowledge on HAM radio and disaster preparedness. Apart from that an in-depth interview has conducted of a professional HAM radio operator to understand the current status and scope of HAM radio for disaster mitigation management and preparedness in West Bengal.

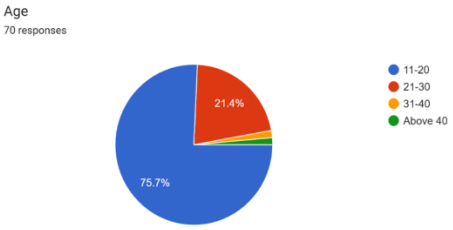
Secondary data has been collected from the related books, journals, news reports, magazines and from concerned institutional records.

DATA COLLECTION

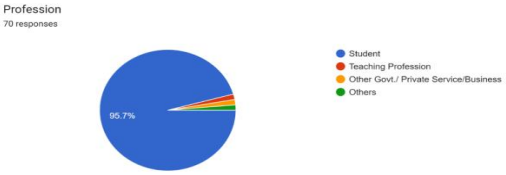
6.1 Survey (Questionnaire)

A survey has been conducted among students, professionals and other business persons to know the idea, knowledge and their views on HAM radio uses in disaster management mitigation in our state. The questions were framed to get answers to a few questions like, whether are they aware of HAM radio or not, do they want disaster management plans should be included in school or college-level syllabus or not etc.

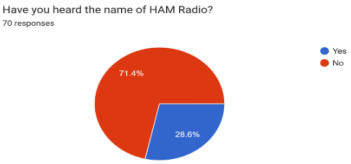
Q.1 This is regarding their age.



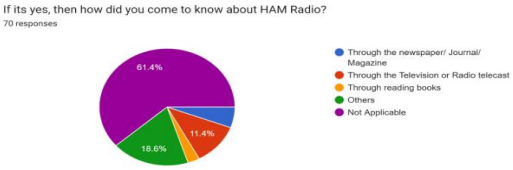
Q.2 The question was about their profession.



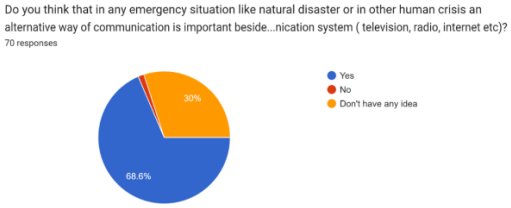
Q.3 Have you heard the name of HAM Radio?



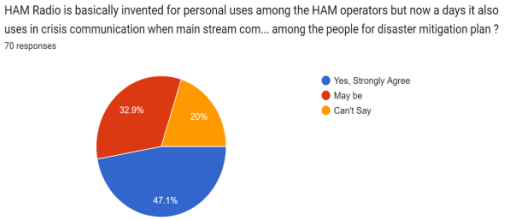
Q.4 if its yes, then how did you come to know about HAM Radio?



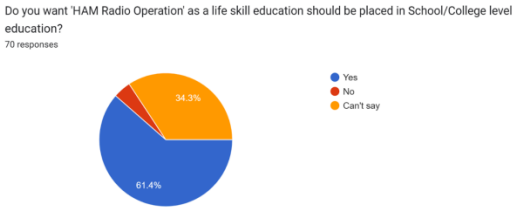
Q.5 Do you think that in an emergency like a natural disaster or another human crisis, an alternative way of communication is important besides mainstream communication systems (television, radio, internet etc.)?



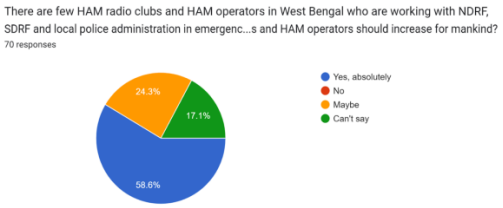
Q.6 The HAM radio was invented for personal uses among the HAM operators but nowadays it is also used in crisis communication when mainstream communication can't work. Do you think HAM radio must be popularised among the people for disaster mitigation plans?



Q.7 Do you want "HAM Radio Operation" as a life skill education should be placed in School/College level education?



Q.8 There are a few HAM radio clubs and HAM operators in West Bengal who are working with NDRF, SDRF and local police administration in emergencies like floods, cyclones, landslides, missing person rescue operations etc. Do you think the number of HAM radio organizations and HAM operators should increase for mankind?



Q.9 This open-ended question was asked to know the responder's view, perception and suggestions regarding HAM radio. Your observation about HAM Radio operation or uses.

Answers:

There are mixed reactions regarding the answers to the questionnaire. Most of the respondents said they hadn't heard about HAM radio before. So they did not have any idea regarding the operations and effectiveness of HAMs. Apart from that, some positive answers have also come from the respondents. Some of those are-

i) 'Hams can operate from just above the AM broadcast band to the microwave region.

A strong initiative must be taken by all the educational institutions into making us aware of its utility and operation as a life skill asset.'

ii) 'HAM radio will remain crucial in the future due to its role in providing reliable communication during disasters when other systems fail. Its ability to facilitate global connections and support community events will continue to be valuable.'

iii) 'I think during the crisis it can be a good alternative to the mainstream media. Because in many places during the crisis, there's no electricity. So people can communicate through HAM Radio.'

iv) 'It is beneficial for the common public. Therefore, it must serve its purpose honestly and diligently.'

v) 'HAM Radio is very useful as with its help we can communicate with others across the world and even in places where cell phones don't work and it also helps a lot during disasters.'

vi) 'This is the first time I have heard about it. And I think it will be helpful in case of emergencies when mainstream operating systems cannot be accessed. It's very helpful and it should be placed in school as a subject.'

vii) 'I have heard about the HAM Radio operation for the first time so I do not have a lot of knowledge about it but I think it should be popularized for communication as a good alternative of mainstream communication systems.'

viii) 'According to me, more people must be educated about HAM Radio and there must be more frequent advertisements about it. So that disastrous or other such alerts are well received by the people as HAM Radio plays a really good role at such times.'

6.2 Interview

An in-depth interview has been conducted with Sri Ambarish Nag Biswas, a pioneer HAM operator, and the Founder & Secretary of 'West Bengal Ham Radio Club'. Some questions were asked to him to know the opportunities, current status, scope and different challenges of HAM radio operations in West Bengal.

Q.1 Sir, tell me about the beginning of this journey with HAM radio.

Ans. In my childhood, I was mainly involved in computer teaching and training. Besides, I had a good relationship with the police administration for various reasons. Later, after my mother passed away when I was very depressed, an IPS officer gave me a CD of a movie and told me to watch the movie to make my mind better. Although, I don't remember the name of the movie at this moment. But after watching the movie, I didn't like it because I saw some ordinary citizens trying to stop the war using wireless radios. I knew this wireless radio could only be used by army personnel and police administration. Then the officer said to me, that's why I asked you to watch the movie as you know the technical field, you will understand it very well. He added the radio used in the movie was called Amateur radio. It can be used by any common citizen apart from the army or police. But before using it, you have to take a license for which you have to pass an exam. In every country, the central government conducts the exam and issues the license who qualify for the exam. In our country, the Ministry of Information and Broadcasting takes this exam. At that time, the exam was conducted for four types of 'Category or Grade' and exam questions were the broad type, but now this exam is conducted for only two types of 'Category or Grade', that is 'General and Restricted Grade' and the questions are becoming multiple choice type.

I had no idea or experience with the syllabus or pattern of this exam. I didn't have any good books or notes to study. Anyway, I passed the exam and got the license in four attempts. I had no idea what to do with the license. Then the internet social media or any other virtual communication were not that advanced, so I couldn't know if there were any work on HAM radio in other states. There were some senior HAMs in our state at that time but most of them did not want this amateur radio communication to spread among the masses. They were very proud of getting this HAM license. They considered themselves elite from the masses and exuded an air of arrogance. This matter struck me very much and then I decided to spread its use among the common people. My struggle started about thirty to thirty-two years ago. Then I prepared a team from my neighbouring with the so-called naughty boys who mainly dropped out of schools, smoked and drank, hung out at clubs, wasted time and no one respected them. I slowly built this team myself, trained them, and helped them to get their HAM license. I inspired them so that they could benefit society and common people by using HAM radio.

Gradually we reached the common people with this team. Explained to them the importance of radio in any natural calamity or any other emergency. Slowly our work reached people, and got their appreciation. Many other people joined us in this work, some were doctors, some were teachers, some were businessmen and some were labourers. In all this, we went to the Gangasagar Fair (the second largest religious fair in our country after 'Kumbh Mela') in the south 24 Pargana district of West Bengal and got the opportunity to work with the police administration. At first, the government did not recognize our work, but slowly they realised the importance of HAM radio.

Q.2 Why is the HAM radio still invaluable in this internet-based digital age? What's your opinion?

Ans. I think science that doesn't serve people or alienates people should be 'thrown down the drain'. So, from the very beginning, my intention was very clear that I would use this HAM radio for mankind, for the benefit of society. So, now when I hear the importance of HAM radio in the mouth of a Union Minister at a HAM FEST (a conference cum workshop organize annually by the HAM clubs and HAM operators of the country) and when he says every village in the country needs a HAM radio station, then I felt very proud of myself. The government of India gave us the license to use HAM radio mainly to give training to others, experimenting and upgrading the devices. However, I believe it is a medium that can be used to stand by common people in any natural disaster. From the work of election to tracing the home address of a missing person, in floods, storms, cyclones or in any accidental place which comes under a Mobile Shadow Zone (MSZ), where mobile networks or signals don't work, even we can use our HAM network smoothly. In natural disasters and rescue operations when all networks stop working, we assist NDRF, SDRF and local police with our HAM radio signals and set a bridge of communication between the affected people and rescue team.

Neither in International HAM radio policy nor our country's HAM radio guidelines for licensing states that HAM radio operators must be involved in emergency communication. But I think it's our basic duty to serve the people and serve the nation in any crisis when needed and HAM is the only communication tool which stands alone in any emergency when other networks fail.

Q.3 At present how many HAM clubs are actively operating in our state?

Ans. At present, there are two or three clubs in West Bengal apart from us as far as I know but how active they are I cannot say. By looking at the media coverage, you will understand that we always rush to be by the side of people in various natural disasters. There are some HAM operators, who give training and conduct workshops for financial benefit, but we don't do that.

Q.4 Is there any political pressure or involvement you felt to run this radio club and does your club gets any financial support from government or any private institutions?

Ans. First, let's say that our club is completely non-political. No leader of any political party is directly or indirectly involved or associated with our club. We work for people only, so we don't want our club to have any political colour. However some HAM operators do not respect our work, they think there is an economic benefit behind it. But, indeed, our organization doesn't get any financial help either from the state or central government. We do all our expenses with our own pocket money.

Q.5 In your opinion, what about the awareness among the people regarding HAM radio as well as disaster management plans?

Ans. To be honest, people do not have the awareness and knowledge they need to deal with disasters. They do not know what to do when a disaster strikes. They think that everything is possible with the mobile phone we have in our hands. They do not know that if, there is such a disaster, when not only the mobile but also the internet stops working, what will happen then? In my opinion, the government should include courses on disaster management in school and college syllabus compulsorily.

We go to various government and private schools and schools and colleges, other educational institutions, government and private hospitals, villages, and blocks and talk with people, aware them, and suggest to them how to deal with the disaster. But I think, it's not enough, the people should be given proper training. Otherwise, our purpose of serving the nation with HAMs will not be fulfilled.

Q.6 How many people can be trained in HAM radio operation? What are the obstacles you have faced in imparting this training?

Ans. The first thing is the financial support from the government whether it is state or central. Because even if we train people for free, they won't be able to actively work until they get the devices which are too expensive for them. It has been seen that most of the people who come to learn the technical operation and training come from very ordinary middle-class families. They can't pay that much money to buy the devices. Common people in remote villages can be harnessed with proper training if they can be given the devices. If not, just training people will not succeed. The government should think about it very seriously. We have given HAM radio training to many boys and girls of Civil Defence in south 24 Pargana, they have been licensed. However, they are not being actively utilized because they don't have the equipment. The government should support them financially and encourage them to use it commercially for the benefit of the people.

7. DATA ANALYSIS

There are many important information, observations, and actual status that have been found after analysing the primary data which are collected through the Survey report among the students and professionals and through the in-depth interview of a pioneer HAM operator of West Bengal.

Through analysing the data from my survey of question number three it has been seen that are large number of students both from schools and colleges have not yet heard the name of HAM radio. In my survey report this percentage is above 70%. It is a major concern to look after. To analyse the fact of question number four it is seen that the major portion of respondents have not read or heard about HAM radio before and that percentage is over 60%. Some of them are aware of HAM radio activities through the mainstream media like television, radio and newspapers. In response to question number five, the major number of respondents have agreed and that is near 70% to have an alternative way of communication in natural calamities. In response to question number six, there has been a mixed response on whether HAM radio operation should be popularised among the people or not for disaster mitigation plans. 47.1% of respondents have agreed with that, 32.9% have told May and 20% of respondents said they cannot say anything. In question number seven, they were asked whether HAM radio operation should be included in school or college level education or not and 61.4% of respondents answered yes, 34.3 % answered could not say and 4.3% did not agree. Through analysis question number eight, it has been seen that major respondents (58.6%) agreed that the number of HAM radio operators must be increased for mankind in disaster mitigation plan, where 24.3% said it may help and 17.1% are not sure about that. An open-ended question was framed to know their suggestions and observations regarding HAM radio. One major observation has found that a large number of respondents are not aware of HAM radio, but they want HAM radio training must be implemented as a life skill education and as a survival strategy in crises. A large number of respondents agreed to popularize HAM radio in mass education as well as in the study course. Maximum respondents appreciated the role of HAM radio in crisis communication.

On the other hand, after conducting the in-depth interview of a distinguished HAM radio operator cum trainer and the secretary of West Bengal Radio Club and the Chairman of the Indian Academy of Communication and Disaster Management, Mr Ambarish Nag Biswas, some major findings have come out. First of all, we are not still well aware of the disaster management plans and the people who are living in vulnerable places like coastal areas, and hilly areas are not being trained to respond during a crisis. Sometimes there remains a communication gap between the government and the disaster

management team or agencies. The proper training or use of HAMs is not initiated on behalf of govt. and there is a financial crisis in the purchase of equipment and devices. The civil defence workers are not being financially gained rather licensed HAM operators become inactive due to a lack of planning and execution of emergency management.

8. SUGGESTION

This research work has been done to know the current status and scope of HAM radio utilization in crisis communication and disaster risk management resilience. The primary objective of the research work is to assess the preparedness and implementation of SDG goals on disaster risk management mitigation plan and strengthening, adaptive capacity to climate-related disasters by the state, as well as the role of wireless amateur radio communication in the disaster management plan as a 'Second Line of Communication' process. After analysing all the Survey data and in-depth interview inputs there are some major findings which need to be given proper attention and importance to implement as the survival strategy in crisis. These suggestions will help the Government officials and social practitioners to get a detailed idea about the present status of the Amateur Radio Communication in West Bengal. These are-

a) There is a knowledge gap regarding disaster mitigation plans and preparedness among the people of vulnerable areas. Awareness camps should be organised for the people who live in the coastal zone, and flood and landslide-prone zones on different aspects of disaster like pre-disaster preparedness, during disaster and post-disaster.

b) HAM radio communication plays a major role in hazardous situations and it can play a major role in search and rescue operations in affected areas but its operational function, implementation process and importance are not addressed in a serious note by government officials.

c) The proper training programme for operating HAM radio should be initiated in large numbers among the people of vulnerable areas like coastal areas, hill areas etc.

d) The government needs to come forward to give financial support to purchase expensive HAM radio devices to the HAM clubs and HAM enthusiasts.

e) A Disaster Management plan must be included in the study programme at the school and college level as a life skill education.

f) An emergency fund needs to be raised by every state for training, awareness, seminars, drills and practice for disaster management mitigation to make India disaster-free.

Our country has a large coastal line in the western, southern and eastern zones which are more prone to cyclonic storms every year and the northern and north-eastern zones are more prone to cloud bursts, landslides, earth quakes. So, to look into the geographical dimensions and climatic imbalance, it can be easily assessed that India is one of the most vulnerable countries to climatic and natural hazards. From the recent example of Kerala's Wayanad, cloud burst and landslide in Uttarakhand and Himachal Pradesh, we have witnessed huge loss of livelihood and social-economic-environmental disruption. So, to build a strong disaster resilience infrastructure, a hazard mapping plan, a quick response and rescue team along with alternative communication system is a need of the hour to minimize the life casualties focusing on the Sustainable Development Goals. India's Vision 2047 sets a tone to make India disaster-

free (minimize the death ratio) and to achieve the milestone of becoming a sustainable developed country.

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An Analytical Study on the Decision-Making Autonomy of Married Women in Kerala

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Abstract

Household decision-making autonomy plays a crucial role in the lives of married women residing in Kerala, a state known for its unique blend of traditions and modernity. Current studies have mainly focused on women's participation in the decision making with respect to healthcare. Literatures analysing the socio-economic aspects of the factors influencing the decision-making autonomy and the comparison of the same over a period of time are scanty. In this context, this study aims to examine the socio-economic factors influencing the married women's decision-making autonomy. It also compares the data to assess the trends and patterns in women's decision-making autonomy. The study utilised the secondary data obtained from the National Family Health Survey (NFHS). It primarily investigated decision-making in personal healthcare, household purchases, and the freedom of movement to visit relatives. The study discovered that married women in Kerala, especially in rural regions, have gained more control over decision-making from NFHS-4 to NFHS-5. The analysis further indicated that education positively correlates with decision-making autonomy, although the relationship varies across education levels. This study added to the existing knowledge of the changing role of married women in making household decisions and emphasized the importance of ongoing initiatives to support gender equality in decision-making.

Keywords: Decision-making, autonomy, household, gender equality, empowerment

1. INTRODUCTION

The autonomy of women in decision-making is a critical marker of gender equality and empowerment, reflecting their ability to exert control over personal and household matters. In India, where traditional norms and cultural practices have historically placed women in subordinate roles, the extent to which married women can influence key decisions within their households has significant implications for their well-being and societal status. Kerala, renowned for its high literacy rates and progressive social indicators, presents a unique setting for exploring the complexities of women's decision-making autonomy within households. Despite its advancements, gender disparities persist, necessitating a detailed examination of the factors affecting women's empowerment in this context.

This research paper presents an analytical study on the decision-making autonomy of married women in Kerala, utilizing data from the fourth and fifth rounds of National Family Health Survey (NFHS). The study aims to achieve the following objectives:

i. **To assess the level of decision-making autonomy among married women in Kerala**: This involves evaluating the extent to which married women participate in critical household decisions

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regarding their own healthcare, major household purchases, and visits to family or relatives.

ii. **To identify socio-economic factors influencing married women's decision-making autonomy in Kerala**: This objective focuses on understanding how variables such as residence (urban vs. Rural), age, education, employment status, and household structure (nuclear vs. non-nuclear) affect women's decision-making autonomy.

iii. **To analyse the trends in decision-making autonomy of married women in Kerala**: This involves examining changes over time by comparing data from NFHS-4 and NFHS-5 to identify patterns and shifts in married women's decision-making autonomy.

Notably, the existing literature emphasizes the substantial impact of married women's decision-making autonomy on various aspects, such as improving health outcomes, promoting economic stability, and advancing social equity. Education and employment opportunities play vital role in empowering women to make informed decisions that positively influence their lives (Menon & Sharma, 2020; Moeeni, 2021). The factors like age and household structure are also significant in shaping women's empowerment levels, which in turn determine their ability to exert influence within their families and communities (Annan et.al., 2021). Additionally, empowering women through enhancing their decision-making capabilities is not only essential for their individual well-being but also plays a fundamental role in fostering positive societal change, bridging gender disparities, and building more inclusive and equitable societies for all members (Mondal & Paul, 2021).

Despite these insights, region-specific analyses are essential to account for local socio-cultural dynamics. Kerala's distinctive socio-economic environment provides a valuable context for examining the interplay of traditional norms and modern influences on women's autonomy. This study aims to contribute to the existing body of knowledge by providing a detailed analysis of the factors driving married women's decision-making autonomy in Kerala, identifying trends over time, and offering recommendations for policy and practice.

By employing a descriptive design centred around percentage analysis, this research quantifies the extent of married women's participation in decision-making across various socio-demographic segments. The findings reveal significant patterns and shifts between NFHS-4 and NFHS-5, highlighting both progress and ongoing challenges in achieving gender parity in household decision-making.

The insights gained from this study are intended to inform policy interventions and contribute to the broader discourse on women's empowerment in Kerala. Understanding these dynamics can guide the development of targeted strategies to enhance the decision-making autonomy of married women, promoting gender equality and improving overall social outcomes in Kerala and beyond.

2. REVIEW OF LITERATURE

The ability of married women to make decisions independently is an important measure of gender equality and empowerment, especially in places such as Kerala where social and cultural norms, as well as economic circumstances, differ greatly. Recent studies emphasize the various factors that affect women's independence in decision-making, such as education, employment, socioeconomic status, and cultural traditions.

2.1. Impact of education and employment on women's decision-making autonomy

Agnihotri (2021) analysed secondary data to compare household decision-making between working and non-working women. It was found that decisions made by employed and educated women hold more significance compared to decisions made by unemployed and less educated women. Other research studies also showed comparable results (Rehman et.al., 2020). In her study, Sultana (2011) investigated the autonomy and decision-making authority of rural women in Bangladesh households. The findings indicated that education, job, salary, and gender awareness play a crucial role in determining the variation in household decision-making authority. Other related studies (Chandradasa et.al., 2021; Muhammad et.al., 2021) also provide support for this.

2.2. Age and decision-making autonomy

Kabir and Jahan (2013) identified the areas where women participate in making household decisions and the factors that influence their level of participation. The study showed a positive correlation between women's age and education and their decision-making capacity. Roy et.al., (2017) examined how women are involved in the decision-making process, their views, and the influence of income on decision-making. The findings showed that the involvement of women in decision-making was inversely correlated with family size, yet directly correlated with the age, education level, farm size, income, and occupation of the respondent.

2.3. Socio-cultural influences on decision-making autonomy

Yogendrarajah (2013) investigated women's empowerment by analysing their decision-making authority within the household. The research acknowledged a significant correlation between decision-making power and the empowerment of women. Nonetheless, cultural norms and personal matters prevent women from making decisions at the household level.

3. METHODOLOGY

3.1. Research Design

The study employs a descriptive research design centred around percentage analysis to provide insights into the autonomy of married women. This design allows for the effective presentation of data and facilitates understanding of the relationships between socio-demographic factors and decision-making autonomy.

3.2. Data Source

Data for this study were obtained from the National Family Health Survey (NFHS), specifically rounds 4 and 5, conducted in Kerala. These surveys provide comprehensive data on health, family welfare, and socio-economic indicators across various states, including Kerala.

NFHS-4 (2015-16) and NFHS-5 (2019-21) datasets were used, focusing on responses from married women aged 15-49 residing in Kerala.

3.3. Variables of Interest

The study focuses on the following key variables related to decision-making autonomy:

i. **Decision-Making Autonomy**: Measured through women's involvement in decisions concerning:

- Own Health Care
- Major Household Purchases
- Visits to Her Family/Relatives

ii. **Socio-Demographic Factors**:

- **Residence**: Urban or rural.
- **Age**: Age groups include 20-24, 25-29, 30-39, and 40-49 years.
- **Education**: Categories include no schooling, <5 years complete, 5-9 years complete, 10-11 years complete, and 12 or more years complete.
- **Employment**: Status is divided into employed, employed for cash, and not employed.
- **Household Structure**: Classified as nuclear or non-nuclear.

3.4. Data Analysis Methods

3.4.1. Percentage Analysis

The data were analysed using percentage analysis to provide a clear and concise representation of women's autonomy in decision-making. Percentage analysis allows for an easy comparison of proportions across different socio-demographic categories.

- **Calculation of Percentages**: Percentages were calculated for each category within the variables to illustrate the proportion of women participating in various decision-making areas.
- **Comparison of Groups**: Percentages were used to compare autonomy across different socio-demographic groups, identifying patterns and trends in decision-making autonomy.

4. RESULTS

The National Family Health Surveys (NFHS) provide comprehensive insights into various aspects of women's lives in Kerala, including their involvement in household decision-making. This analysis compares data from NFHS-4 and NFHS-5 to examine changes in women's participation in decision-making related to their own health care, major household purchases, and visits to family/relatives. The analysis also explores variations across different socio-demographic factors, including residence, age, education, employment status, and household structure.

4.1. Residence: Urban vs. Rural Married Women's Decision-Making Autonomy in Kerala

A comparison of NFHS-4 and NFHS-5 data reveals a notable shift in married women's decision-making participation based on residence in Kerala.

Table 1

Decision Making Participation of Married Women by Residence in Kerala in 2015

Residence	Own Health Care	Major Household Purchases	Visits to Her Family/ Relatives	Participate in all 3 decisions	Participate in none of the 3 decisions
Urban	80.6	80.9	84.2	69.1	8.3
Rural	80.6	78.2	83.3	66.3	7.6
Total	80.6	79.4	83.7	67.6	7.9

Source: National Family Health Survey-4, 2015-16

*Figures are given in percentage

- **Urban Areas:** In NFHS-4, urban married women were slightly more involved in decision-making compared to their rural counterparts in Kerala. However, NFHS-5 data indicates a slight increase in urban married women's participation in their own health care, with a marginal decrease in other decision-making areas. Specifically, the percentage of urban married women participating in all three decision-making areas decreased from 69.1% to 66.4%, while those participating in none of the decisions decreased from 8.3% to 6.4% (Tables 1 & 2).

Table 2

Residence	Own Health Care	Major Household Purchases	Visits to Her Family/ Relatives	Participate in all 3 decisions	Participate in none of the 3 decisions
Urban	81	79	82.9	66.4	6.4
Rural	84.6	83.2	86.2	72.2	5.4
Total	82.8	81.1	84.6	69.3	5.9

Decision Making Participation of Married Women by Residence in Kerala in 2019

Source: National Family Health Survey, 2019-20

Figures are given in percentage

Rural Areas: Rural married women have shown significant improvements in decision-making participation in Kerala. Participation in their own health care increased from 80.6% to 84.6%, major household purchases from 78.2% to 83.2%, and visits to family/relatives from 83.3% to 86.2%. The percentage of rural women participating in all three decisions increased from 66.3% to 72.2%, and those participating in none of the decisions decreased from 7.6% to 5.4% (Tables 1 & 2).

4.2. Age: Age as a Determinant of Decision-Making Autonomy of Married Women in Kerala

The data reveals age-related trends in married women's decision-making participation that have evolved between NFHS-4 and NFHS-5 in Kerala.

Table 3

Age	Own Health Care	Major Household Purchases	Visits to Her Family/ Relatives	Participate in all 3 decisions	Participate in none of the 3 decisions
20-24	78.4	72.1	79.5	65	14.3
25-29	80.5	79.4	83.9	66.2	7.1
30-39	79.6	79.7	84.1	67.4	7.6
40-49	82.3	82.2	84.6	69.9	6.8

Decision Making Participation of Married Women by Age in Kerala in 2015

Source: National Family Health Survey-4, 2015-16

Figures are given in percentage

- **Younger Women (20-24 years):** Between NFHS-4 and NFHS-5, a notable decline in participation rates among younger married women was observed across various decision-making areas in Kerala. In NFHS-4, 78.4% of them took part in decisions related to their healthcare, 72.1% in major household purchases, and 79.5% in visiting family or relatives. However, in NFHS-5, there was a drop in these participation figures, indicating a shift in involvement. The percentage of younger women participating in decisions related to their own healthcare decreased to 76.2%, in major household purchases to 69.5%, and in visits to family or relatives to 79.3%. Moreover, there was an observable decline in the overall engagement of younger women across all three decision-making areas, with the percentage decreasing from 65% in NFHS-4 to 56.5% in NFHS-5. In contrast, the number of younger married women abstaining from participating in any of these decisions saw a slight increase, rising from 14.3% in NFHS-4 to 10.9% in NFHS-5 (Tables 3 & 4).

- **Middle-Aged Women (30-39 years):** In this age group, there was a notable surge in engagement levels. In the NFHS-4 survey, it was observed that 79.6% of married women were actively involved in decisions regarding their own healthcare, followed by a participation rate of 79.7% in major household purchases and 84.1% in visits to family and relatives (Table 3). Transitioning to the NFHS-5 dataset, these figures demonstrated an upward trend, indicating an increase to 86.5%, 82.9%, and 85.8%, respectively (Table 4). There was also a rise in the percentage of married women participating in all three categories from 67.4% to 72.7%. Conversely, the percentage of married women opting out of all three decisions decreased from 7.6% in NFHS-4 to 4.7% in NFHS-5.

Table 4

Age	Own Health Care	Major Household Purchases	Visits to Her Family/ Relatives	Participate in all 3 decisions	Participate in none of the 3 decisions
20-24	76.2	69.5	79.3	56.5	10.9
25-29	76	80.9	80.3	66.6	9.1
30-39	86.5	82.9	85.8	72.7	4.7
40-49	82.8	81.7	85.9	69.6	5.1

Decision Making Participation of Married Women by Age in Kerala in 2019

Source: National Family Health Survey, 2019-20

Figures are given in percentage

4.3. Education: Impact of Educational Attainment on the Decision-Making Autonomy of Married Women in Kerala

Educational attainment has a profound effect on married women's decision-making participation, with notable changes between NFHS-4 and NFHS-5 in Kerala.

Table 5

Education	Own Health Care	Major Household Purchases	Visits to Her Family/ Relatives	Participate in all 3 decisions	Participate in none of the 3 decisions
No schooling	50.9	57.9	64.4	29.1	19.8
<5 years complete	66.7	72.5	75.2	55.9	17.1
5-9 years complete	74.6	76.2	78.7	60.1	9.5
10-11 year complete	84.8	80	82.5	68.9	7.9
12 or more years complete	83.9	82.1	88.5	73.4	6.1

Decision Making Participation of Married Women by Education in Kerala in 2015

Source: National Family Health Survey-4, 2015-16

Figures are given in percentage

No Schooling to 5-7 Years Complete: The data from NFHS-4 indicates a noticeable disparity in

participation rates among married women based on their level of education. Notably, married women with no schooling exhibited lower participation rates in decision-making regarding health care, with a substantial increase as education levels progressed. For example, the percentage of married women involved in health care decisions jumped from 50.9% for those with no schooling to 66.7% for individuals with less than 5 years of education, with a further increase to 74.6% for those with 5-9 years of schooling (Table 5). Building upon this trend, NFHS-5 data confirms a continuation of these patterns, with even greater improvements in participation rates observed among married women with 5-7 years of schooling and beyond (Table 6).

Table 6

Education	Own Health Care	Major Household Purchases	Visits to Her Family/ Relatives	Participate in all 3 decisions	Participate in none of the 3 decisions
5-7 years complete	82.3	76.2	78.5	65.2	9.6
8-9 years complete	80.1	79.9	81.9	67.8	7.5
10-11 years complete	83.2	84.2	83.1	70.1	4.4
12 or more years complete	83.5	81.2	87.1	70.1	5.3

Decision Making Participation of Married Women by Education in Kerala in 2019

Source: National Family Health Survey, 2019-20

Figures are given in percentage

10-11 Years and 12 or More Years Complete: When analysing the data for married women completing 10-11 years of education, NFHS-4 revealed participation rates of 84.8% in health care decision-making and 80% in significant purchases (Table 5). These statistics experienced a slight decline in NFHS-5, with figures standing at 83.2% and 84.2%, respectively, indicating a minor shift in participation rates. Encouragingly, the trend of improvement in participation rates was also evident among married women with 12 or more years of education in NFHS-5, demonstrating the enduring positive influence of education on married women's involvement in decision-making processes (Table 6).

4.4. Employment: Employment Status and Decision-Making Participation of Married Women in Kerala

The NFHS-4 and NFHS-5 data reveal the influence of employment on married women’s decision-making.

Table 7

Employment (past 12 months)	Own Health Care	Major Household Purchases	Visits to Her Family/ Relatives	Participate in all 3 decisions	Participate in none of the 3 decisions
Employed	82.2	80.2	88.1	67	3.3
Employed, for cash	82.7	81	89	68.2	3
Not employed	80.2	79.2	82.5	67.8	9.2

Decision Making Participation of Married Women by Employment in Kerala in 2015

Source: National Family Health Survey, 2015-16

Figures are given in percentage

Employed Women: In NFHS-5, an increase in the engagement of employed married women was observed across various decision-making areas. Noteworthy progress was seen in health care decisions, major household purchases, and visits to family or relatives. Specifically, the percentage of employed women involved in health care decision-making rose from 82.2% to 87.1%, in major household purchases from 80.2% to 84.2%, and in visits to family or relatives from 88.1% to 88.3%. Furthermore, the percentage of employed married women participating in all three decision categories increased from 67% to 73.1%, while the proportion of those not participating in any decision decreased from 3.3% to 2.4% (Tables 7 & 8).

Not Employed: Non-employed married women experienced a slight increase in their involvement across the same decision categories. Moreover, the percentage of non-employed married women not engaging in any decision-making dropped from 9.2% to 7.3% (Tables 7 & 8).

Table 8

Employment (past 12 months)	Own Health Care	Major Household Purchases	Visits to Her Family/ Relatives	Participate in all 3 decisions	Participate in none of the 3 decisions
Employed	87.1	84.2	88.3	73.1	2.4
Employed, for cash	87.3	84.6	88.6	73.7	2.4
Not employed	81.1	79.9	83	67.8	7.3

Decision Making Participation of Married Women by Employment in Kerala in 2019

Source: National Family Health Survey, 2019-20

Figures are given in percentage

4.5. Household Structure: Nuclear vs. Non-Nuclear Households and Married Women's Decision-Making Autonomy in Kerala

The data indicates variations in married women's decision-making participation based on household structure.

Nuclear Households: There was a slightly higher level of participation in decision-making areas among nuclear households in both NFHS-4 and NFHS-5. The data from these surveys revealed that participation rates increased across the board from NFHS-4 to NFHS-5, with a noticeable improvement from 69.5% to 69.9% in nuclear households. Moreover, the proportion of married women engaging in none of the decisions decreased notably from 7.1% to 5.4% during the same period (Tables 9 & 10).

Table 9

Household Structure	Own Health Care	Major Household Purchases	Visits to Her Family/ Relatives	Participate in all 3 decisions	Participate in none of the 3 decisions
Nuclear	82.5	80.9	85.3	69.5	7.1
Non-nuclear	79.3	78.4	82.6	66.3	8.5

Decision Making Participation of Married Women by Household Structure in Kerala in 2015

Source: National Family Health Survey, 2015-16

Figures are given in percentage

Non-Nuclear Households: The scenario was somewhat different in non-nuclear households, where overall participation rates tended to be lower compared to their nuclear counterparts. Despite this discrepancy, the participation rates in decision-making in non-nuclear households experienced positive growth from NFHS-4 to NFHS-5. Specifically, the percentage of married women involved in all three decisions in non-nuclear households rose significantly from 66.3% to 68.9%, while those taking part in none of the decisions saw a decline from 8.5% to 6.3% (Tables 9 & 10).

Table 10

Household Structure	Own Health Care	Major Household Purchases	Visits to Her Family/ Relatives	Participate in all 3 decisions	Participate in none of the 3 decisions
Nuclear	82.5	82.5	85.7	69.9	5.4
Non-nuclear	83	80.2	83.8	68.9	6.3

Decision Making Participation of Married Women by Household Structure in Kerala in 2019

Source: National Family Health Survey, 2019-20

Figures are given in percentage

4.6. Overall Trends in Married Women's Decision-Making Autonomy in Kerala (NFHS-4 vs. NFHS-5)

The study examines the shifts in decision-making autonomy among married women in Kerala over time by comparing data from the National Family Health Survey (NFHS) rounds 4 (2015-16) and 5 (2019-20). The focus will be on changes in women's participation in decisions related to own health-care, major household purchases, visits to their family or relatives, and overall autonomy.

- **Own healthcare:** Across many demographic categories, there is a small but notable increase in women's decision-making autonomy concerning their own health care from NFHS-4 to NFHS-5. For example, in NFHS-4, around 80.2% of women made decisions regarding their own health care, which increased slightly to 84.2% in NFHS-5 for certain groups (like employed women).

- **Major household purchases:** In NFHS-4, 80.9% of women participated in decisions related to major household purchases. This figure declined slightly to 79% in NFHS-5. Despite the small drop, this rate remained high, suggesting that women's involvement in significant financial decisions is a relatively stable aspect of household dynamics.

- **Visits to her family/ relatives:** The percentage of women participating in decisions about visiting family members showed a similar pattern. In NFHS-4, 84.2% of women were involved, and this dropped to 82.9% in NFHS-5. Although participation slightly decreased, family visit decisions still show a high level of involvement.

- **Participation in all 3 decisions:** Participation in all three decisions (own health care, family visits, major purchases) decreased from 69.1% in NFHS-4 to 66.4% in NFHS-5. This suggests that while women remain involved in individual decisions, their autonomy across multiple areas has seen a minor decline.

- **Participation in none of the 3 decisions:** A key positive finding is the decline in women excluded from decision-making processes. The percentage of women who did not participate in any of the three decisions dropped from 8.3% in NFHS-4 to 6.4% in NFHS-5. This indicates an expansion of autonomy for a significant portion of women, particularly those who were previously excluded from decision-making processes.

The comparison of NFHS-4 and NFHS-5 data shows incremental improvements in married women's decision-making autonomy, though these gains are not uniformly distributed across all demographics. These findings suggest that future policy efforts should focus on enhancing education access and employment opportunities for married women to further improve their decision-making autonomy. Addressing these disparities is essential for advancing gender equality and empowering married women in all aspects of their lives.

5. DISCUSSION

Traditionally, urban married women are perceived to have more autonomy due to better education and economic opportunities. However, the increase in rural married women's autonomy between NFHS-4 and NFHS-5 may suggest improvements in rural development, education, and employment opportunities, aligning with studies that emphasize the impact of economic empowerment on married women's autonomy (Kabeer, 2005; Acharya et al., 2010). The literature supports the finding that older married women generally have more decision-making power due to accumulated experience and increased familial and societal influence over time (Malhotra and Mather, 1997). Younger women may face more barriers to autonomy due to limited experience and potential socio-cultural constraints (Mason and Smith, 2000). This aligns with the observed decrease in autonomy among the youngest group in NFHS-5, which may be exacerbated by socio-economic changes affecting young couples.

Moreover, education is a well-documented driver of married women's empowerment and decision-making autonomy (Jejeebhoy, 1995; Banerjee et al., 2020). Educated married women are more likely to challenge traditional norms and participate in decision-making processes. Employment, especially with financial independence, is strongly associated with increased autonomy (Krumbiegel et.al., 2020; Soharwardi & Ahmad, 2020). Women who contribute economically to their households often gain greater respect and decision-making power. While employment boosts autonomy, non-economic factors such as family dynamics and cultural norms still play significant roles, as highlighted in studies by Bau and Fernández (2023).

Interestingly, nuclear families often afford married women more autonomy due to less hierarchical and traditional constraints, as supported by Biswas et.al., (2020) and Pandey et.al., (2021). In contrast, non-nuclear families might reinforce traditional roles and limit married women's decision-making power, highlighting the need for cultural shifts to improve married women's autonomy across family types. These findings underscore the importance of cultural transformation across different family types to enhance women's autonomy universally.

6. CONCLUSION

The findings from NFHS-4 and NFHS-5 reveal significant trends and changes in the decision-making autonomy of married women in Kerala, reflecting broader socio-economic and cultural dynamics. The analysis aligns with existing literature, emphasizing the importance of education, employment, and household structure in enhancing women's autonomy. However, the data also point to ongoing challenges, especially for younger and less educated women, underscoring the need for targeted interventions and policies to address these gaps.

6.1. Policy Recommendations

i. **Enhancing Educational Opportunities**: Strengthening educational programs and access for women, especially in rural areas, to empower them with knowledge and skills for greater autonomy.

ii. **Promoting Employment and Economic Independence**: Implementing policies that support women's employment, particularly in cash-earning jobs, to boost their economic standing and decision-making power.

iii. **Supporting Rural Development**: Focusing on rural development initiatives that enhance infrastructure, healthcare, and employment opportunities for women.

iv. **Encouraging Cultural Change**: Promoting cultural change towards gender equality and challenging traditional norms that restrict women's autonomy, particularly in non-nuclear families.

v. **Addressing Age-Specific Needs**: Tailoring interventions to address the specific needs and challenges faced by younger women to ensure they can exercise greater autonomy.

By understanding and addressing these factors, policymakers and stakeholders can create a more enabling environment for married women in Kerala to exercise decision-making autonomy, contributing to gender equality and empowerment.

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Inter-State Disparities in Healthcare Sector of India: A Challenge in the Roadmap of SDG-3

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Archna Chaudhry [**]

Abstract

India is emerging as a leading economy being at the forefront worldwide in every field but failing in social infrastructure. In spite of continuous efforts by nations, there are at least 400 million people in the world who lack access to basic healthcare and 40 per cent lack social safety (as per UNDP). Healthcare delivery may not be similar among states which is causing a hindrance in achieving targets of SDG-3 that aims at providing good health and maintaining the well-being of the community. The study aims to explore the inter-state disparities in the Indian health sector. For the fulfilment of the purpose of the study, data is extracted from the Handbook of Statistics on Indian States. The period of the study spans from 2015 to 2020 for all the Indian states. Infant mortality rate (IMR) and life expectancy (LEI) are the health outcomes taken into consideration whereas public expenditure on health (PEH) is taken as health input. Mean, standard deviation, coefficient of variation, and disparity ratios are calculated to ascertain the differences among states. It has been found that disparities in IMR have been widening over time whereas it is declining and fluctuating in PEH as well as LEI. The study suggests that the expenditure on health should be increased and inequalities should be reduced to make healthcare accessible to every section of the population. This study adds to our knowledge of India's regional health disparities and lays the groundwork for future investigations and the creation of policies targeted at enhancing national health equity.

Keywords: healthcare, social safety, SDG-3, infant mortality, life expectancy, disparity ratio

1. Introduction and Review of Literature

Health plays a vital role in shaping any nation's progress. Government expenditure on health influences healthcare status and outcomes of the country. Since the government enacted the economic reforms, there has been a deepening of inequality due to inadequate policy, an excessive focus on developed areas, and a disregard for the states with lower incomes (Nagaraja & Veerabhadrappa, 2018). Due to these regional differences, the country has experienced uneven development in its frontier. Another possible cause could be the availability of different factor endowments and resources, either natural or man-made.

Since the state is in charge of health in India, the budgetary allotment made by each state has an impact on healthcare finances. Thus, differences amongst states in terms of availability and the need for public health care arise (Ganesan & Veena, 2018). Since the majority of the population belongs to low and middle-income sections, it is essential that the services are provided within the purchasing power of people. The 2030 Agenda recognizes the intricate relationship and interdependence between sustainable development and good health. It considers the growing prevalence of HIV along with other infectious diseases and new issues including non-communicable diseases. Reaching SDG-3 will require universal health coverage. However, the progress observed is uneven, (as per UNDP) the difference in

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life expectancy between the nations with the shortest and longest life expectancies is 31 years. Furthermore, national averages conceal the fact that many nations are falling behind, even while some have made remarkable progress. The issue of inadequate healthcare quality is not exclusive to India (Mohanan et al., 2016).

The main issue Indian health systems face is the ongoing lack of infrastructure and manpower, which results in significant inter-State differences. These disparities are particularly severe when it comes to primary health care and have a negative influence on less developed, rural, and backward regions (Kathuria & Sankar, 2005). Even with the last thirty years of health progress, early childhood disorders still claim lives. India has the third-highest rate of HIV/AIDS among nations having HIV-positive citizens (Singh, n.d.). Despite the economic slump that occurred between 2008 and 2009, India's growth rate has increased after the reforms. Nonetheless, the current pattern of growth has exacerbated intra-rural and intraurban inequality, expanded the gap between rural and urban areas, and exacerbated inter-state inequality (Radhakrishna & Mishra, 2020). There is a considerable urban bias in the availability of healthcare facilities. As a result, residents of rural areas bear the extra burden of this circumstance and make up a disproportionately higher part of the unhealthy population (Baru et al., n.d.). This highlights the need to lower the costs of services and also expansion to rural and remote areas. Expanded health insurance coverage can offer further security against health hazards, and early disease detection can aid in maintaining good health and reducing the cost of treatment (Barik & Thorat, 2015). Focusing on governance concerns is necessary to raise the standard of healthcare at the systemic level. These challenges include enhancing public sector management, expanding institutional capacity, and encouraging an environment of data-driven policymaking (Mohanan et al., 2016).

2. Methodology

The present study wants to address the following research questions:

RQ1: Whether the indicators included in the study (IMR, PEH and LEI) have improved over the time period 2015-2020?

RQ2: Whether the inter-state disparities have reduced over the time period in the study?

The study is based on secondary data extracted from the Handbook of Statistics on Indian States (2023) ranging from 2015 to 2020. The tools used were mean, standard deviation, coefficient of variation, and disparity ratio given by Bhattacharya (2009) and also followed by Ganesan & Veena (2018) in their study. The variables taken into account for the study are infant mortality rate, public expenditure on health, per capita expenditure on health and life expectancy. Data for infant mortality, public expenditure on health, and life expectancy has been extracted for the study. The life expectancy survey is quinquennial. The population used to calculate per capita expenditure on health is the projected population extracted from a government report published in 2020. Formula used for calculation of statistics:

- $\text{Mean}(\mu) = \frac{\Sigma X}{N}$ (where X=Value in the data distribution and N= No. of observations)
- $\text{Standard Deviation}(\sigma) = \sqrt{\frac{\Sigma (X-\mu)^2}{N}}$ (where X= Value in the data distribution, μ=population mean and N= No. of observations)

- Coefficient of Variation $= \frac{\sigma}{\mu} * 100$ (where σ =standard deviation and μ=population mean)
- $$Disparity\ Ratio = \frac{Maximum\ value - Minimum\ Value}{Average\ Value} * 100$$

3. Results and Discussion

3.1 Infant Mortality Rate

Infant Mortality rate refers to the number of infants dying per 1000 live births before reaching the age of one.

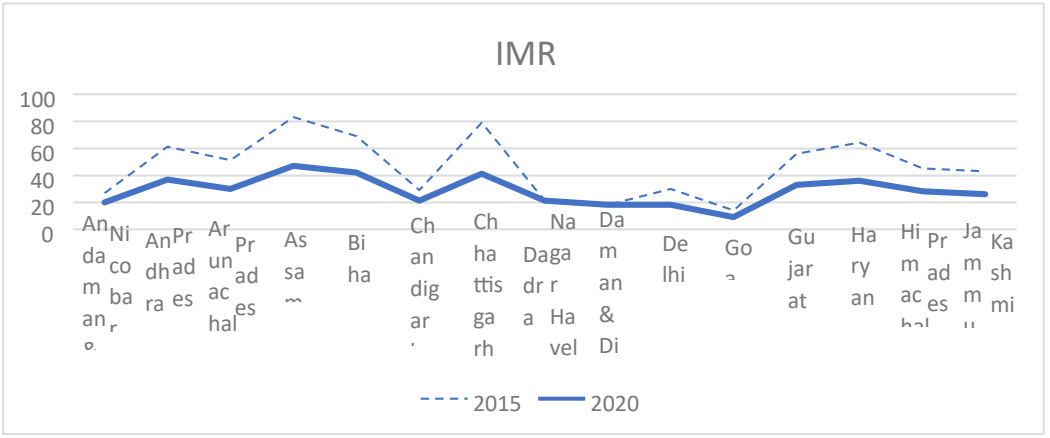

Figure 1.1: Infant Mortality Rate in 2015 and 2020

With reference to Figure 1.1 and Figure 1.2, it can be inferred that IMR has declined from 2015 to 2020 which is an indicator of progress in the nation. But the progress is not even, in some states it has a great decline like Assam and Chhattisgarh whereas it is less in Goa, Himachal Pradesh, and Jammu.

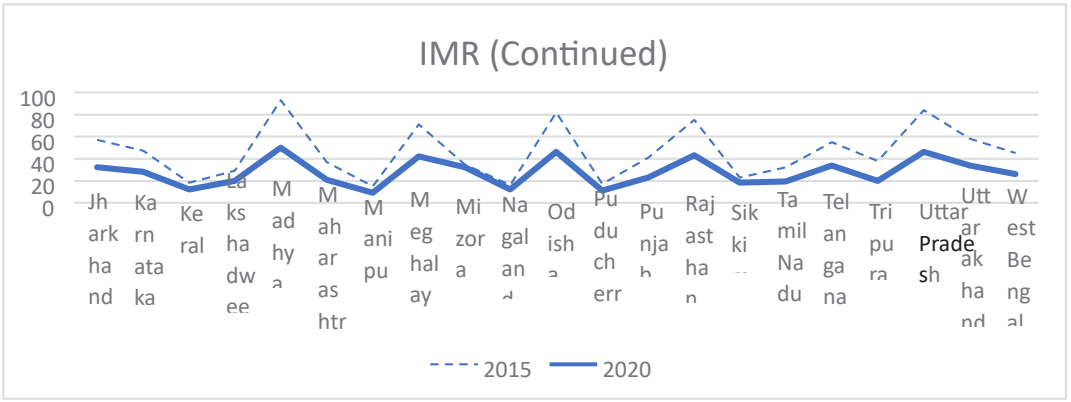

Figure 1.2: Infant Mortality Rate (Continued) in 2015 and 2020

Figure 1.2 is in continuation of Figure 1.1 depicting IMR in the rest of the states. In this, we can see the uneven progress of IMR from 2015 to 2020. Madhya Pradesh, Odisha, Rajasthan, and Uttar Pradesh have experienced a decline in IMR more as compared to other states.

Table 1.1: Vital statistics from Table 1 given in Appendix A

Statistics	2015	2016	2017	2018	2019	2020
Average	27.91	26.16	24.88	22.88	20.77	19.20
Standard deviation	11.58	11.18	11.32	12.09	11.68	11.17
Coefficient of variation	0.41	0.42	0.45	0.52	0.56	0.58
Disparity Ratio (%)	146.90	149.08	160.77	192.30	207.02	208.33

Source: Calculated by authors (based on Table 1 given in Appendix A)

$$Disparity\ Ratio = \frac{Maximum\ value - Minimum\ Value}{Average\ Value} * 100$$

In 2015, the highest IMR was observed in Madhya Pradesh followed by Assam while the lowest was in Manipur. Madhya Pradesh is the state with the highest IMR again in 2020 whereas the lowest IMR is observed in Mizoram in 2020. Table 1.1 shows that during 2015, the coefficient of Variation was 0.41 but gradually it increased and was found to be 0.58 in 2020. Similar behaviour is depicted by the Disparity ratio, the increasing percentage from 146.90 in 2015 to 208.33 in 2020 represents the increasing variations and widening disparities in IMR between states over time.

3.2 Public Expenditure on Health

Public finance is the most important determinant in improving a nation's health status. The expenditure by the government on building infrastructure and making health services accessible to all sections of the population is the ultimate requirement for reducing health inequalities.

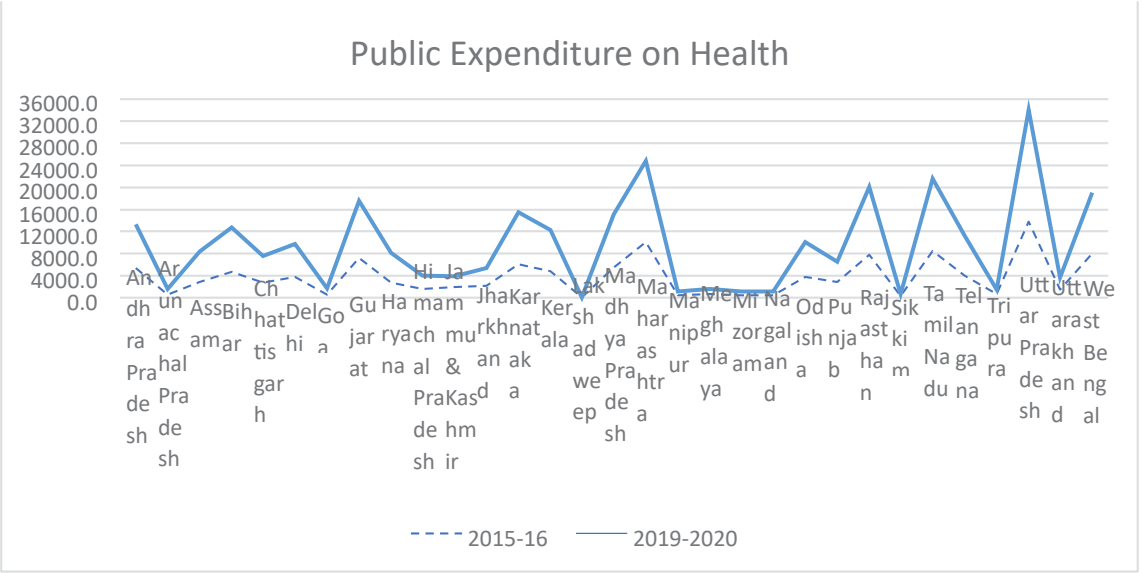

Figure 2: Public Expenditure on Health in 2015 and 2020

Concerning Figure 2, it can be interpreted that PEH has increased from 2015 to 2020 which is an important determinant for the improvement in the health sector with time. There has been unbalanced progress across states, that is why the standard deviation is also high (refer to Table 2.1). Madhya Pradesh, Maharashtra, Rajasthan and, Tamil Nadu have done more expenditure on health in comparison to other states. This uneven spending is giving rise to disparities in healthcare.

Table 2.1. Vital statistics from Table 2 given in Appendix B

Statistics	2015-16	2016-17	2017-18	2018-19	2019-20
Average	3245.7	4251.1	4822.1	5391.6	5808.3
Standard Deviation	3297.89	3709.10	4088.46	4606.45	4931.61
Coefficient of Variation	1.01	0.87	0.84	0.85	0.84
Disparity Ratio (%)	423.26	377.80	348.43	332.67	341.28

Source: Calculated by authors (based on Table 2 given in Appendix B)

Table 2.1 depicts that PEH is increasing over time. Uttar Pradesh is the state with the highest expenditure followed by Maharashtra, Tamil Nadu, and West Bengal whereas Sikkim is the state with the lowest expenditure on health. In the case of UTs, Delhi has the highest PEH whereas Lakshadweep has the lowest. The coefficient of variation is declining from 2015-16 to 2017-18 from 1.01 to 0.84 respectively, it again increased to 0.85 in 2018-19 and fell to 0.84 in 201920 again indicating the fluctuations in disparities. The disparity ratio is declining reflecting that over time the states are experiencing a reduction in disparities from 423.26 per cent in 2015-16 to 332.67 in 2018-19

respectively. It again increased to 341.28 per cent in 2019-2020 increasing differences among states.

3.3 Per Capita Expenditure

Per capita expenditure on health is the ratio of total expenditure on health to the population.

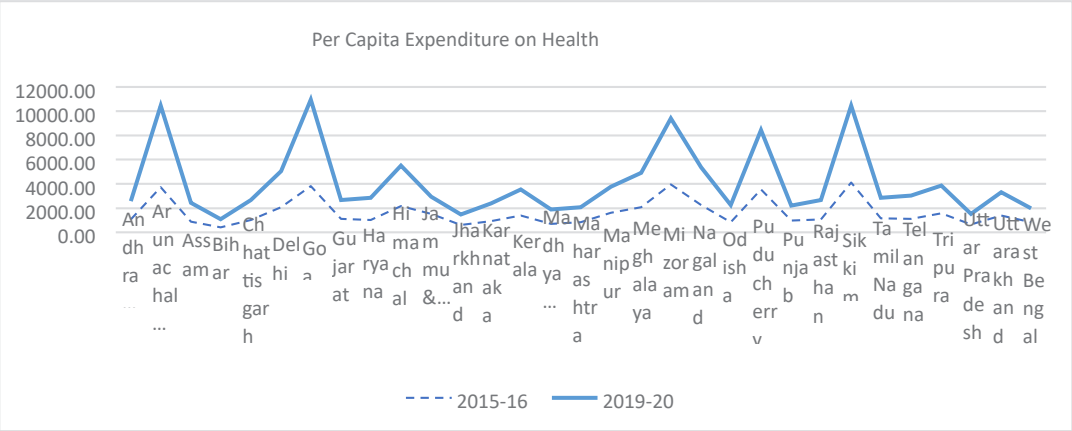

Figure 3: Per capita expenditure on health in 2015-16 and 2019-20

With reference to Figure 3, it can be inferred that there is an increase in PCEXP across all states which is a good indicator. Arunachal Pradesh, Goa, Mizoram, and Sikkim are the states where the spike is much higher as compared to other states. Therefore, it can be seen the growth in PCEXP is uneven in the nation which causes disparities amongst states.

Table 3.1: Calculated statistics from Table 3 given in Appendix C

Statistics	2015-16	2016-17	2017-18	2018-19	2019-20
Average	1914.60	1828.68	2259.68	2354.97	2459.71
Standard Deviation	1579.95	1210.30	1728.47	1752.71	1752.80
Coefficient of Variation	0.82	0.66	0.76	0.74	0.71
Disparity ratio (%)	193.15	238.72	291.01	290.99	262.36

Source: Calculated by authors (based on Table 3 given in Appendix C)

Table 3.1 reveals the disparity among states in per capita expenditure on health. In 2019-20 the state with the highest PCEXP is Goa while the state with the lowest PCEXP is Bihar. The disparity ratio increased from 193.15 per cent in 2015-16 to 291.01 per cent in 2017-18, then it declined to 290.99 per cent in 2018-19 and further dropped to 262.36 per cent in 2019-20. The disparities are showing a trend where it increased initially and then declined but it is evident that there exist disparities among states which need to be addressed seriously.

3.4 Life Expectancy

Life Expectancy is the number of years a person is expected to live at the time of birth. It represents the health status of the nation.

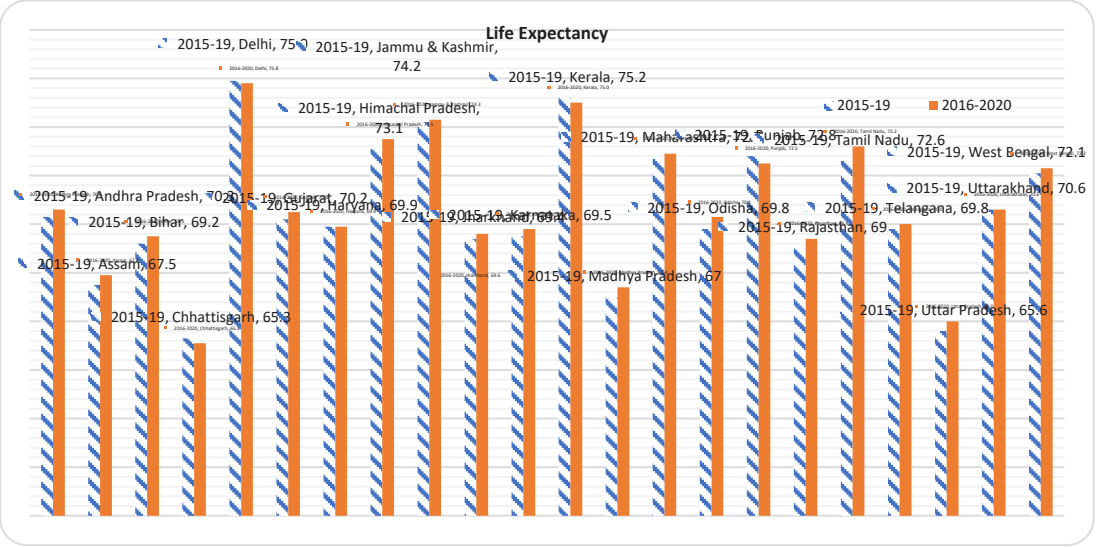

Figure 4: Life Expectancy in 2015-19 and 2016-20

Figure 4 represents Life Expectancy in 2015-19 and 2016-20. It can be inferred that the majority of the states have improved in their life expectancy but there are some states like Bihar, Chhattisgarh, Kerala, Maharashtra, and Punjab where a fall in life expectancy has been observed.

Table 4.1. Calculated statistics from Table 4 given in Appendix D

Year	2012-16			2013-17			2014-18			2015-19		
Statistics	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Average	68.10	68.55	69.73	68.53	71.70	70.02	68.77	71.95	70.27	68.99	72.25	70.53
Standard Deviation	2.70	0.73	2.95	2.67	3.39	2.90	2.56	3.36	2.79	2.58	3.29	2.76
Coefficient of Variation	0.03	0.01	0.04	0.03	0.04	0.04	0.03	0.04	0.03	0.03	0.04	0.03
Disparity Ratio (%)	13.36	4.23	14.77	13.86	17.01	14.56	14.68	16.81	14.37	15.36	15.64	15.02

Source: Calculated by authors (based on Table 4 given in Appendix D)

Table 4.2. continued

Year	2016-20		
Statistics	**Male**	**Female**	**Total**
Average	69.09	72.53	70.73
Standard Deviation	2.52	3.26	2.70
Coefficient of Variation	0.03	0.04	0.03
Disparity ratio (%)	13.17	15.57	15.12
*: Quinquennial Survey. -: Not Available.			

Source: Calculated by authors (based on Table 4 continued given in Appendix D)

Table 4.1 and Table 4.1 (continued) represent the disparity in life expectancy from 2015 to 2020. The disparity in life expectancy of males increased from 13.36 in 2012-15 to 15.36 in 2015-2019 and later it declined to 13.17 in 2016-2020. The highest life expectancy in males is recorded in Delhi i.e., 74.3 years in the survey of the year 2015-19. The disparity ratio in female life expectancy is declining from 17.01 in 2013-17 to 15.57 in 2016-20. The highest life expectancy recorded in females is 78 years in Kerala in the survey of 2016-20. The total life expectancy has shown a declining trend in disparity between states initially from 14.77 in 2012-15 to 14.37 in 2014-18 but then it increased to 15.02 in 2015-2019 and 15.12 in 2016-2020 indicating an increment in disparities among states.

4. Conclusion

The present study has been able to address the research questions framed in methodology section regarding the direction of movement of variables under study and inter-state disparities for the time period 2015-2020. It is evident that the disparities among states are increasing over time. Whereas IMR has declined which is a good indicator on the other hand, disparities in IMR have increased over time among states from 2015 to 2020. Madhya Pradesh is the state with the highest IMR indicating the available health facilities are not good. Public expenditure on health is the major determinant for health improvement which can be used to improve a nation's health multiple times. Uttar Pradesh is the state with the highest PEH i.e., 20250.2 crores followed by Maharashtra (14755.8 crores), Tamil Nadu (13012.4 crores), and Rajasthan (12210.7 crores). PCEXP also revealed disparities among states. Bihar has the lowest per capita expenditure on health, a major reason for the poor health infrastructure in the state. Indian states have disparities in life expectancy as well. It can be concluded that state healthcare financing is the cause of inter-state disparities and also a hindrance in achieving the targets of SDG-3. This is a serious concern that should be taken care of otherwise situation will get worse.

5. Future Scope

The study adds to the knowledge that there are differences in states' health. Future research can be done to find the possible reasons for the inter-state disparities in India. Healthcare financing is the obvious reason for disparities in health among Indian states but the reasons for disparities in IMR and LEI are still unknown. It might be due to poor nutrition, sanitation issues, unaffordability, etc. The study puts forward the need to find the reasons behind the issues and formulations of policies accordingly to achieve national health coverage and targets of SDG-3.

6. Policy Implications

There are several ways to improve the health status of the country. The foremost and most crucial is increasing public expenditure on health and making health services accessible and affordable. Academicians have argued in favour of a policy matrix that includes fundamental interventions that are indirectly related to people's health in addition to urgent or immediate health interventions like medical facilities. The majority of the time, these investments are made in the form of funding for basic education, improved housing, water, and sanitary conditions, as well as the implementation of programs that guarantee financial stability (Joe et al., n.d.). Public awareness campaigns should be organized regarding preventive measures for diseases and impart health literacy. Skilled practitioners should be employed and training must be given on upcoming therapies and treatments. Given that many of the factors impacting health outcomes are outside of the Ministry of Health's direct jurisdiction, the Ministry of Health has to establish greater collaborations with other public health agents (Lakshminarayanan, 2011). Comprehensive public and private sector regulation is necessary for drugs, medical technologies, and provisioning. This is essential for reducing expenses, raising standards, and fostering accountability (Baru et al., n.d.). Collaborative efforts of states are required to overcome this hurdle of disparity in the path of sustainable development in health.

7. Conflicts of Interest

The author declares no conflict of interest.

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9. Appendices

Appendix A

Table 1. Infant Mortality Rate from 2015-2020

STATE/ UTs	2015	2016	2017	2018	2019	2020
Andaman & Nicobar Islands	20	16	14	9	7	7
Andhra Pradesh	37	34	32	29	25	24
Arunachal Pradesh	30	36	42	37	29	21
Assam	47	44	44	41	40	36
Bihar	42	38	35	32	29	27
Chandigarh	21	14	14	13	13	8
Chhattisgarh	41	39	38	41	40	38
Dadra & Nagar Haveli	21	17	13	13	11	16*
Daman & Diu	18	19	17	16	17	16*
Delhi	18	18	16	13	11	12
Goa	9	8	9	7	8	5
Gujarat	33	30	30	28	25	23
Haryana	36	33	30	30	27	28
Himachal Pradesh	28	25	22	19	19	17
Jammu & Kashmir	26	24	23	22	20	17
Jharkhand	32	29	29	30	27	25
Karnataka	28	24	25	23	21	19
Kerala	12	10	10	7	6	6
Lakshadweep	20	19	20	14	8	9
Madhya Pradesh	50	47	47	48	46	43
Maharashtra	21	19	19	19	17	16

Manipur	9	11	12	11	10	6
Meghalaya	42	39	39	33	33	29
Mizoram	32	27	15	5	3	3
Nagaland	12	12	7	4	3	4
Odisha	46	44	41	40	38	36
Puducherry	11	10	11	11	9	6
Punjab	23	21	21	20	19	18
Rajasthan	43	41	38	37	35	32
Sikkim	18	16	12	7	5	5
Tamil Nadu	19	17	16	15	15	13
Telangana	34	31	29	27	23	21
Tripura	20	24	29	27	21	18
Uttar Pradesh	46	43	41	43	41	38
Uttarakhand	34	38	32	31	27	24
West Bengal	26	25	24	22	20	19
ALL INDIA	37	34	33	32	30	28

Source: Handbook of Statistics on Indian States

Appendix B

Table 2. Public Expenditure on Health From 2015 to 2020 (in crores)

State/Union Territory	2015-16	2016-17	2017-18	2018-19	2019-20
Andhra Pradesh	5347.0	6713.5	6753.4	7522.1	7940.9
Arunachal Pradesh	536.0	708.4	936.1	1118.3	1013.0
Assam	2864.0	3196.8	4514.9	4663.0	5446.3
Bihar	4653.0	5593.1	6378.2	7741.2	8078.5
Chandigarh	374.0	-	-	-	-
Chhattisgarh	2754.0	3353.2	4081.3	3830.8	4787.5
Dadra & Nagar Haveli	101.0	-	-	-	-
Daman & Diu	64.0	-	-	-	-
Delhi	3759.0	4167.4	4882.2	5634.9	5930.4
Goa	575.0	670.7	923.2	954.2	1097.9
Gujarat	7199.0	7781.9	8623.6	10100.0	10395.9
Haryana	2706.0	3288.4	3624.6	4302.3	5378.3
Himachal Pradesh	1533.0	1916.8	2153.0	2378.3	2460.9
Jammu & Kashmir	1954.0	1938.4	2109.3	1904.3	1882.5
Jharkhand	2182.0	2489.2	2853.7	3382.2	3151.8
Karnataka	6015.0	7042.1	8317.5	9705.1	9474.1
Kerala	4772.0	5987.9	6482.1	7099.0	7539.2
Lakshadweep	58.0	-	-	-	-
Madhya Pradesh	5523.0	6012.5	7524.8	7826.0	9672.7
Maharashtra	10052.0	10771.6	12221.9	13054.9	14755.8
Manipur	486.0	479.6	580.2	493.9	667.8
Meghalaya	644.0	814.8	1446.4	1108.5	910.7

Mizoram	451.0	491.0	664.3	653.8	651.2
Nagaland	465.0	495.6	613.3	630.2	668.9
Odisha	3744.0	4790.8	5057.4	5833.2	6293.0
Puducherry	488.0	491.2	504.6	579.7	734.6
Punjab	2801.0	3042.4	2812.7	3437.2	3777.3
Rajasthan	7818.0	8317.9	10068.5	12665.6	12210.7
Sikkim	262.0	283.3	463.2	408.5	427.1
Tamil Nadu	8525.0	8848.1	10864.7	13157.8	13012.4
Telangana	3948.0	5154.0	5213.2	5545.2	7303.8
Tripura	610.0	690.2	785.5	934.9	907.4
Uttar Pradesh	13796.0	16344.1	17265.3	18344.9	20250.2
Uttarakhand	1496.0	1541.9	1659.8	2146.4	2144.7
West Bengal	7976.0	8367.7	9107.1	9982.6	11093.0

Source: Handbook of Statistics on Indian States

Note: -: Unavailable

Appendix C

Table 3. Per capita Expenditure on Health from 2015-2020

State/Union Territory	PCEXP 2015-16	PCEXP 2016-17	PCEXP 2017-18	PCEXP 2018-19	PCEXP 2019-20
Andhra Pradesh	1048.18	1306.86	1307.40	1448.28	1520.63
Arunachal Pradesh	3711.91	4855.38	6350.74	7510.40	6735.37
Assam	873.81	963.82	1346.00	1374.78	1558.16
Bihar	414.85	489.86	550.04	657.48	675.91
Chhattisgarh	1013.76	1216.20	1459.90	1351.72	1666.72
Goa	3830.77	4435.84	6069.69	6232.52	7129.22
Gujarat	1121.09	1194.31	1304.94	1507.23	1531.91
Haryana	1000.96	1197.74	1300.95	1522.07	1875.80
Himachal Pradesh	2159.15	2677.84	2987.78	3279.05	3371.09
Jammu & Kashmir	1530.02	1502.98	1622.66	1453.55	1425.81
Jharkhand	619.21	695.30	785.40	917.35	842.65
Karnataka	945.72	1096.40	1284.51	1486.80	1439.87
Kerala	1389.47	1731.70	1864.76	2031.59	2146.39
Madhya Pradesh	712.00	762.94	941.21	965.10	1176.26
Maharashtra	855.80	907.25	1019.60	1078.81	1207.97
Manipur	1630.87	1592.29	1907.29	1607.22	2152.11
Meghalaya	2080.10	2604.02	4575.76	3472.74	2824.75
Mizoram	3938.86	4243.73	5682.63	5535.98	5463.08
Nagaland	2251.81	2375.83	2909.39	2960.07	3111.16
Odisha	859.34	1089.66	1141.31	1306.19	1398.32
Punjab	970.51	1044.06	957.35	1160.47	1265.04

Rajasthan	1069.46	1120.40	1338.04	1660.93	1580.38
Sikkim	4113.02	4399.06	7126.15	6217.65	6350.90
Tamil Nadu	1149.89	1185.51	1448.83	1746.40	1719.05
Telangana	1091.51	1413.52	1419.94	1500.04	1962.33
Tripura	1591.02	1781.62	2006.89	2365.03	2273.04
Uttar Pradesh	648.21	756.36	788.18	826.29	900.09
Uttarakhand	1408.53	1433.65	1524.99	1948.96	1925.05
West Bengal	845.64	880.07	951.74	1036.64	1144.71

Source: Population- Population Projection for India and States 2011-2036 (2020).

Note- Population used for calculating per capita public expenditure on health is projected population.

Appendix D

Table 4. State-wise Life Expectancy (years)

State/Union Territory	2012-16			2013-17			2014-18			2015-19		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
	59	60	61	62	63	64	65	66	67	68	69	70
Andhra Pradesh	68	71.4	69.6	68.3	71.2	69.7	68.7	71.4	70.0	68.9	71.8	70.3
Assam	64.4	66.8	65.5	65.4	67.3	66.2	66.1	67.9	66.9	66.8	68.3	67.5
Bihar	68.9	68.5	68.7	69.2	68.6	68.9	69.4	68.7	69.1	69.6	68.8	69.2
Chhattisgarh	63.6	68.5	65.2	63.8	66.6	65.2	63.7	66.6	65.2	63.7	66.9	65.3
Delhi	72.7	68.5	74.2	73.3	76.3	74.7	73.8	77.0	75.3	74.3	77.5	75.9
Gujarat	67.4	68.5	69.5	67.6	72.0	69.7	67.8	72.3	69.9	67.9	72.8	70.2
Haryana	67.2	68.5	69.4	67.6	72.3	69.7	67.7	72.3	69.8	67.7	72.6	69.9
Himachal Pradesh	69.4	68.5	72.3	69.8	75.6	72.6	69.6	76.8	72.9	69.9	77.1	73.1
Jammu & Kashmir	71.6	68.5	73.5	72.1	76.7	74.1	72.2	76.2	74.0	72.6	76.1	74.2
Jharkhand	67.8	68.5	67.9	68.8	68.4	68.6	69.9	68.5	69.1	70.2	68.8	69.4
Karnataka	67.6	68.5	69.1	67.7	70.8	69.2	67.9	70.9	69.4	67.9	71.3	69.5
Kerala	72.2	68.5	75.1	72.5	77.8	75.2	72.5	77.9	75.3	72.3	78	75.2
Madhya Pradesh	63.7	68.5	65.4	64.2	67.9	66.0	64.8	68.5	66.5	65.2	69.1	67
Maharashtra	70.8	68.5	72.2	71.2	73.9	72.5	71.3	73.8	72.5	71.6	74	72.7
Odisha	66.2	68.5	67.6	67.1	69.9	68.4	68.0	70.8	69.3	68.5	71.1	69.8
Punjab	71	68.5	72.5	71.0	74.0	72.4	71.0	74.8	72.7	71.1	74.7	72.8

Rajasthan	66.1	68.5	68.3	66.3	70.9	68.5	66.5	71.6	68.7	66.8	71.3	69
Tamil Nadu	69.5	68.5	71.4	69.9	73.7	71.7	70.2	74.2	72.1	70.6	74.9	72.6
Telangana	-	-	-	-	-	-	68.6	70.2	69.6	68.6	71.1	69.8
Uttar Pradesh	63.9	68.5	64.8	64.3	65.6	65.0	64.8	65.8	65.3	65	66.2	65.6
Uttarakhand	68.5	68.5	71.5	68.8	74.2	71.0	67.9	74.3	70.9	67.6	73.9	70.6
West Bengal	69.8	68.5	70.8	70.4	72.2	71.2	70.7	72.6	71.6	71	73.2	72.1
ALL INDIA	67.4	68.5	68.7	67.8	70.4	69.0	68.2	70.7	69.4	68.4	71.1	69.7

Table 4. State-wise Life Expectancy (continued)

State/Union Territory	**2016-20**		
	Male	**Female**	**Total**
	71	**72**	**73**
Andhra Pradesh	69.1	72.2	70.6
Assam	67.3	68.6	67.9
Bihar	69.7	69.2	69.5
Chhattisgarh	63.5	66.8	65.1
Delhi	74.1	77.7	75.8
Gujarat	68.1	73.2	70.5
Haryana	67.3	73.0	69.9
Himachal Pradesh	70.3	77.5	73.5
Jammu & Kashmir	72.6	76.3	74.3
Jharkhand	70.5	68.9	69.6
Karnataka	67.9	71.9	69.8
Kerala	71.9	78.0	75.0
Madhya Pradesh	65.5	69.5	67.4
Maharashtra	71.6	74.3	72.9

Odisha	69.1	71.4	70.3
Punjab	70.8	74.5	72.5
Rajasthan	67.1	71.7	69.4
Tamil Nadu	71.0	75.5	73.2
Telangana	68.7	71.4	70.0
Uttar Pradesh	65.3	66.7	66.0
Uttarakhand	67.5	73.9	70.6
West Bengal	71.1	73.6	72.3
ALL INDIA	68.6	71.4	70.0

Source: Handbook of Statistics on Indian States

Note: Data relating to Bihar, Madhya Pradesh and Uttar Pradesh include Jharkhand, Chhattisgarh and Uttarakhand, respectively.

Human Development and Poverty Indices: A Case Study of Brick KILN Workers in Haryana

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Abstract:

This paper reviews the Human Development Index (HDI) and Poverty Index (PI) of the brick kiln labourers in the state of Haryana in India in order to assess their socio-economic status. The research brings forth the enormous hurdles faced by these workers like earning very low income, lack of basic services, poor health and low educational levels. The analysis shows that the backlog of human development indices is heavy among the squatter settlement industrial workers. The study focuses on the need to implement minimal steps by policy-oriented bodies for the improvement of socioeconomic and working conditions of brick kiln construction workers. The following measures include enhancing self-sufficiency, improving social protection, enhancing employment laws, and making education and health more available and active. The research has found that it is necessary to box the pessimistic order of abject poverty for brick kiln workers in Haryana through sustaining and improving the socio-economic conditions that had previously been reversed and exacerbated.

Keywords: Brick Kiln Workers, Human Development Indices, Poverty Indices, SDGs.

1. INTRODUCTION:

Brick kiln workers are one of the most marginalized and vulnerable groups of workers in India. The brick kiln industry plays an important role in the manufacturing trade, which is crucial for the development of the country's raw materials. However, bricks are often made under abusive and harsh conditions. Workers in this sector often endure dangerous working conditions, fair wages, and extended hours. Most of these workers are migrants from cash-strapped states including Bihar, Uttar Pradesh and West Bengal, who migrate to Haryana in search of more lucrative employment opportunities Haryana has a large number of brick kilns, a state that it is growing rapidly and manufacturing is improving. Despite its significant contribution to the country's economic growth, the living and working conditions of brick kiln workers remain dismal. The human development of all these workers is severely affected by the lack of access to basic facilities such as clean water, sanitation, health care and so on. Furthermore, the high prevalence of child labour, indentured labor and lack of education among these workers highlights the need for comprehensive policy interventions.

Indonesia's HDI is boosted by employment, economic growth rate, FDI, and domestic investment, with employment and FDI being particularly important in strengthening the country's economy. **(Feriyanto, N. (2016))**. The association between HDI and various variables, including literacy rate, income, and income, is significant, suggesting a positive correlation between these factors. **(Singariya, M. R. (2014))** The socioeconomic situation of brick kiln workers must be studied for several reasons. It first highlights the condition of an unseen and underrepresented worker population in policy deliberations. It then raises larger issues of social fairness, economic exploitation, and worker rights. Understanding these workers' human development and poverty indexes reveals their quality of life and structural obstacles. This may help create more effective policies that fulfil their needs and improve their quality

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of life. Construction relies on brick kiln workers, yet their efforts are often disregarded. The paper highlights socio-economic challenges this group confronts and proposes solutions. Due to the high movement rate of migrant workers in Haryana, the study examines their dynamics and their effects on human development.

The educational component is adversely affected by the substantial impact of migrant labourers on HDI ranking. 14 countries with a migrant guest worker population exceeding 30% have high HDI rankings, demanding a thoughtful interpretation. **(Mamtani et. al. 2014)**

UN-established Sustainable Development Goals (SDGs) address global issues including poverty, inequality, and sustainable development. Brick kiln workers are among the most underprivileged and sometimes have significant developmental gaps. This research compares Haryana brick kiln workers' HDI and HPI to state averages. By prioritizing these indicators, it becomes evident that there is a pressing need to accomplish many Sustainable Development Goals (SDGs), namely in the areas of health, poverty eradication, significant employment, and decrease of inequality.

2. OBJECTIVES OF THE STUDY:

- To measure the Human Development Index and Multidimensional Poverty Index of brick kiln workers of Haryana.
- To compare the HDI and MPI of brick kiln workers with HDI and MPI of Haryana state.
- To examine the attainment of SDGs for brick kiln workers.

3. RESEARCH METHODOLOGY:

3.1 Data Collection

This study utilizes a mixed-methods approach, which involves the integration of qualitative insights and quantitative data acquisition to conduct a thorough evaluation of the human development and poverty indices of brick kiln labourers in Haryana. Data was gathered from a sample of 100 brick kiln labourers, who were randomly selected from each of Haryana's six administrative divisions: Ambala, Rohtak, Hisar, Gurgaon, Karnal, and Faridabad. The participants were chosen to ensure that the sample was representative of a variety of socio-economic circumstances, including gender, age, and migration status.

Quantitative data were collected through structured interviews with standardized questions on important aspects of human development, including education, health, income and living conditions, in addition to in-depth interviews interviewing local officials, kiln owners and workers to obtain a detailed understanding of the social -economic challenges faced by workers. Similarly, qualitative data were collected through focus group discussions.

Representative Nature of the Population: The sample size was decided in such a way so as to fairly represent the brick kiln worker population from the study area. While this may be somewhat difficult given that the workers are often employed informally, the sample taken stood as an adequate percentage of the accessible workforce in the area. The cross –sectional study was conducted to collect information on workers basing upon age gender and class factors in order to make the picture representative of brick kiln workers in Haryana, as a whole.

The sample is collected according to the six divisions of Haryana. The sample size determined according to total no. of brick kiln in the division.

3.2 Divisions of Haryana:

Sr. no	Division	Total no. of brick kilns	Percentage share of brick kilns	Total sample size taken
1	Ambala	454	14	13
2	Hisar	904	28.41	29
3	Gurugram	434	13.64	14
4	Karnal	322	10.12	10
5	Rohtak	879	27.63	28
6	Faridabad	189	5.93	6

Source: Directorate of Food and Supplies, Govt. of Haryana, Chandigarh. And calculation by author.

3.2.1 Sample Size Justification Using Power Analysis: In order to justify the sample size of 100 brick kiln workers for this study, a power analysis was performed using the following parameters:

Effect size (Cohen's d): 0.8(large effect size)

Level of significance (α): 0.05

Desired power: 0.80 (the probability of detecting an effect if it truly exists is 80%)

Sample size (n): 100 workers

The power of the study was estimated by employing these parameters as follows:

Power: 1- Type error rate.

A power analysis for a two-tailed t-test for independent means was conducted and a large effect size of 0.8 has been assumed. As a result, the power for the study is quite high and it is in the range of 0.9999 or 99.99%.

This implies that in a study with 100 worker samples, risks of false negative findings make the study more likely to determine a large effect size (0.8) in the observed differences between brick kiln workers' HDI and MPI in any of the six divisions of Haryana and the population at large, than it is not.

Power was estimated at 0.9999 for a study with a large effect size (0.8), a sample size of 100, and an alpha level of 0.05.

So, in this case, a second error (β) is possible:

$\beta = 1 - \text{Power}$

substitute the power value:

β= 1- 0.9999= 0.0001

Therefore, the probability of a Type II error is 0.0001 or 0.01%.

These figures confirm that the study has a very high power (99.99%) to detect effect size, and the risk of missing a true effect (Type II error) is very low at 0.01% .

A sample size of 100 employees gives a power of 99.99%, with a negligible Type II error rate.

3.3 The Statistics of Human Development Index

Each worker's Human Development Index (HDI) was determined using three main factors:

$$\sqrt[3]{Life\ Expectancy\ Index\ (LEI) * Education\ Index(EI)\ * Income\ Index\ (II)}$$

3.4 Human poverty Index (HPI) calculation:

$$\left[\frac{1}{3}(p_1^3 + p_2^3 + p_3^3) - 3\right]^{\frac{1}{3}}$$

P_1: Number of individuals not expected to live to 40 years

P_2: Percentage of adult literacy rate

P_3: deprivation index

$P_3 = \frac{P31+p32}{2}$

P_{31}: Percentage of people without access to clean water, sanitation, and healthcare

P_{32}: the percentage of underweight children under age 5 (whichever is worse)

The HPI was calculated as a composite index by averaging the deprivation metrics across the three dimensions.

3.5 Calculation of MPI: Headcount Ratio **(H)** × Intensity of Poverty **(A)**

3.6 Data Analysis

The HDI, HPI and MPI values for the sample were determined by analysing the accumulated data using statistical software. The socio-economic characteristics of the workers were summarized using descriptive statistics, and regional disparities were identified by conducting comparative analyses across brick kiln workers in Haryana and Haryana. To enhance the quantitative findings, qualitative data was thematically analysed to offer a comprehensive comprehension of the obstacles encountered by brick kiln labourers in Haryana.

4. HUMAN DEVELOPMENT INDEX OF BRICK KILN WORKERS:

The United Nations Development Program's Human Development Index classifies countries according to human development. Unlike GDP, which measures economic growth alone, the HDI includes education, age, and standard of living to measure well-being. Age at birth is a reliable indicator of population health and life expectancy. The education dimension includes expected school years as juniors and average school years for adults considering existing and potential education options. Gross domestic product (GNI) adjusted for purchasing power parity (PPP) measures financial wealth. By incorporating this attribute, the HDI provides a comprehensive view of human development and shows how governments can improve the lives of citizens. It provides scholars and policymakers with a comprehensive picture of countries' development and guides their efforts to improve human well-being.

Sen emphasized HDI as a comprehensive human development indicator, encompassing important elements of well-being that extend beyond income, emphasizing autonomy and empowerment. **(Sen (1999)).** While assessing the Human Development Index (HDI) of brick kiln workers in Haryana, the three key dimensions of health, education and standard of living should be adjusted to suit their unique circumstances :it helps in reducing expectations , which shows the high health risks faced daily brick kiln workers have low literacy rates, many adults lack adequate education, and often miss out on children's education due to labor demand This lack of education hinders their empowerment the course of rising socio-economic status. The standard of living for these workers is often low, as their wages are often insufficient to meet basic needs. This limits poor living conditions and inadequate access to safe water, sanitation and housing. The calculated HDI for brick kiln workers in Haryana is expected to reflect much lower levels of human development than the general population. This highlights the urgent need for targeted interventions to improve their overall quality of life and health.

The HDI provides a comprehensive view of development by including health and education; However, he also suggested that the index could be improved to include more robust indicators **(Desai, 1991).**

4.1 Calculation of HDI of brick kiln workers:

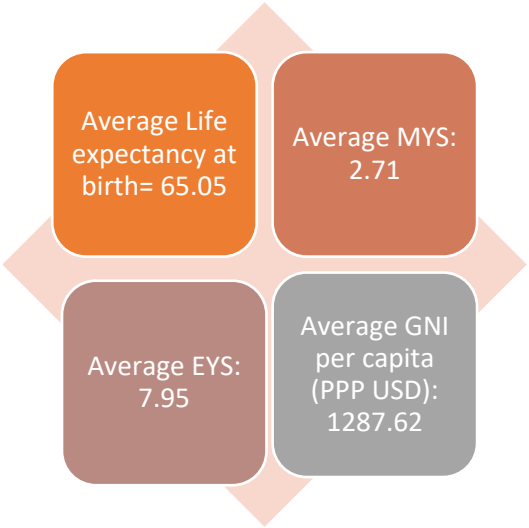
Initially calculation of averages of primary data collected

Average Life expectancy at birth: ∑Life Expectancy at Birth of all workers / total Number of workers

Average MYS= ∑Mean Years of Schooling of all workers/ total Number of workers

Average EYS=∑Expected Years of Schooling of all workers/ total Number of workers

Average GNI per capita (PPP USD): Average GNI=∑GNI per capita of all workers/ total Number of workers



Source: calculated from primary data.

Calculation of aggregate HDI

Life Expectancy Index (LEI)= $\frac{65.05-20}{85-20} = 0.693$

Mean Years of Schooling Index (MYSI): $\frac{2.71-0}{15-0} = 0.181$

Expected Years of Schooling Index (EYSI): $\frac{7.95-0}{18-20} = 0.442$

Education Index (EI): $\frac{0.181+0.442}{2} = 0.311$

Income Index (II): $\frac{\log(1287.62)-\log(100)}{\log(75000)-\log(100)} = 0.386$

Aggregate HDI: $\sqrt[3]{0.693 * 0.311 * 0.386} = 0.437$

4.2 Human Poverty Index:

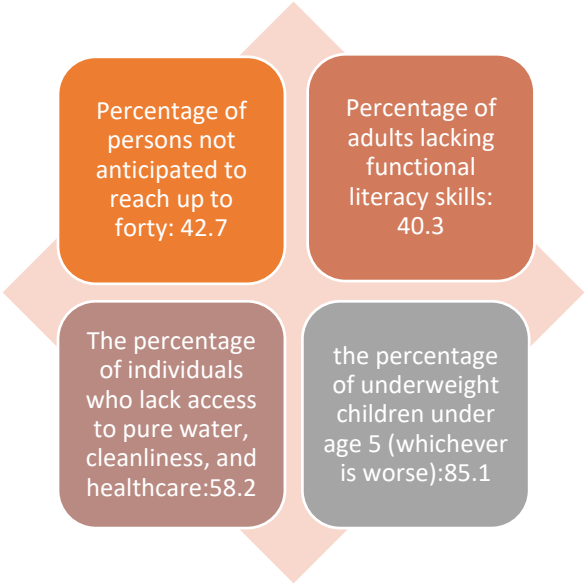
Based on poverty theory, three main factors help to define the human poverty index:

Longevity: This is expressed as the percentage of people who do not expect to live beyond forty. It captures the risk of premature death, and therefore reflects the overall state of health and well-being in the community.

Literacy: This is measured by the proportion of adults with no functional literacy skills. The emphasis is on educational problems in a segment of society, which can impede personal growth and economic opportunities.

Standard of Living: This data focuses on the number of people who lack basic amenities such as health care, sanitation and drinking water. It includes indicators of malnutrition and poor health, such as the number of underweight children under five. This aspect refers to the general living conditions and the ability of society to meet basic needs, especially for vulnerable populations such as children

Together, these factors, which relate to basic aspects of people's lives, form a broader picture of poverty that transcends the income line.



Source: Calculated from primary data

Human Poverty Index (HPI)

$$\left[\frac{1}{3}(p_1^3 + p_2^3 + p_3^3) - 3\right]^{\frac{1}{3}} \quad \left[\frac{1}{3}(42.7^3 + 40.3^3 + 87.1^3) - 3\right]^{\frac{1}{3}} = 0.644$$

5. MULTIDIMENSIONAL POVERTY INDEX (MPI) OF BRICK KILN WORKERS:

There are many forms of poverty experienced by individuals, and the Multidimensional Poverty Index is a comprehensive database that analyses these forms of poverty in three main dimensions: health, education, and quality of life. These measures include many factors such as nutrition, child mortality, years of schooling, school attendance, safe drinking water, sanitation, electricity, housing, and property ownership A person is said to be poor in many different aspects in that he does not have one-third or more of these weighted values.

The global MPI 2018 aligned five metrics with the SDGs. The study emphasizes poverty measurement to address the lack of information. Many research problems remain, such as data availability, interactions between people and families, the need to measure poverty in different ways and many users can use global MPI to detect and combat it poverty in many SDGs. Research and public action are needed to enhance the measurement of poverty. (**Alkire, S., & Jahan, S. (2018)**. The Multidimensional

Poverty Index provides a comprehensive understanding of poverty by measuring its magnitude and magnitude across multiple dimensions. This will lead to more successful and effective policies and programs to address poverty on a global scale. There are many forms of poverty experienced by individuals, and the Multidimensional Poverty Index is a comprehensive database that analyses these forms of poverty in three main dimensions: health, education, and quality of life. These measures include many factors such as nutrition, child mortality, years of schooling, school attendance, safe drinking water, sanitation, electricity, housing, and property ownership A person is said to be poor in many different aspects in that he does not have one-third or more of these weighted values.

Table: 1, Deprivation Scores and MPI of brick kiln workers.

Dimensions	Indicators	Total percentage of workers deprivation identified (Deprivation scores)	Weighted Deprivation Scores
Health	Nutrition	66	66×0.167=11.022
	Child Mortality	47	47×0.167=7.849
education	At least six years of schooling	68	68×0.167=11.356
	Are the worker's children not attending school until they reach the age at which they must finish 8th grade?	69	69×0.167=11.523
Standard of living	Cooking Fuel	88	88×0.056=4.928
	Sanitation	100	100×0.056=5.6
	Drinking Water	72	72×0.056=4.032
	Electricity availability	32	32×0.056=1.792
	Pucca House	94	94×0.056=5.264
	Assets	93	93×0.056=5.208
	Total Deprivation Score for All Workers		68.574
	Average Deprivation Score per Worker		68.574/100=0.6857

Source: Analysis of the preliminary data collected by the author

A multidimensional poverty index is calculated for a group of workers with particular emphasis on three key areas: health, education, and quality of life, as shown in Table 1. Each dimension is evaluated on the basis of specific data. Some indicators of health issues include nutrition, for which 66 workers are recognized as healthy, and child mortality, affecting 47 vulnerable workers, are assessed by

education to determine whether individuals completed at least years six education (68 disadvantaged) and whether their children completed complete 8th grade whether they are enrolled in school until they reach the appropriate age (69 disadvantaged). The standard of living includes several indicators, such as the type of fuel used for cooking, with 88 workers not having enough fuel other indicators are sanitation, with 100 workers lacking adequate facilities, safe drinking water, 72 workers lack this basic need, electricity availability, 32 workers do not have rights, good housing, 94 workers live in substandard conditions and own property, including 93 who do not have significant property.

To calculate a weighted score related to absenteeism, the number of innocent workers is multiplied by the weight assigned to each symptom. For example, the nutrition record has a mean score of 11.022, which is calculated by multiplying the number of employees (66) by their weight (0.167) and the child mortality score is 7.849. The table calculates the total score for all employee exemptions by summing these weighted scores, yielding a score of 68.574.

The average score for each employee is obtained by dividing the total score by the number of employees (100) and a mean score of 0.6857 is obtained. The median score provides insight into the severity of poverty in the workforce.

Identification of Multidimensionally Poor

- Threshold: 33.3%
- 69 workers have deprivation scores above the threshold.

Headcount Ratio (H): $\frac{69}{100} = 0.69$

Intensity of Poverty (A) = 0.6857

MPI Calculation (MPI) = H×A= 0.69×0.6857 = 0.4731

Based on available data, the MPI (multidimensional poverty index) of 100 brick kiln workers is estimated to be 0.4731. These data show the extent (69% poor) and severity (68.57%) of their poverty.

6. COMPARING HDI AND MPI OF BRICK KILN WORKERS WITH HARYANA: SDGs ACHIEVEMENT

When compared to the whole population of Haryana, the Human Development Index and Multidimensional Poverty Index of brick kiln workers provide a revealing perspective on the disparities that exist in terms of the achievement of the Sustainable Development Goals. There has been a disparity in the degree to which different demographic groups in Haryana have benefitted from the state's improving economic conditions, educational opportunities, health care, and overall living standards. The condition of brick kiln workers, a group that is victimized and sometimes overlooked, brings to light the limitations of development plans since they are subjected to a great deal of hardship in a variety of domains. Through this study, the difficulties that excluded groups experience in achieving the Sustainable Development Goals (SDGs) are brought to light, and a demand is made for specific actions to bridge the accomplishment gap.

Tabele:2 Comparison of HDI of brick kiln workers and Haryana.

HDI Indicators	Indicator values of brick kiln workers	Indicator values of Haryana
Life Expectancy Index (LEI	0.693	0.756
Education Index (EI	0.311	0.613
Income Index (II	0.386	0.713
HDI	0.437	0.691

Source: Global data lab by Institute for Management Research, Radboud University, and computation by author

Brick kiln workers in Haryana had much lower earnings, lower levels of education, and shorter life expectancies than the general population, as shown by key indicators taken from the Human Development Index (table 2). Brick kiln workers only manage to achieve a Life Expectancy

Index of 0.693, which is much lower than Haryana's 0.756. This is most likely due to the fact that these individuals have shorter life spans as a result of the hazardous goods they work with, the inadequate medical treatment they get, and the severe working circumstances they are subjected to. Construction workers at brick kilns in Haryana have an Education Index (EI) of 0.613, which is much lower than the average for the state, which is 0.311. This specific group is afflicted with a severe deficiency in educational opportunities, as seen by the gap that exists between them and the general population. This deficiency is compounded by the widespread employment of children. Additionally, when compared to Haryana's value of 0.713 on the Income Index (II), the result for brick kiln workers is 0.386, which is much lower. Consequently, this indicates that the working conditions in the brick kiln industry are not formal, and the remuneration is not satisfactory. Haryana's Human Development Index (HDI) is 0.691, which is much higher than the aggregate HDI for brick kiln workers, which is 0.437. This is because of the lower indices. In the conclusion, the disparities in these variables demonstrate that brick kiln workers have a difficult time in comparison to the rest of Haryana's population in terms of human development. This is due to the severe working and living conditions that they are forced to face. This discrepancy is reflected in every aspect of their lives, including their lower income, lower levels of education, and shorter life expectancy.

Table:3 Comparison of deprivation scores and MPI of brick kiln workers in Haryana and of Haryana.

Dimensions	Indicators	Weighted Deprivation Scores of brick kiln workers	Total percentage of workers deprivation identified in Haryana (By report NFHS 2019-21)	Weighted deprivation scores in Haryana
Health	Nutrition	66×0.167=11.022	26.19	4.374
	Child Mortality	47×0.167=7.849	1.85	0.309
education	At least six years of schooling	68×0.167=11.356	5.51	0.93
	Are the worker's children	69×0.167=11.523	4.31	0.72

	not attending school until they reach the age at which they must finish 8th grade?			
Standard of living	Cooking Fuel	88×0.056=4.928	43.93	2.47
	Sanitation	100×0.056=5.6	15.11	0.847
	Drinking Water	72×0.056=4.032	6.71	0.38
	Electricity availability	32×0.056=1.792	0.40	0.023
	Pucca House	94×0.056=5.264	23.95	1.35
	Assets	93×0.056=5.208	5.21	0.292
	Total Deprivation Score for All Workers	68.574		11.695
	Average Deprivation Score per Worker	68.574/100=0.6857		
Headcount Ratio		0.69	0.4334	
Intensity of Poverty		0.6857	0.0707	
MPI Calculation		0.4731	0.031	

Source: Calculation of primary data collected by author and https://www.niti.gov.in/sites/ default /files/2023-08/India-National-Multidimentional-Poverty-Index-2023.pdf

When the Multidimensional Poverty Index (MPI) indicators for brick kiln workers in Haryana are compared with the total population of Haryana, it is possible to see that there are significant inequalities in the poverty rates affecting health, education, and quality of life. This author's own examination of primary data acquired from brick kiln workers in Haryana lends weight to these results, which are backed by the National Family Health Survey (NFHS) 2019-21. Those who work in brick kilns have a weighted deprivation score of 11.022 when it comes to nutrition, and 66 percent of them are experiencing hunger. On the other hand, the state of Haryana has a score of 4.374, and around 26.19 percent of its people is considered to be living in poverty. The remarkable discrepancy shows that workers in brick kilns are more likely to suffer from malnutrition. This might be due to the fact that they get poor earnings and have limited access to diets that are high in nutrients. The child mortality rate among brick kiln workers is much higher than the score of 0.309 (1.85% poor) that Haryana received. The rate of 7.849 (47% destitute) is significantly higher. The gap is a result of the fact that the rates of child mortality are greater among workers in brick kilns. This is because of the severe living and working circumstances that these workers are constantly exposed to.

There is also a clear indication of the magnitude of the deprivation in the field of education. 68% of brick kiln workers have been deprived at some point in their lives, and their weighted score for the number of years they have spent in school is 11.356. A far lower score of 0.93 is assigned to the state of Haryana, which has a poverty rate of just 5.51 percent of its population. In general, brick kiln workers are confronted with financial restrictions, early labor engagement, and restricted access to educational resources; this disparity highlights the serious educational disadvantage that they face. Despite the fact that 69% of brick kiln workers are considered to be disadvantaged (deprivation score: 11.523), just 4.31 percent of the population in Haryana is considered to be impoverished (deprivation score: 0.72). This disparity is comparable to the one that occurs in the proportion of the population that attends school. The results of this study indicate that a significant number of children who come from families who

are employed in brick kilns do not have the chance to attend school. One possible explanation for this is that they are being compelled to work as children, that they are often moved, or that they are not getting sufficient assistance for their education. The inequalities in deprivation ratings across a number of variables shed light on the tremendous poverty and challenging living circumstances that brick kiln workers in Haryana are forced to face in comparison to the overall population of the state.

6.1 Sustainable Development Goals (SDGs) Attainment for Brick Kiln Workers

During the year 2015, the United Nations approved a series of objectives that are referred to as the Sustainable Development Goals (SDGs) with the intention of combating poverty and inequality and ensuring long-term prosperity. By the year 2030, these goals will have been achieved as a result of the policies and efforts that have been implemented by governments all over the world. Haryana, a state in India, has been making significant progress toward the Sustainable Development Goals (SDGs). In an effort to improve the health of the general population, it has launched a variety of different projects. The state of Haryana, which is well-known for its thriving economy, has made great progress in reducing poverty, expanding education, improving healthcare, and enabling urbanization. However, the benefits of these advancements have not been distributed evenly among all populations. While the living standards of the majority of Haryana's people have improved, as has their access to various services, there are still sectors of the population that remain underprivileged and continue to struggle with various issues. There is a substantial workforce in the state that runs brick kilns, but they are not given the recognition they deserve. Brick kiln workers in Haryana are subjected to a number of challenges, including low pay, long hours, and potentially hazardous working conditions. It is estimated that a significant percentage of these workers have emigrated from neighbourhoods and families with low incomes. The majority of the time, informal labourers are not eligible for benefits or protections while they are on the job. Due to the fact that they are vulnerable, they have a reduced capacity to get the healthcare, education, and fundamental needs that they require once they have left their place of employment. Goal 1: Achieving Zero Poverty; Goals 3–5: Achieving Good Health and Well-Being; Goal 4: Achieving Quality Education; Goal 8: Achieving Decent Work and Economic Growth; Goal 10: Achieving Reduced Inequality; and Goal 11: Achieving Sustainable Cities and Communities are the six Sustainable Development Goals (SDGs) that are compared in this analysis with the population of Haryana and the brick kiln workers. The purpose of this essay is to examine these objectives from the perspective of brick kiln workers in order to illustrate the massive socioeconomic gaps that exist in the field of sustainable development. Brick kiln workers continue to be denied access to vital opportunities and services that may significantly improve their quality of life, despite the fact that the neighbourhood has benefitted from a number of programs that have been led by the government. As a result of this comparison, it is abundantly evident that workers in brick kilns need particular help in order to address the specific challenges they face. The implementation of a number of measures is necessary in order to ensure that the state's progress toward the Sustainable Development Goals (SDGs) is both equitable and inclusive. Given that the comparison draws attention to the differences in Haryana's Sustainable Development Goals (SDGs), it is necessary to adopt a governance strategy that is more nuanced and takes into consideration the interests of all persons.

It is possible for the Sustainable Development Goals (SDG) to be accomplished in poor nations with little to no effect on the economy or society if the informal sector is included. In this research, a bidirectional causal link between informal employment and economic development is shown via the use of panel data analysis in combination with macroeconomic parameters. It has been determined that the economy is comprised of both formal and informal sectors, as shown by the information obtained. The work of **Sultana, Rahman, and Khanam (2022)** serves as the basis for this. For the purpose of

accomplishing the Sustainable Development objectives (SDGs), it is not sufficient to simply have broad objectives. It is of the highest significance to have a complete understanding of the difficulties that are experienced by the most socioeconomically disadvantaged groups and to put into action solutions that are specifically geared to address these issues.

Table: 4 Sustainable Development Goals (SDGs) Attainment for Brick Kiln Workers

SDG	General Haryana	Brick Kiln Workers of Haryana
SDG 1: No Poverty	A higher Human Development Index (HDI) of 0.691 than the brick kiln workers' HDI of 0.437 shows that the economy is in much better shape. Haryana has a Multidimensional Poverty Index (MPI) of 0.031, which means that poverty is not too bad there. Efforts to Reduce Poverty: Programs at the state level, such as PMAY and Mukhya Mantri Parivar Samridhi Yojana, have helped reduce poverty, but there are still areas of severe poverty, especially in rural areas.	An MPI of 0.4731 and a poverty intensity of 0.6857 imply severe poverty for these workers. Brick kiln workers are more impoverished in diet, sanitation, and housing.
SDG 3: Good Health and Well-being	Improved Healthcare Accessibility: AB-PMJAY and NHM have reduced maternal and neonatal mortality by improving healthcare access. Rural-urban disparities and healthcare infrastructure gaps are issues. A Life Expectancy Index (LEI) of 0.756 means that people can expect to live quite long time. The health factors point to a better overall health state, but there are still problems, especially in poor and rural places.	Children die more and have poorer access to health care (7.849 deaths per 100,000 vs. 0.309 in Haryana). Brick kiln workers have alarmingly high food insecurity (11.022 vs. 4.374 in Haryana), causing serious health issues.
SDG 4: Quality Education	Education Progress: Programs like SSA and Beti Bachao, Beti Padhao have made it easier for more people to get an education, but there are still problems with quality and dropout rates, especially in rural areas. The Education Index (EI) is 0.613, which means that students are doing better in school. There isn't much lack in learning, and most kids go to school.	Educational inadequacy is shown in the Education Index of 0.311. Unlike Haryana, where educational disadvantage is substantially smaller, many students fail to finish grade 8 (11.523 years).
SDG 8: Decent Work and Economic	Economic growth in Haryana is robust because of the state's robust industrial base and initiatives to improve vocational skills, such as	A 0.386 income index suggests their work generates little economic results. Their job has

Growth	the Pradhan Mantri Kaushal Vikas Yojana (PMKVY). Nevertheless, challenges include unemployment and inequality in the labour market. Economic conditions are conducive to improved employment prospects and economic expansion, as evidenced by an Income Index of 0.713.	poor working conditions and little economic mobility.
SDG 10: Reduced Inequality	Despite SCSP and other programs to eliminate gender and caste inequality, rural disparities stay the same.	Systemic inequities: Marginalized brick kiln workers face significant social and economic inequities, including limited government programs and social mobility. Gender inequality is extreme.
SDG 11: Sustainable Cities and Communities	Urban Development: The Smart Cities Mission and AMRUT are improving urban infrastructure, but affordable housing and urban growth remain.	Poor Living Conditions: Workers live in substandard housing with poor sanitation and limited services. Government-implemented urban development has not improved citizens' lives.

In terms of fulfilling the Sustainable Development Goals (SDGs), the general population of Haryana and workers in brick kilns have drastically different degrees of achievement, according to the statistics. Both the management of poverty and the promotion of Sustainable Development Goal 1 (No Poverty) in Haryana are aided by a better economic condition, as shown by a lower MPI and a higher HDI. This indicates that there are widespread issues with housing, sanitation, and nutrition among brick kiln workers, as shown by their low HDI and MPI. By engaging in healthcare access initiatives, which contribute to Sustainable Development Goal 3 (Good Health and Well-being), the general population of Haryana has the potential to raise their life expectancy and minimize the number of difficulties they have with their health. Because of the high rates of infant mortality and nutritional poverty that brick kiln workers endure, there is a possibility that health inequities are at play among these individuals. In terms of Sustainable Development Goal 4 (Quality Education), Haryana has achieved significant progress. This is largely attributable to the state's high Education Index as well as the fact that the majority of its young people are students and are getting educational advantages. Children of brick kiln workers, who often skip school, are subject to educational challenges that are reflected in a lower Education Index. These children are frequently absent from school.

Haryana is able to accomplish Sustainable Development Goal 8 (Decent Work and Economic Growth) by increasing employment and economic growth. This is made possible by investments in industry development and skill-building inside the state. The low economic returns and poor working conditions that brick kiln workers experience are two factors that lead to a lower Income Index. These factors make it difficult for brick kiln workers to advance their careers. Brick kiln workers are a disadvantaged group that faces gender discrimination, limited government aid, and systemic social and economic

imbalances. This makes it all the more difficult to accomplish Sustainable Development Goal 10 (Reduced discrimination), which says that discrimination should be reduced. Lastly, but certainly not least, the affordable housing dilemma from Sustainable Development Goal 11 continues to exist despite the improved infrastructure in Haryana's growing urban regions (Sustainable Cities and Communities). Workers at brick kilns are a classic example of how urbanization has ignored their need for amenities such as proper housing, sanitation, and other services.

Conclusion:

As part of this study, a comparison is made between the people who work in brick kilns in Haryana and the entire population of the state. Additionally, an analysis of the scores on the Multidimensional Poverty Index and the Human Development Index is provided. The results point to evident disparities due to the fact that workers in brick kilns had a higher Multidimensional Poverty Index and a substantially lower Human Development Index, both of which suggest severe deprivation in a variety of dimensions. When compared side by side, the Sustainable Development Goals (SDGs) make it abundantly evident that workers in brick kilns are lagging far behind in regards to critical areas such as healthcare, education, employment, and the reduction of inequities. Despite the fact that Haryana has been successful as a whole, these statistics demonstrate that groups who are already at a disadvantage, such as workers in brick kilns, are being left behind as a result of the uneven distribution of the advantages of development. Specifically tailored policies and initiatives are urgently required to meet the specific issues that these workers are confronted with, as the research demonstrates. The implementation of this will guarantee that the state's development efforts are comprehensive and that the Sustainable Development Goals framework does not exclude any group.

A variety of legal changes might significantly enhance the lives of brick kiln workers, according to the findings of researchers in the state of Haryana. In order to relieve their acute multidimensional poverty, it is required to implement a variety of programs that include housing subsidies, direct monetary transfers, and food security programs. Health care that is provided on a regular basis and mobile health clinics are required in order to address severe health disparities, particularly among youngsters. Educational assistance programs should offer children of brick kiln workers with lunch money, tutors, and scholarships in order to assist these youngsters in completing their education and climbing out of poverty. In order for these persons to attain economic stability and dignity, it is essential that labor legislation that seek to improve working conditions and wages be consistently enforced. In order to achieve economic and social inclusion, it is necessary to implement social protection programs that include workers in brick kilns, combat gender discrimination, and, as a final step, improve infrastructure for potable water, sewage, electricity, and permanent housing in order to raise living standards and promote long-term sustainability. There is a direct correlation between Haryana's implementation of these procedures and the achievement of the Sustainable Development Goals as well as the safety of workers in brick kilns.

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Women Empowerment through SHG for Sustainable Future

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Abstract

Many believe that microfinance, which operates on a group basis, can significantly help the poor by enhancing their access to capital. When Dr. Muhammad Yunus established Grameena Bank in 1976 in Bangladesh, Dr. Muhammad Yunus was a trailblazer in the field of microcredit. A pilot initiative for bank connection with self-help groups was launched by NABARD in 1992. Self-Help Groups (SHGs) are cooperative organizations whose members voluntarily bring together people from similar socioeconomic situations. In rural areas, The poor's economic and social development, as well as women's empowerment, are greatly aided by SHGs. This study looks at how self-help groups (SHGs) have transformed the socioeconomic status of rural Indian women and how they have helped the UN achieve its Sustainable Development Goals (SDGs). We explicitly addressed SDGs including no poverty (SDG 1), zero hunger (SDG 2), good health and well-being (SDG 3), high-quality education (SDG 4), and gender equality (SDG 5) in order to examine the impact of SHGs on rural women in this study. Everyone can see that the SHG bank connection program is sustainable and viable because of the funding of SHGs. To sum up, the most effective method and tool for alleviating poverty and empowering women is microfinance through SHGs. The SHG program's microfinance initiatives have improved the mental health and social empowerment of rural women. When calculating a composite index of women's empowerment, just three criteria are considered: economic empowerment, autonomy, and gender relations.

Keywords: SHG, Empowerment, Gender Equality, SDG, Sustainability, Poverty Reduction, Microfinance.

INTRODUCTION

In the introduction section we will be discussing the works related to themes of the study, basically Women empowerment, SHGs, the results from SHG membership and SDGs. India is still one of the world's developing nations. However, this was called the Golden Bird a couple of centuries ago. There was an abundance of beautiful scenery, intelligent people, agricultural products, minerals, and nature. India had the highest per capita income before the British invasion. The population remained stable, and there was an abundance of food for everyone. Trade with other countries and the agricultural sector were both booming. From religious observance and intellectual achievement to monetary prosperity, we were unrivaled. India was almost as large as Europe in the 1500s, accounting for 24.5% of world trade. As a whole, the world was still relying on barter when the Greeks and Indians started using money. India used to be a lot more forward-thinking when it came to gender equality. It is true that female deities are venerated in Indian mythology. Women in that era were fierce, self-reliant, and unafraid.

Countless nations have exercised control and occupation over India. As a result of its recent spate of setbacks, the nation's prestige has been dwindling, and it is currently lagging behind in all areas. Aiming to become known as Sone ki Chidiya by 2022, India aspires to be proclaimed by Prime Minister Narendra Modi. However, this can only be achieved by nurturing the core elements of the family, which encompass women.

The concept of self-help groups was one that empowered women. Some point to NABARD's initial heavy promotion of SHGs in 1991 and 1992 as the start of the SHG movement.

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It wasn't until 1993 that SHGs were granted more banking privileges by the Reserve Bank of India. The trend has been expedited by the availability of financial services. For organizations that help women help themselves to survive in the long run, government-backed bank loans are a lifesaver. Obtaining low-interest loans is one method that women's self-help groups can empower themselves with. Members can borrow money from the organization with low interest and no collateral for unexpected expenses by contributing to a common fund on a monthly basis (Singh, 2008). Locally, Self-Help Groups (SHGs) provide low-income individuals—particularly women—with the tools they need to find work, hone their skills, increase their income, and escape poverty (Duncombe and Heeks, 2002; Deininger and Liu, 2009). According to Duncombe and Heeks (2002), micro and small business owners can find a home in a strong SHG fraternity. This, in turn, gives these entrepreneurs more leeway with their money and helps low-income women put more of their resources into local businesses rather than spending it on consumption. Promoting women's economic independence is central to self-help groups. Despite the pervasiveness of sustainable development problems, it is not always easy to incorporate them into public policy. But if we provide women the tools they need to become self-sufficient, we can ensure our success in the long run. According to the Brundtland report, the consensus definition of sustainable development is to meet present needs without compromising the ability of future generations to meet their own needs.Proposals for sustainable growth were put out. As stated in their 1980 report The World Conservation Strategy, the IUCN stressed the importance of considering social and economic aspects in addition to ecological ones in order for development to be deemed sustainable.

The main idea of Self-Help Groups is to provide empowerment to women and give them strength to face problems. These groups entitle them to raise revenue, improve living style & condition in the community (Gupta & Aggarwal, 2015). It tries to pull up backward people of the society and meet them with the community. Finally, the country dissects the benefits of socialism.

To pull up the villagers, different kinds of plans have been launched through the Government of India and state governments. Nevertheless, rural poverty and unemployment conditions did not vary very much day by day. It became rigid and intense but our government took the initiative to overcome poverty. The data of the Indian Economy shows the bitter result as approx. 27% of the population lives below the poverty line.

In the Indian Economy, containing a huge part of the population, it performs a significant role in household activities as well as national activities (Sundaram, 2012). It contains approx. 1/3 part of the labor force of the nation. Female participants give a big part of their income for conservation which shows that amount earned by women directly & undoubtedly impresses the phenomenon & conservation of indigence.

Self Help Groups work on associative theory & give a marketplace for participants to develop support for each other. This is mainly recognized as a means of strengthening the process. These clusters are mainly built for poor people who are not approaching banking institutions in the consolidated portion. Deficiency in reliability & transparency is causing a severe problem in the cluster. In spite of this, Self Help Groups are insured through the blanket activity of the fellow. This plan was mainly organized for villagers, particularly women, to constitute a cluster for fraternal advantages.

In light of the Sustainable Development Goals (SDGs) of the UN, namely no poverty (SDG 1), zero hunger (SDG 2), good health and well-being (SDG 3), high-quality education (SDG 4), and gender equality (SDG 5), this study looks at the effect of SHGs on the socioeconomic development of rural women in India. In order to set the stage for this conversation, the study begins by critically evaluating

the recent literature on the SDGs in relation to SHGs. This is followed by an examination of how rural women's involvement in SHGs helps to achieve SDGs 1, 2, 3, 4, and 5 goals. In this sense, SHGs' facilitation of the socioeconomic growth of rural women depends heavily on their ability to obtain microcredit. The importance of microcredit in accomplishing the Sustainable Development Goals has drawn scholarly attention to the study of the effects of SHGs on women's socio economic development. In light of this, the study intends to investigate two important questions: first, whether or not rural women's involvement in SHGs might affect their socioeconomic growth; and second, whether or not rural women's awareness levels can fluctuate both before and after SHG participation.

OBJECTIVES OF SELF HELP GROUPS (SHGS)

1. The Self-Help Groups are businesses. For daily necessities, little sums of money are raised. When the saving groups are converted to earning groups, women's output and credibility are both increased.

2. Women have several opportunities to learn about banking, gram panchayats, zilla parishads, law, and the judiciary, among other topics.

3. The family structure is preserved as long as affordable alternatives are available.

4. SHGs are a useful tool for putting an end to consumer exploitation.

5. The growth of self-assurance is attained.

6. There is a shared forum for discussion and idea exchange.

NEED OF THE STUDY

The emphasis in the field of sustainable development for women living in rural areas needs to be on empowering women by giving them more influence in the economy, society, participation, and decision-making processes.To a great extent, this is made possible by the creation of SHGs. Economic, social, and cultural sustainability make up the three pillars of sustainable development. The primary goal of SHGs is economic sustainability. This essay reviews the body of research on the role of self-help groups to sustainable development. The emphasis in the field of sustainable development for women living in rural areas needs to be on empowering women by giving them more influence in the economy, society, participation, and decision-making. To a great extent, this is made possible by the creation of SHGs.

OBJECTIVES OF THE STUDY

1. To comprehend the contribution that self-help groups provide to sustainable development.

2. To examine the income-generating activities that SHGs are promoting.

3. The primary aim of this study is to examine the empowerment of women through self-help groups. The specific goal is to ascertain how SHG members' economic circumstances have changed.

REVIEW LITERATURE

Extensive studies by many researchers in different countries have focused on the theoretical and empirical aspects of self-help groups. Further, they have highlighted the link between self-help groups

and improving the socio-economic status of rural women.

SHGs aim to promote sustainable socio-economic development, discuss their problems, and resolve them through exact decision making ways by decision making participation process. (Balraj and Rao, 2016) called these local organizations with its objectives. So SHGs work as Quasi-banks, using the members' savings and loans from the banks to lend their members.

Richa Made a study in the Meerut district to see the impact of SHGs in upliftment of the poor and the case study was done on female SHGs. She studied 300 women from female SHGs and 300 men from male SHGs in Meerut District and Used Qualitative and Quantitative-with Survey Method and Depth Interview". The research was specified to study the components affecting micro financing, the impact of microfinance in women empowerment, to study whether the economically benefited what proportion of, expenditure and how much is savings of the members after joining self-help GroupsThe purpose of this study is to examine the impact of self-help groups on employment, poverty reduction, and gender equality in Meerut by comparing the effectiveness of women's and men's SHGs.

Qualitative and quantitative-a questionnaire was used to collect a total of 811 sample respondents, out of which 210 respondents from Dakshina Kannada, 216 respondents from Udupi, 198 respondents from Devanagari and 187 respondents from Haveri were selected as samples for the case-study. The objective was to understand the need to empower women, examine the social and economic profiles of the respondents as members of SHGs, understand the nature, functioning, programmers and problems of SHGs and SHG members., so that SHGs can be assessed. Contribute to empower rural women so that they can achieve socio-economic independence and mobility - to understand how SHGs instill confidence in women to achieve 'gender equality' In patriarchal male dominated gender biased male dominated societies ensure their individual place in family and social life (Singh et al., 2020).

There were many studies which were going on in that era on the topic of discussion but the most important study concerned women's strengths and potency, noting that the phrase or idea of empowerment did not originate in a gender context, but was invented by Brazilian educator Paulo Freire (1921-1997). Along with this, the role of NGOs was also explained here. Also, it is behind China and Bangladesh. At 17 per cent, women's contribution to India's GDP was lower than the global average of 37 per cent After India's Independence, the Government's main focused field was developing, formulating and creating new policies for Empowering Women's and There were policies introduced that time which give full power to Females in Developing and empowering them (Mohan, 2016). He also focused on the roles of Government and NGOs as they have prioritized women's economic contributions through self-employment and industrial companies.

We can see that gradually with the "improvement in the lives of women" they had started becoming less reliable on the males for their life and financial support. With all the growth of the particular trading class inside society during previous centuries, women began learning basic enterprise skills and attained elegant entrepreneurship information to start-up their own particular businesses. MFIs were the one which provided both financial and non-financial help to the poor people (Dondo, 1991). His works covered the complications he faced in India and also provided us with research on Women and Development (Seth, 2001).

set out to investigate the challenges and possibilities encountered by female entrepreneurs in India and

Prakash and Goyan Proven that female entrepreneurs are determined, hardworking, and competitive;

so, there needs to be an ongoing endeavor to motivate, educate, and assess women's entrepreneurship on an individual and corporate level (Goyal and Parkash, 2011).

Singh, examined the reasons behind women's entrepreneurship, the ways in which they built their companies, the difficulties and barriers they encountered in their attempts. Major barriers to the emergence of women entrepreneurs have been identified, including gender discrimination, family obligations, social rejection of female entrepreneurs and a dearth of interaction with prosperous business owners (Singh, 2018).

Over 1.5 million women in one of Northern India's poorest rural regions have joined a self-help group initiative. That application is examined in this work. The four main principles of the program are microsavings, education on nutrition and health, training for agricultural entrepreneurs, and political engagement. How participating in a program can enhance one's standard of living is the focus of this study. The research estimates propensity score matching models and exhibits evidence of variances in specific dimensions using fresh data on a range of self-reported capability indicators from members and non-members. It also draws attention to the substantial advantages enjoyed by the most marginalized members of society, the scheduled castes and tribes. After examining robustness, Anand, Saxena, Gonzalez, and Dang's (2019) research demonstrated that the program made a contribution to some areas of sustainable development.

Every nation is built on a foundation of education and research centered on sustainable growth.

Policies for sustainable development also place a strong emphasis on education, which is now necessary to increase environmental protection knowledge among researchers, teachers, students, and local populations. An overview of how research and higher education support a country's sustainable growth is given in the current article. A summary of the state of the country's financial institutions, both state and federal, and the higher education system has also been attempted (Sharma, 2014).

Self-Help Groups for achieving Sustainable Development Goals (SDGs)

There is an increasing amount of research on how SHGs contribute to women’s self-reliance, as microcredit through SHGs plays a major role in contributing to achieving the SDGs. Several SDGs are directly or indirectly affected by the availability of microcredit through self-help groups. A few possible applications and functions that SHGs might have in accomplishing SDGs are shown in Figure 1. There have been extensive discussions in the literature regarding the possible direct impact of SHGs on accomplishing SDG 1.

Individuals who earn 2 USD or 3 USD per day and are economically disadvantaged can apply for microcredit through SHGs. (Murugesan and Ganapathi, 2010; Wickramasinghe and Fernando, 2017) Low-income households may benefit from this system by having better financial circumstances and being able to sustain a consistent level of consumption. Another grave problem that affects people everywhere is malnutrition. (Adamsen and Rasmussen, 2001) Many researchers have looked into the relationship between participants' nutritional status and SHG program participation in an effort to discover a solution to this problem. According to research by (Hamad and Fernald, 2015), employing microcredit through SHGs had a positive effect on participants' levels of food security and nutritional status.

Individuals with low socioeconomic position and those living in poverty typically have poor health. By giving low-income people the financial means, microcredit through SHGs enables them to start

small businesses, increase income, and get closer to economic independence. (Deaton, 2008) Consequently, the consensus across the globe is that wealth and health are related. (Mahajan, 2005) Poverty and health disparities are inextricably linked, and microcredit via Self-Help Groups (SHGs) programs provides ways to address multiple of these problems at once. (Brody et al.,2015), low-income families that take part in SHGs programs have a higher chance of being able to obtain insurance. In addition, the utilization of microcredit through SHG initiatives can help facilitate the fulfillment of SDG 4.

In order to maintain their current quality of life, many low-income rural families employ their children to work on family farms, which makes up the bulk of these households. Children continue to skip school as a direct result. With the help of microcredit from SHGs, these families may stabilize their financial status and increase the likelihood that their kids will attend school. (Nader, 2008) Nader found a strong link between children's education and microcredit obtained through SHGs. Based on the discussion, we discovered that the introduction of microcredit through SHGs has raised household consumption, empowered people to access better health care, improved the nutritional supply for children, transformed the income levels of rural women, and encouraged women's empowerment. It has also increased savings to help achieve SDGs 1, 2, 3, 4, and 5.

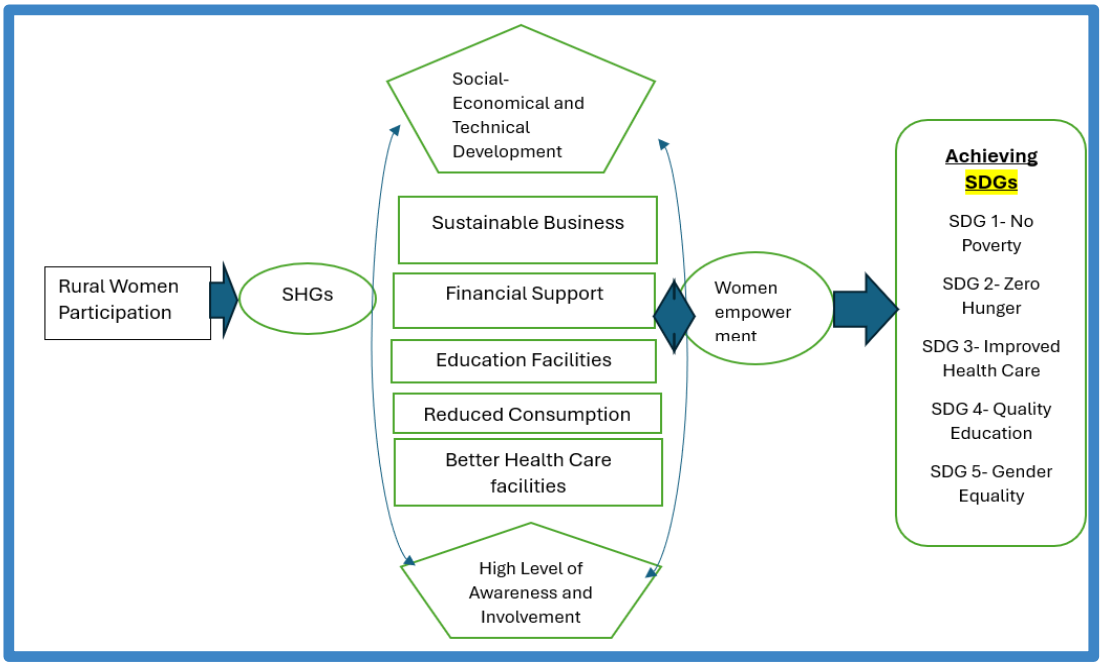

Fig.1 Shows the Framework of SHGs to Achieve SDGs

RESEARCH METHODOLOGY

Research Design: Exploratory study that draws off earlier reviews of the literature.

Sources of Data: Secondary sources, such as websites, journals, books, and published research, are a major source of data.

RESULTS AND DISCUSSIONS

The emphasis in the field of sustainable development for women living in rural areas needs to be on empowering women by giving them more influence in the economy, society, participation, and decision-making. To a great extent, this is made possible by the creation of SHGs.

For rural and migrant populations, Self-Help Groups (SHGs) have given them a stable means of subsistence, enabling them to grow without external pressure and with full effort. Sustainability is understood in terms of the financial, economic, and social spheres, where people actively contribute to the growth of businesses, families, and cultures. It is evident from the discussion above that SHGs are a means of empowering women and achieving sustainable livelihoods in both urban and Indian villages.

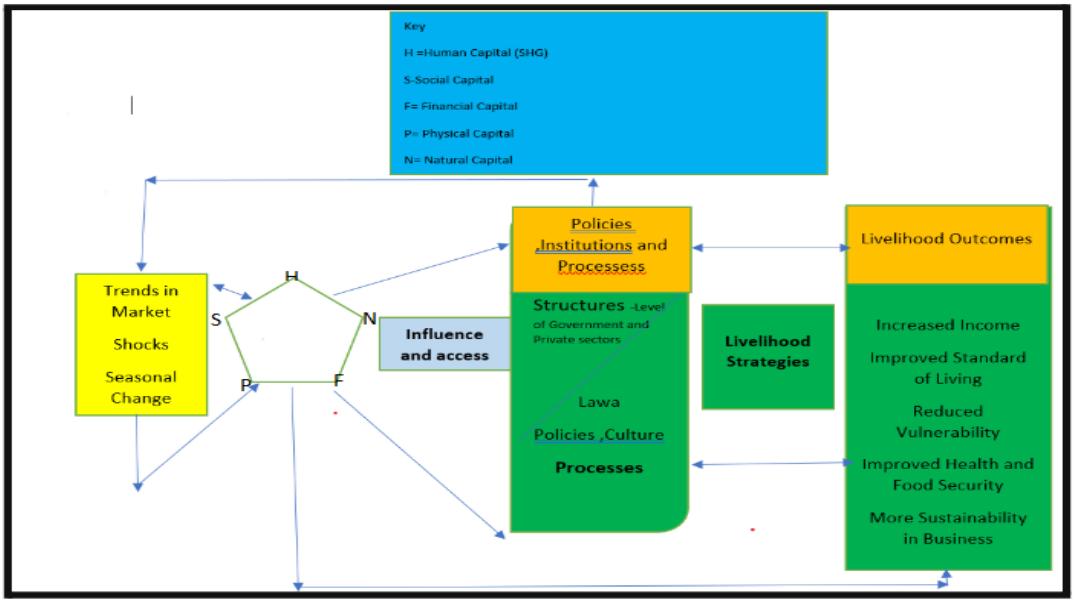

Figure 1- Sustainable Employment via SHG

RECOMMENDATIONS

SHGs should receive sufficient financial help from the government in the form of concessions. To ensure that the members of SHGs are qualified, the government should arrange for the appropriate occupational training. To ensure that SHGs are operating efficiently, the district authority might have to implement a day-to-day system. The government ought to take the required actions to enable and motivate all impoverished rural women to join SHGs.

Regulatory bodies are taking the creation and promotion of SHGs seriously, as evidenced by new guidelines and policy frameworks. In addition, the government has promised funding for this industry in an effort to alleviate financial difficulties, indicating that there will be more opportunities for new businesses to emerge in the future. In order to verify transparency and establish a single portal for quick entry into this industry, this will be useful for audit and research purposes.

CONCLUSION

It has been discovered that microfinance via SHGs is the best strategy and practical instrument for reducing poverty and empowering rural women. The SHGs have revolutionized the lives of rural women by empowering them to become independent, self-sufficient, and self-employed. It is concluded from study that it is a gradual and consistent procedure and women have started taking additional responsibilities and they are willing to become fully developed in all ways for the family and Living. The concept of SHGs has not only motivated the Rural Women but also the Semi Urban Women population for the improvement of their living conditions. It is also concluded that SHGs is a path to abolish poverty in India through women empowerment.

The results also emphasized the significance of SHGs in accomplishing SDGs. In addition to enhancing the lives of individual women, the financial and social empowerment of rural women—facilitated by Self-Help Groups—contributes to the overall growth of the community and the country. Consequently, the study's findings unambiguously demonstrated that enabling rural women through SHG microcredit is a critical step towards the realization of a developed, just, and inclusive society. The findings highlighted the necessity of expanding and maintaining these kinds of programs in order to guarantee long-term socioeconomic growth and the accomplishment of the SDGs in India's rural areas. However, the study's cross-sectional methodology restricts causal inference, its dependence on source data from SHG members may introduce bias, and its district-specific focus may have an impact on the conclusions' application.

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Paradoxes of Rural Development Model: An Experience of Independent India

Vinita Dubey*

Abstract

Rural development in India has been a cornerstone of national policy since independence, driven by the need to uplift the vast rural population that forms the backbone of the country's socio-economic fabric. Despite significant investments and decades of developmental initiatives, rural India continues to face entrenched poverty, socio-economic inequalities, and uneven growth. This paradox calls for a deeper examination of the strategies and models of rural development that have been employed since the 1950s. This paper critically analyzes the rural development models in India, focusing on the dichotomy between social improvement and social transformation approaches, both of which have shaped policy-making. While social improvement emphasizes gradual, system-preserving changes, social transformation advocates radical reforms that challenge existing socio-economic structures. The analysis reveals that the persistence of a top-down, bureaucratic approach, combined with cultural resistance and inadequate grassroots participation, has undermined the potential for holistic and sustainable rural development.

Keywords: Rural development, paradoxes, inequality, poverty, agrarian economy, rural transformation.

1. INTRODUCTION

Rural development in India has long been a focus of national planning, given that the majority of its population resides in rural areas. In India, where approximately three-fourths of the population live in villages, agriculture and its allied sectors have historically formed the backbone of the economy. However, despite efforts through various development programs, rural India continues to face significant socio-economic challenges. This paper aims to explore the paradoxes inherent in India's rural development strategies and the reasons behind their mixed success.

Despite significant investments in rural development, India's countryside continues to grapple with poverty, inequality, and uneven growth, necessitating an examination of the paradoxes underlying rural development models. This study aims to uncover the gaps and contradictions in India's rural development strategies since independence to ensure inclusive and sustainable growth. The significance of this paper lies in identification of paradoxes and challenges hindering the rural progress.

2. CONCEPTUAL FRAMEWORK

Rural development is the process of improving the quality of life and economic well-being of rural people through sustainable growth across social, economic, and environmental dimensions. Post-independence, India's approach to rural development has evolved through two key approaches: **social improvement** and **social transformation**.

- **Social improvement** refers to gradual change within the existing systems and structures.

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- **Social transformation** involves radical, systemic change aimed at overhauling the socio-economic structure.

These approaches have been applied in tandem in India, with mixed outcomes. The establishment of the Planning Commission in 1950 laid the groundwork for India's five-year planning approach, with a focus on agricultural productivity and basic infrastructure development in rural areas.

3. METHODOLOGY

This paper utilizes a historical and analytical approach to examine the evolution of rural development strategies in India. The study draws upon government reports, academic literature, and policy documents to explore the paradoxes and challenges within these strategies.

4. HISTORICAL CONTEXT OF RURAL DEVELOPMENT IN INDIA

The British colonial period left India's agrarian economy in a state of ruin, necessitating focused rural development efforts post-independence. Programs like the Community Development Programme (CDP), launched in 1952, aimed to improve agricultural productivity, health, education, and infrastructure in rural areas. However, over time, the limitations of these programs became evident, as they often failed to reach the poorest sections of society.

During the 1970s and 1980s, employment generation schemes were introduced to address rural poverty, with varying degrees of success. By the 1990s, economic liberalization brought new challenges, with market-driven globalization exacerbating inequalities in rural areas. Despite gains in food security and literacy, rural poverty persisted due to the widening gap between the affluent and marginalized populations.

The independence of many poorest and potentially weak countries of Asia, Africa and Latin America in 1950s brought about the thought for the urgency of rural development in many parts of the globe. For a country like India, where about three-fourth of country's population live in nearly six lakhs villages, with no less than ninety-one cultural traditions flourishing among more than four thousand communities[1], and for them agriculture has been the mainstay of their lives. The agriculture and its allied activities had in past set the tone of country's economic structure. Hence agrarian economy, since long, has been the dominant sector of Indian economy not only in terms of quantum of labor force it provides, but also its contribution in country's GDP. Historical evidences suggest that this dominating sector has taken several twist arid turn in various periods.

It is vastly recognized that nearly two hundred years of the British rule and vis-a-vis its laissez faire policy ruined India's economic infrastructure in general, and agrarian economy in particular: Various agrarian policies envisioned during the colonial rule not only throttled and shattered the productive energies of agrarian economy, but also reduced its productive capacities to shambles, in fact, leaving Indian agrarian society and agrarian economy on the brink of extreme backwardness and utter poverty. The planners and policy makers in independent India took resort to various approaches viable of bringing about plethora of changes-institutional, structural, cultural etc., to which rural societies have been and are being proposed to be subjected.It was realized that rural social structure has remained not only excluded and discouraged from realizing its socio-political interests and economic potential, but has been rendered profoundly helpless against the traditional force of conservatism. it was also realized that the age-old conservatism and traditional rural norms have riddled rural economy to contribute potentially in country's economic development. Hence, rural development as a concept of rural

transformation vis-à-vis rural change gained currency not only among planners and policy makers, but also among intellectuals of diverse disciplines.

Consequently, very shortly after independence, India had perforce to embark on a tortuous and long-drawn process of recovering from ruinous state and achieving economic development in then existing context of world scenario. In order to restore vigor and dynamism to an economy crippled by extreme obsolete and sterile socio-economic structures, and a formidable task of a "tryst with destiny", as independent India's first Prime Minister Pt. JawaharLal Nehru remarked in his historical broadcast to the Nation, the planners and policy makers resorted to socialist pattern of society and planned development. In this regard two approaches, namely social improvement' and 'social transformation" were considered to be relevant[2], in mitigating the inherent problems in rural India Social improvement implies and envisages changes within the existing system. It has been liberal in nature and its main thrust has being 'change through part accommodation and part assimilation'. However, social transformation is concerned with radical form of change. It is radical in nature because it implies more or less a complete change of the existing system/structure and therefore, 'change of the system through radical revolutionary efforts'. Both approaches are binary opposites. But our experiences suggest that we have in India a synchronization of approaches to form a mixed baggage of strategies of social change and social development in rural India.

The establishment of the Planning Commission in March, 1950 by a resolution of the Government of India and the aims of the planning as envisioned in the resolution to promote a rapid rise in the standard of living of the people by efficient exploitation of the resources of the country, increasing production and offering opportunities to all for employment in the service of the community"[3], paved way for the beginning of the Five Year Plan in 1951 in India. The stress in the First Five Year Plan was on the 'improvement' in agricultural production. Ushering in the dreams of the Father of Nation, Mahatma Gandhi, rural development in 1950s was conceptualized as a panacea for speedy and all round development of rural society. And in this context, program like Community Development Programme (CDP) launched in 1952, was considered as medium to fulfill the desired aims and objectives. The programs of rural development with the twin objectives of growth and justice, were concerned with (a) providing basic infrastructure facilities in the rural areas; (b) improving agricultural productivity in rural areas; (c) making social services like health and education most viable for socio-economic development; (d) implementing schemes for the promotion of rural industry, agricultural productivity and rural employment; (e) assisting individual families and self-help groups, and (f) ameliorating rural poverty. Therefore, the maximization of agricultural production by optimum utilization of natural resources, labor and capital; and minimization of level of inequality between the various agrarian classes/agrarian categories became core to the implementation of programs for rural development at various levels: **macro** (national level), **meso** (state level) and **micro** (district, block & village level).

It needs to be emphasized that the inception of Community Development Programme and National Extension Programme in the early years of planning aimed at utmost harnessing rural resources. In a rather strict sense, CDP was based on twin objectives (i) to provide a substantial increase in the country's agricultural production, improvements in the systems of communication in rural areas, improvement in rural health and hygiene and village education; (ii) to initiate and direct a process of integrated cultural change aimed at transforming the social and economic life of the village[4]. The idea of cultural change was viewed as a primary objective by the planners who wished to stimulate "in the Indian masses the burning desire for change, which through progressive adaptation of modern techniques, will lead to their achieving higher standard of life"[5]. Influenced by the vision and appropriateness of the programs, many non-governmental organizations focused their attention to rural

problems and these made noticeable efforts towards arousing public awareness to the needs of rural population. To get amicable and fruitful results, much money was spent on these developmental programs. It is perhaps, the inspiration of the success of extension work in many parts of the world, especially in USA, and also as the influence of the British paternalism and more specifically movements for "village uplift"[6], the community development program emerged as "program of village self-help"[7].

But gradually, structural changes through land reforms etc. began to be seriously considered from the beginning of the Fourth Five Year Plan. Considering the state of rural settings and its bearings and to open and enlarge structural changes in the rural settings, the thrust of rural development programs in the Fourth Five Year Plan has been to make a concerted efforts for the amelioration of abject rural poverty **(garibi hatao)** through three-fold strategy: (a) augmentation of the asset holding of the rural poor through land reform measures, (b)augmentation of wage income through expansion of employment in rural areas, (c) improvement in the poor's access to important services like health and education etc. The Fifth Plan (1974-79), the Sixth Plan (1980-85) and the Seventh Plan (1985-89) laid utmost emphasis on ameliorating the economic lot of the rural poor through a plethora of employment generation programs viz. (i) programs with focus on self-employment and income generation like IRDP, DWCRA, TRYSEM, Supply of Improved Tool Kits to Rural Artisans etc.; and (ii) programs with focus on wage employment and infrastructural development like JRY, EAS, MWS, IAY etc. It was realized that poverty need not remain confined only to agricultural sector and this led the government to formulate programs in the Sixth Plan for the poor wherever they are located in the rural sector, and since then the Integrated Rural Development Programme (IRDP) extended the benefits to poor fishermen, artisans etc. Therefore, a sharp shift in the emphasis was recognized in the succeeding years by taking into account the high intensity of poverty in rural India in mid-eighties[8], as rural poor pass through series of problems which affect their survival and quality of life. These problems can be grouped into four broad categories namely livelihood, health, education and social development, hereby referred to as 4A's-Anna', 'Arogya", "Akshar and 'Acharan.

During 1990s, the government of India undertook various neo-liberal policies to revamp the allying economy and to speed up the process of economic growth through liberalization, privatization and globalization. Notwithstanding, the realization that rural India accounts for three-fourth of country's population with a large segment of people living below the poverty line, economic liberalization and restructuration or structural adjustments in the economy have to be matched with rural development because full benefits of economic reforms could only be derived by concomitant investment in the rural sector, hence, a substantial shift in the paradigm of economic growth, i.e. from nationalization to open-economy, took place. This shift, undoubtedly, has brought phenomenal growth in Indian economy on various fronts' viz. self- sufficiency in food grains, impressive gains in demographic transitions; steady improvements in social indicators; significant decline in the incidence of poverty, rise in the standards of the standards of livings; availability of sophisticated technologies for average Indian; marked improvements in average literacy, quality of health, general life expectancy etc.; but at the same time agriculture, which traditionally been a major factor of economic growth in general but rural sector in particular. The experience of succeeding decades, reveals that market, money,modernity, middle class, migration, media, multiculturalism and multinational corporations have been the mediums through which globalization has gained ground in India. It seems that economic globalization has led to the concentration of crisis in rural society ‘crisis of poverty’ and ‘crisis of survival’, Safety nets, as the experience of some countries suggest, when better targeted and effectively implemented plays a vital role during reform period to attack poverty especially rural poverty. It is regarded that "misguided government intervention and consequent moral hazard are 'sins of commission or omission' as Asian

states fall to 'captured liberalization with poorly designed reforms and weakly regulated liberalization inducing culpable self-serving rent-seeking and increased vulnerability"[9]. The 'market-driven global integration' and 'lure of profit maximization' have given impetus to homogenization, hybridization, hegemonic tendency, ethnic pluralism, regionalization and counter-globalization, which in turn have widened the gap between "perceived goal" and "achieved goal" of rural development.

5. DISCUSSION

The paper identifies several paradoxes in India's rural development models:

1. **Top-down Bureaucratic Approach vs. Local Participation**: Many rural development programs were implemented in a top-down manner, with little input from local communities. This led to a mismatch between program objectives and local needs, as exemplified by the failure of the Community Development Programme.

2. **Social Improvement vs. Social Transformation**: While social improvement approaches focused on incremental changes, they often failed to address deep-rooted inequalities in rural society. On the other hand, efforts toward social transformation faced resistance from entrenched social norms and conservative forces.

3. **Economic Liberalization vs. Rural Poverty**: The shift toward a market-driven economy in the 1990s led to impressive national economic growth, but rural poverty remained high. The benefits of liberalization disproportionately favored urban and affluent populations, while rural areas lagged behind.

4. **Modernization vs. Cultural Resistance**: Efforts to modernize rural India through infrastructure and agricultural reforms often clashed with traditional social structures, resulting in limited acceptance and implementation of these changes at the grassroots level.

On the basis of fore going discussions, it is quite apparent that both approaches- social improvement and "social transformation', continued to be adopted in a rather mixed way by the policy makers in the context of rural development since the beginning of planning era in India. However, we all recognize that rural development, in a broader perspective, consists of intermixing of three dimensions: material, human and social, and include qualitative changes in rural infrastructure. Thus, it helps to liberate the energies of the rural people, especially the poor, so that they can realize their full potential for the improvement in their lives. Broadly speaking. Under the aegis of rural development as an integrated concept of growth and development, concerted efforts have been made to eradicate the obsolete and deficient constituent elements of rural socio-economic structure; and to make agrarian economy most viable for the overall development of the country. The tyranny with the efforts made for rural development in India till now, has been the intermixing and juxtaposition of indicators of socio-economic change in rural setting. All the strategies adopted for rural upliftment were made without scrutinizing the real character of rural settings and rural population. In such a situation the pertinent questions arise: (a) **how** transformation or improvement has been or is being attempted; (b) **how** the policies are executed; (c) **who** assumes the responsibility of implementing the policies with **what** mental framework, with **what** strategy and mind-set (d) **how** the different levels of social structure respond to the situation; (e) **what** the various plans and projects have contributed for rural development in its totality; and (f) **how** the rural population perceive and analyze the issues of development.

It is a well-known phenomenon in India that bureaucracy has been working as the sole instrument of

change in the countryside. Since independence, our leaders considered bureaucracy to be "the only credible instrument of action with accountability to democratic institutions... which could be depended upon for execution of policies and programmes"[10]. The policy makers, thus decided to mobilize and manipulate the state administrative personal as a valid and legitimate means of initiating change in the rural world. This clearly epitomizes that they (policy makers) have been rather pessimistic about the nature and capability of rural settings as well as rural population; and believed that change could be brought in the rural society only by imposingalterations from above. This sort of tendency exemplifies "mechanical strategy" of rural development in the sense that society or people are considered as an object to be manipulated or handled for repair or overhauling by some external agency. Thus, transformation taking place a result of the working of such strategy is 'mechanical transformation'. But such a strategy has proved to be tedious in bringing about social transformation as envisioned. An experience of various developmental programmes/projects for rural settings launched during five decades after India got independence reveals a lop-sided growth. There have been so many changes in rural world, no doubt, but these changes have been far away from reality. The progress is segmental or sectorial. Agrarian reforms begun in the 1950s has remained "unfinished and long overdue" and poverty alleviation programmes have achieved only "limited success". Hence, the programmes have failed to bring structural changes. It seems that central to overall failures are excessive reliance on a top-down centralized bureaucracy. The three tier levels of planning for rural development- macro, meso and micro, have its own miseries. Decentralized planning for rural development has got awesome blow from two preceding levels. It also seems paradoxical that a bureaucracy created to govern a colonial feudal system at macro and meso levels, has failed in implementing agrarian reforms and associated policies that were inherently anti-feudal, progressive and democratic.

Against this backdrop, the rural development programme should identify the problems of the poor and address the local needs, instead of forcing them to accept pre-conceived plans. Hence, there is prime viability of the approach- 'moral transformation', because changes through this approach are brought about by the people themselves. All that they (rural people) need in this context from outsiders is encouragement and/ or assistance for obtaining necessary resources and priorities of change. Once they are committed to it, they become ready to organize and prepare for change. The change that follows, in due course, encompasses all the sections of the community, that is, the benefit of change flows to all lanes and by-lanes. Such a change is least costly in the sense that it encounters, possibly, least amount of cultural resistance. Mechanical transformation or improvement, on the other hand, is not so effective. Its coverage remains circumscribed. Under modernizing ethos, it has brought about structural contradictions and thus fails to deliver goods to the peripheral corners consisting of the people of lower rung. We may recollect the experiences of Community Development Programme, which was coupled with (a) growth center approach (fostering growth by increasing resource mobility); and (b) area development approach (coupling local factors of economic growth). But, notwithstanding the vision, the story of success of this programme has been very gloomy and zigzag. About seventy percent of the benefits of this particular programme went to the affluent or elite sections or upper rung of agrarian social structure. Artisans, agricultural labourers and other forming the mass of rural population has remained more or less ignored. As a result, new frontiers of structural contradictions at inter-personal, inter-positional and inter-organizational level of agrarian social structure have emerged in the countryside; which in turn, have hindered the pace of development. The entire programme virtually collapsed within a period of about two decades"[11]. The main reason lying behind this monumental failure was that the programme was conceived and formulated at a level that was far away from its targets, and therefore, the objectives of the CDP could not be accepted by the people as their objectives. The objective ‘change from above’ failed to liaison the levels of agrarian social structure. This resulted in the identification of goals and objectives (as perceived by the government and bureaucracy) by the

rural mass as **"sarkari"**[12], i.e. the concern of the government. Mechanical transformation, in this regard, yielded some improvement but that has generally skewed in favour of some at the cost of the rest of the population.

In sharp contrast, the strategy of moral transformation', does not allow such a contingency to arise. It proceeds by ensuring the voluntary participation of all sections of rural people. This strategy incorporates "actor-oriented perspective' as its leading perspective, in the sense, that formulation and implementation of programme of change in this context, depends upon **what people want**. Understanding people's world view- their conception of good life as well as bad life, their cultural convenience and inconvenience etc., is the prime pre-requisite for incorporating the 'actor-oriented perspective. This type of strategy has been adopted in varying degrees, perhaps, by the different voluntary agencies or NGOs, which are operating at grass root level of agrarian social structure. In order to identify the viability and appropriateness of any strategy for rural development, let us consider- "**A**" as a voluntary agency and "**B**" as the community for which development is being conceived. In the process, "**A**" approaches "**B**" for transforming or developing it. In the initial stage, the viewpoint of "**A**" towards "**B**" is essentially based on the strategy of mechanical transformation (i.e. imposition of programmes and perspective). But in order to bring about change through the strategy of moral transformation, "**A**" has to give up the idea of imposition of programmes and perspectives. Instead, "**A**" has to consider the structure of "**B**" first, because structure of society is not external to its members. As memory traces and as instantiated in social practices, it is in a certain sense more external than exterior[13]. It is both a medium and outcome of human activities which it recursively organizesand it is always both constraining and enabling.

The social environment in which we live, just not consist of random assortments or events or actions; there are underlying regularities or patterns, in how people behave and in the relationship in which they stand with one another. It is these regularities to which the concept of social structure refers". This notion of structure refers to primary level structure and stands for spontaneous and habitual crystallization of behavioral patterns and is internalized by the members of the community. Thus, man by virtue of being a member of a socio-cultural formation is knowledgeable, capable and rational. It is this characteristics of individual through which he/she (as a member of the community-"**B**") can and does offer resistance to any new idea or action from the points of view of his own socio-cultural structure. In such a situation, "**A**" has to face a series of difficulties. "**A**" can develop a sense of empathy for "**B**" on the basis of what Gadamer called- “enabling prejudices"[15]. The sense of insecurity in terms of social, cultural economic etc. compels the member of "**B**" not to indulge in with the ideas of "**A**". These are crucial consideration for any exterior agency to take into account in the process of development Malinowski had much earlier suggested "to grasp the to realize his vision of his world native's point of view, his relation to life, to realize his vision of his world”

Hence, the interaction between "**A**" and members of "**B**" not only signifies "double hermeneutics but 'multiple hermeneutics'. In the villages, there are socially and economically disadvantaged as well as advantaged people. The socio-economic disadvantaged people/group is linguistically disadvantaged as well. They lack codes for communication. The people/group (say, $\mathbf{B}_1$) tries to escape the situation of facing the outsiders. The conveyance of message is done by other group (say, $\mathbf{B}_2$). Here, inter-personal and inter-positional level of structural contradiction plays a vital role. The external agency-"**A**", again faces lack of communication The incongruence between motives, cognition and values play a decisive role in creating multiple hermeneutics. The danger in this case, is that the original point of view of the target group- the group of the disadvantaged, gets distorted in the way till it reaches the outsiders (external agency) who are interested in understanding them. It is therefore, necessary that "**A**" should

be in direct contact with all the categories (**B1, B2, By**.....) of people of "**B**". In this regard, "**A**" has to acquire (a) competence in dialect of "B", and (b) knowledge of the tradition and historical background of "**B**". This also suggests of ethno-methodological perspective, ie correspondence between appearance and reality.

Hence, "**A**" facing "B" in the context of a particular issue (i.e. issue of rural development), "**A**" must follow the principles of multiple hermeneutics, and must (a) hear what the members (**B1, B2, B3**.....) of "**B**" say; (b) observe what members of "**B**" (**B1, B2, B3**.....) do (c) interact with members **B1, B2, B3**....., in order to resolve the difference between 'what is said and 'what is done'; (d) interact with members in order to resolve the difference in the versions of different groups of "**B**"; (e) interact in order to resolve the difference between 'what is reported' and 'what is observed'by "**A**"; (f) interact in order to resolve the difference between 'what is reported' and 'what should be accepted'; and finally (g) interact in order to resolve the difference between 'what is reported' and 'what remains unreported' due to lack of discursive consciousness among the members of "**B**". Giddens[17] distinguishes between 'practical consciousness' and 'discursive consciousness'. Individuals having practical consciousness can simply say 'what they do'; while having discursive consciousness can say not only 'what they do' but also 'why they do' and 'how they do'. Through resolving these differences, there is greater chance of "**A**" for entering inwardness of wider socio-cultural milieu of "**B**". Such inwardness of "**A**" develops, as the intensity of understanding of "**A**" for "**B**" increases. Hence, we are akin to "the more inwardness of external agency, the greater is the understanding as well as greater is the chance of close correspondence between motives, cognition and values". In such a situation, informal groups lying in the periphery become active and work as instruments in implementing the projects of development vis-à-vis transformation. Since the informal groups belong to the domain of secondary level structure, transformation or development of the social structure occurs through secondary level structure; and this is possible without any imposition from outside (i.e. mechanical strategy). The danger of imposition of development schemes from 'above' will increase when "**A**" goes beyond its role of providing guidance and assistance to theexecution and implementation of developmental activities, partly or totally. Hence, there is possibility of the end of transformation/improvement under the threat of mechanical transformation/improvement. The external agency has to remain constantly alert in his context and should not cross the limit. The rural transformation or development then becomes an undertaking or mission of rural population of the village itself, and, thereforethe chance of itsmanipulation in favour of any particular segment remains quite slim.

6. CONCLUSION

The experience of rural development in independent India highlights the complexities of transforming an agrarian society. While significant strides have been made in agricultural productivity, literacy, and infrastructure development, the persistence of poverty and inequality reveals the limitations of past strategies. For rural development to be truly inclusive and sustainable, future efforts must prioritize local participation, cultural sensitivity, and the equitable distribution of resources. Programs should shift from a top-down approach to one that empowers rural communities to take ownership of their development.

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The Environmental Kuznets Curve in India: A Pathway towards Achieving Sustainable Development Goals

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Abstract

The Environmental Kuznets Curve (EKC) theory posits a relationship between economic development and environmental quality, suggesting that environmental degradation worsens initially but improves beyond a certain income threshold. This study examines the applicability of the EKC hypothesis in India within the context of achieving Sustainable Development Goals (SDGs). Despite rapid economic growth and integration into the global economy, India faces significant environmental challenges, particularly concerning greenhouse gas emissions and resource depletion. The study is based on secondary data from World Development Indicators (WB), Climate Watch, and the Organization for Economic Co-operation and Development (OECD) for 1991-2020. The present study used Ordinary Least Squares (OLS) regression to analyze the EKC Hypothesis in India. The findings reveal an inverted U-shaped relationship, indicating that environmental degradation initially rises with economic growth but diminish as income levels increase. Aligning with SDG targets, the study underscores the importance of balancing economic prosperity with environmental sustainability through targeted policies and regulations. Concluding all the findings, India can open its markets for foreign investors to accumulate eco-friendly economic growth in the long run, subject to a certain level of environmental check. It recommends that India focuses on enhancing environmental governance, implementing stringent regulations, and promoting sustainable practices to harmonize economic growth with long-term environmental sustainability and SDG achievement.

Keywords: Environmental Kuznets Curve, Economic Growth, International trade, Environmental Regulations, Environment, Sustainable Development etc.

1. INTRODUCTION

Achieving stable economic growth is a fundamental objective for countries, but this growth often comes at the expense of environmental degradation, particularly in developing economies. The increasing industrialization and reliance on fossil fuels can exacerbate issues like climate change, loss of biodiversity, depletion of the ozone layer due to increased GHG emissions and CO2 emissions, and depletion of natural resources, which directly relates to SDGs (Climate Action and Life on Land). Greenhouse gases in India are the third largest in the world, and the main source is coal. India emitted 2.8 Gt of CO2e in 2016 (2.5 including LULUCF), and 79% were CO_2e, 14% were methane, and 5% were nitrous oxide. India emits about 3 giga tonnes (GT) CO2e of greenhouse gases each year, about two tons per person, which is half the world average. The country emits 7% of global emissions. Environmental degradation occurs with economic growth, and trade openness entails transitioning to clean and renewable energy. Trade openness refers to the total share of imports and exports in GDP. In other words, trade openness generally shows the foreign trade power of countries. The overall sense in the economics literature states that trade liberalization has a favorable impact on economic growth. The impact of foreign trade-oriented growth on the environment differs depends on the development levels of the countries. Advanced economies try to create sustainable production methods to overcome

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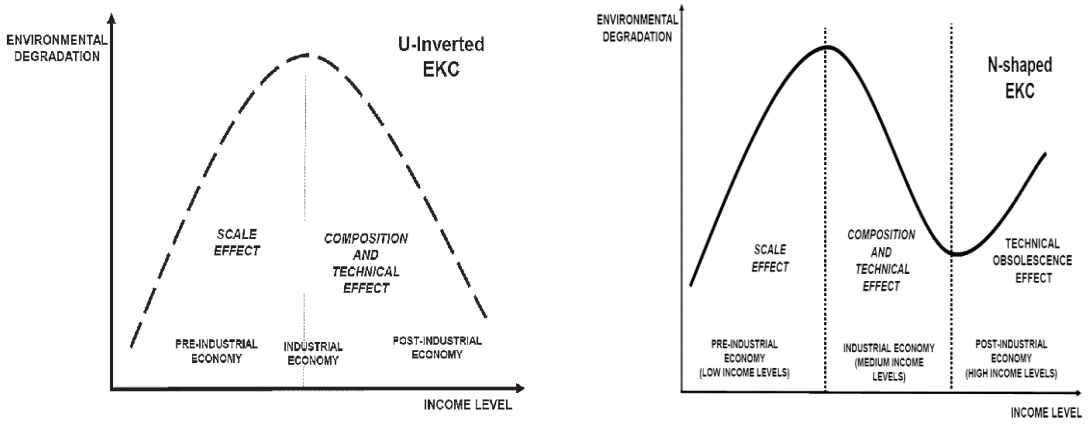
environmental challenges. Due to these countries' high per Capita income, consumer preferences consist of better recyclable products and less environmental harm. This reduces the damage and pollution to the environment. However, it does not seem easy to implement these systems in developing countries due to their higher cost. In addition, the flexibility or absence of environmental standards in developing countries harms the environment. In fact, due to this flexibility, some developed countries escape from the high environmental standards in their own countries and carry out industrial production in developing countries. When the trade barriers are removed, trade between countries increases, and its various effects on the environment arise in this way. Accordingly, trade liberalization leads to specialization: countries specializing in less pollution-intensive products create a cleaner environment, or countries specializing in more pollution-intensive products cause a more polluted environment. However, even if policies to protect the environment are adopted, and clean technologies are used in production, the total volume of various pollutants may increase due to continuous production. Several issues, such as non-environmental industrial production, rapid urbanization, and adverse effects of technological development, raise ecological problems. Scientists conducting solution-oriented research on environmental challenges have been creating several techniques to measure the productivity of natural resources. International trade is an essential factor in relation to environmental challenges since it is the core dynamic of economic development. Suppose there is a negative relation between environmental problems and international trade. In that case, this is considered as the country will be able to mitigate its emissions of greenhouse gases as it opens up to international markets.

On the contrary, if there is a positive relation between environmental problems and international trade, trade liberalization is yet to be optimal in the country. Accordingly, environmental pollution will occur at the early stages of economic expansion, but after a certain threshold level is exceeded, aligning with SDGs (Decent Work and Economic Growth, Responsible Consumption and Production). In this regard, an essential factor to analyze is the impact of GDP on CO2e emissions. The environmental Kuznets curve (EKC) is the term used in economic literature to describe the inverted U-shaped relationship between environmental contaminants and economic growth. To explain the relationship between income inequality and per capita income, Simon Kuznets initially proposed the inverted U-shaped relationship in 1955. Economists like Shafik and Bandhyopadhay (1992), Panayotou (1993), Grossman and Kruger (1991), Selden and Song (1994), and others embraced the Kuznets curve in environmental economics literature during the 1990s.



Source: Sriyuktha RB (2018)

The EKC theory postulates a dynamic process of change: as an economy's income increases over time, emission levels initially raise, peak, and then begin to decline after a certain income threshold is reached. Furthermore, the relationship between environmental degradation and per capita income shifts as the economy grows to higher income levels. Income and environmental degradation continue to trend in the same direction after the second turning point. Since EKC is a long-term occurrence, time is not specifically mentioned in it. It is a course of development that leads a single economy through many stages of growth throughout time. Although linear and N-shaped curves are also conceivable, an inverted U-shaped curve is the usual EKC. When the scale effects outweigh the composition and technical impacts, an N-shaped curve might occur, as demonstrated by Torras and Boyce (1998). While many economists believed it to be new phenomena, the concept of an N-shaped curve was discovered in the 1990s. These are the studies that demonstrate the existence of an N-shaped curve. Using sulphur dioxide (SO2) and economic growth for EKC, Grossman and Krueger (1995) and Panayotou (1997) discovered an N-shaped relationship.

The primary issues in the above cases were that the existence of a few observations made following the second turning point. The N-shaped curve was disregarded due to the data set's conclusion. Lee et al. (2009) demonstrated that the quadratic model being employed is what causes the occurrence of an inverted U-shaped curve; the cubic model will produce an N-shaped curve. In order to demonstrate the existence of an N-shaped EKC, Moomaw and Unruh (1997) used the FEM and cross-sectional OLS methodologies in their research. The location of the N-shaped EKC for Austria and 15 Latin American nations is also investigated using techniques such as pooled OLS and generalized least squares, respectively. As stated, the result of trade openness on the environment exists through several factors, and the existing literature mainly focuses on the impacts of economic growth on the environment. However, few studies investigate the effects of trade openness on the environment and modeling the carbon emission equivalent (CO_2e) as an environmental indicator. Therefore, the study's main objective is to examine the effect of economic growth, trade liberalization, foreign direct investment, industrialization and environmental stringency index on the environment and to present policies that promote sustainable development. Section 2 of the study discuss the theoretical framework literature review and then discusses how we contribute to the current literature. Section 3 analyzes the EKC hypothesis for India using non-linear OLS econometric techniques. Empirical findings and policy suggestions are discussed in section 4.

2. LITERATURE REVIEW

Several studies concentrate on the relation between the economy and the environment. Firstly, many studies investigate the impact of economic growth on the environment by referring to the Environmental Kuznets Curve (EKC) hypothesis. However, many studies examining the link between trade openness and the environment degradation are still limited, and existing studies are mainly within the scope of the EKC hypothesis, pollution refuge hypothesis, and pollution haven hypothesis, in which CO_2 emission is employed as an environmental indicator. However, it is hard to say that sufficient studies show that CO2e consider as an environmental indicator. To our understanding, studies have yet to explore the connection between international trade and CO2e.

The Environment Kuznets Curve (EKC) hypothesis, which posits an inverted U-shaped link between economic growth and environmental degradation, is a recurrent theme. Shahbaz et al. (2010) provided evidence for the EKC in Portugal, indicating that while environmental degradation increases with initial economic growth, it eventually decreases once a certain income level is achieved. This suggests a turning point at which economic development leads to environmental improvements. Similarly, Gopal et al. (2022) confirmed the EKC's existence in India, showing that as India's economy grows, CO2

emissions initially rise but later decline, supporting the idea that economic development and growth can eventually lead to better environmental outcomes. However, Riyaz and Masudul (2019) and Haider and Nazim (2022) challenged this view by finding no significant evidence related to the existence of the EKC in India, highlighting the possibility that the link between economic growth and environmental quality might not follow a universal pattern.

Trade openness, another significant factor, demonstrates varying impacts on environmental quality across different contexts. Jorgenson and Rica (2005) observed a negative relationship between exports and the ecological footprint, suggesting that increased exports could reduce a country's ecological impact. Conversely, Fotros and Maaboudi (2010) discovered that trade liberalization has a favorable impact on CO2 emissions in Iran, implying that greater trade exposure might exacerbate environmental degradation rather than alleviate it. Ali et al. (2022) found mixed results among OIC countries. While trade openness negatively affected CO2 emissions in some countries like Suriname and Malaysia, it positively impacted the ecological footprint in others like Oman and Kuwait. This variation shows that the environmental effects of trade liberalization are not uniform and depend on specific national contexts and trade dynamics. Many empirical studies have also examined the roles of energy consumption, urbanization, and additional factors that influence ecological footprints. Al-Mulali et al. (2014) utilized panel data across 93 countries to demonstrate that urbanization, energy use and trade openness are significant contributors to an increased ecological footprint, suggesting that higher consumption levels are closely related with more significant environmental impacts. Gao and Tian (2016) focused on China, finding that China acts as a net importer of ecological footprints, meaning that its environmental impact from imports exceeds the footprint it exports. This finding points to a need for China to refine its trade policies to focus more on high-value-added exports and improve the environmental sustainability of its imports. Rehman et al. (2021) and Veli et al. (2022) further investigated these relationships, finding that globalization and trade openness are linked to changes in ecological footprints. However, results vary depending on the country and specific context.

Regarding methodological approaches, studies employed diverse techniques such as OLS, ARDL, and co-integration tests to analyze the relationships between economic variables and environmental outcomes. Muhammad et al. (2021) used the ARDL approach to examine the long-term link between CO2 emissions and rice production in South Korea, revealing that increased CO2 emissions positively affect rice production. Rehman et al. (2021) applied ARDL limit tests to explore the impact of globalization, energy use, and foreign trade on the environmental footprint in Pakistan, finding that both short- and long-term relationships exist between these variables. Veli et al. (2022) tested dynamic symmetric and asymmetric causality between the environmental footprint and trade openness in G7 countries, identifying unidirectional causality, which indicates a complex and often one-way connection between trade openness and environmental impacts. Similarly, Kingsley et al. (2022) utilized Driscoll-Kraay regression and Dumitrescu-Hurlin causality tests to explore the long-term relationship between trade and environmental pollution, finding that economic progress and exports influence emissions significantly.

3. RESEARCH METHODOLOGY

The main objective of the study is to verify the EKC hypothesis for India. In order to, the study examines whether the EKC follows a linear, quadratic form. Existing literature predominantly discusses quadratic form and a cubic form of EKC relationship exists between environmental pollutants and economic growth. The time period of the present study is taken from 1991 to 2020. The study is based on secondary data, which are taken from different sources like; World Development Indicators (WB), the Organization for Economic Cooperation and Development (OECD), Penn World Table and climate watch etc.

TABLE: 1 DSECRIPTION OF VARIABLES

Variables	Description	Measurement Units	Source
Mt (CO_2e) Per Capita	Carbon dioxide emission equivalent Per Capita	Metric tons	Climate Watch
GDPpc (PPP)	Per Capita Gross domestic product (Purchasing Power Parity)	US$ (Million)	Penn World Table
TOI	Trade openness index	Percent	WDI
FDI	Foreign direct investment	Percent	WDI
GCF	Gross Capital Formation	Percent	WDI
IND	Industrialization (value added)	Current US$ (Trillion)	WDI
ESI	Environmental stringency index	Degree	OECD

Source: Author's Own Calculation

The table 1 presents a set of critical variables that analyze the interplay between economic development, environmental impact, and trade dynamics.

In order to determine whether the EKC is valid in India, the following equation has been used in this study.

3.1 Model Specification

$$CO_2e_t = \alpha_0 + \beta_1 GDP_t + \beta_2 GDP_t^2 + \beta_3 GCF + \beta_4 TOI_t + \beta_5 FDI_t + \beta_6 IND_t + \beta_7 ESI_t + \mu_t \ldots\ldots\ldots \text{eq.(1)}$$

Where:

CO2e =It signifies environmental pollutants as measured by carbon emissions equivalent

GDPpc = Per Capita Gross domestic Production

GDP^2pc = Square of GDPpc

GCF = Gross Capital Formation

TOI = Trade Openness Index

FDI =Foreign Direct Investment

IND =Industrialization

ESI = Environmental Stringency Index

t = Time Period

α; β = Intercept and Slope Coefficient

u_t= Error Term

β1 and β2 collectively determine the shape of the EKC curve, i.e., a linear, inverted-U EKC curve.

Mathematically

(1) A linear relationship implies: β1 >0 and β2 = β3 = 0.

(2) An inverted U-shaped relationship implies: β1 > 0; β2 < 0 and β3 = 0:

(3) A U-shaped curve implies: β1 < 0; β2 > 0 and β3= 0:

Ɣ = Exp. (-β1/ 2β2) (First Turning Point)

4. RESULT AND DISCUSSION

The empirical study used time series data to investigate the EKC hypothesis for India. So, before using any method on time series data, the first thing to do is to check whether our data is stationary or not. Many tests are available in applied economics to check the stationary of the variables, but here the unit root test is used to check the stationary level of the variables. Dickey and Fuller (1979) developed a procedure for testing whether a variable has a unit root. Hamilton (1994) describes the four different cases to which the augmented Dickey–Fuller test can be applied. The null hypothesis is always that the variable has a unit root. ADF test assumes that mean and variance remains constant over time, no serial correlation and sample size should be large. The true model is to be.

$y_t = \alpha + y_{t-1} + u_t$……..eq.(2)

Where, u_t is an independent and identically distributed zero-mean error term.

$y_t = \alpha + \rho y_{t-1} + \delta_t + u_t$…….eq.(3)

The Dickey–Fuller test involves fitting the model by ordinary least squares (OLS), perhaps setting α = 0 or δ = 0. However, such a regression is likely to be plagued by serial correlation. To control for that, the augmented Dickey–Fuller test instead fits a model of the form.

$\Delta y_t = \alpha + \beta y_{t-1} + \delta t + £_1 \Delta y_{t-1} + £_2 \Delta y_{t-2} + \ldots\ldots + £_k \Delta y_{t-k} + e_t$……eq(4)

Where, k is the number of lags specified in the lags () option. The no constant option removes the constant term α from this regression, and the trend option includes the time trend δt, which by default is not included.

Stationarity analysis

H_o = There is a unit root.

H_a = There is no unit root.

TABLE: 2 RESULTS OF UNIT ROOT TEST

Standard Unit Root Test			
Augmented Dicky-Fuller			
Variables	**At level**	**At First Difference**	**Integration Order**
CO_2e	0.8084	0.0068*	I(1)
GDP	1.0000	0.0387*	I(1)
GDP^2	1.0000	0.0119*	I(1)
TOI	0.4869	0.0014*	I(1)
GCF	0.4139	0.0000*	I(1)
FDI	0.3614	0.0000*	I(1)
IND	0.9702	0.0161*	I(1)
ESI	0.9934	0.0001*	I(1)

Source: Author's Own Calculation (indicates significance level at 5% level)

The table 2 indicates the results of the Augmented Dickey-Fuller unit root test, revealing the stationarity properties of various variables. The results indicate that all variables are nonstationary at level 1(0) and stationary at first difference 1(1), with p-values below 0.05, indicating significant evidence against the null hypothesis of a unit root.

TABLE: 3 DESCRIPTIVE STATISTICS OF VARIABLE

Variables	Mean	Standard Error	Standard Deviation	Range	Minimum	Maximum
CO_2e	1.791724138	0.081740713	0.440187208	1.31	1.21	2.52
GDP	4283463.228	476677.2099	2566985.335	7817474.625	1324646	9142121
GDP^2	2.47E+13	4.77E+12	2.57E+13	8.18E+13	1.75E+12	8.36E+13
IND	3.22E+11	42193569751	2.27E+11	6.42E+11	7.14E+10	7.14E+11
GCF	31.88620784	1.038273992	5.591276562	19.23438772	22.71641	41.95079823
FDI	1.255050006	0.155292801	0.836277325	3.593297695	0.027226	3.620523235
TOI	36.01185849	2.351598584	12.66374594	38.80599517	16.98773	55.79372172
ESI	1.429310345	0.118528468	0.638295336	2.05	0.64	2.69

Source: Author's Own Calculation

The table 3 shows the descriptive statistics results of various variables like carbon dioxide emissions equivalent (Co2e), Gross Domestic Product (GDPpc), industrialization (IND), Gross Capital Formation (GCF), Foreign Direct Investment (FDI), Trade Openness Index (TOI) and Environmental Stringency Index (ESI), providing a summary of their central tendencies and variability. Carbon dioxide emissions (CO2e) average 1.79 metric tons, with a standard deviation of 0.44, reflecting moderate variability.

Gross Domestic Product (GDP) has a mean of approximately 4.28 million US dollars, indicating significant economic scale and variability (standard deviation of 2.57 million). The square of GDP (GDP2) averages about 2.47 trillion, while industrialization (IND) averages 322 billion, highlighting disparities in industrial contributions. Gross Capital Formation (GCF) shows a consistent investment level with a mean of 31.89% and low variability. Foreign Direct Investment (FDI) averages 1.26 percent, with notable variability, while the Trade Openness Index (TOI) averages 36.01percent. In the last, the Environmental Stringency Index (ESI) averages 1.43, reflecting differences in regulatory stringency.

TABLE: 4 CORRELATION TEST FOR VARIABLES

Variables	CO_2e	GDP	GDP^2	IND	GCF	FDI	TOI	ESI
CO_2e	1							
GDP	0.985244618	1						
GDP^2	0.941824917	0.981637155	1					
IND	0.97995441	0.993167787	0.966163784	1				
GCF	0.573340586	0.480565255	0.329226862	0.527734827	1			
FDI	0.711711447	0.65080677	0.542881603	0.676113467	0.713849508	1		
TOI	0.826845131	0.771063964	0.645730557	0.798877301	0.864247451	0.811507616	1	
ESI	0.964102617	0.973680519	0.957827124	0.961713294	0.485734014	0.633230113	0.736713273	1

Source: Author's Own Calculation

The table 4 represents the results of correlation. Correlation shows how each variable is related to others. Strong correlations indicate that variations in one variable are closely associated with variations in another, while weaker correlations indicate less direct relationships. There is a highly positive correlation between CO2 emissions (CO2e) and both GDP (0.99) and GDP2 (0.94), indicating that higher economic output is associated with increased emissions. Similarly, CO2e shows significant correlations with industrialization (IND) and the Trade Openness Index (TOI) at 0.98 and 0.83, respectively. Gross Capital Formation (GCF) has a moderate correlation with CO2e (0.57) and a stronger correlation with FDI (0.71). The Environmental Stringency Index (ESI) also correlates strongly with CO2e (0.96) and GDP (0.97), suggesting that strict environmental laws are associated with economic performance.

TABLE: 5 RESULTS OF REGRESSION

Variables	Coefficients	Std. Error	T-statistics	p-value
C	0.667388	0.083049	8.036071	0.0000*
GDPpc	4.26E-07	6.38E-08	6.676423	0.0000*
GDP^2pc	-1.71E-14	4.47E-15	-3.826513	0.0010*

IND	-8.36E-13	3.80E-13	-2.199402	0.0392*
GCF	0.006868	0.004254	1.614617	0.1213
FDI	0.012354	0.017681	0.69869	0.4924
TOI	-0.006839	0.003100	-2.206586	0.0386*
ESI	0.002761	0.064888	0.042547	0.9665
R-squared ($R^{2)}$	0.992529			
Dubin-Watson	1.527066			
Shape of EKC	**Inverted- U**			
Turning point	GDPpc= 1.2465 (US Million $) CO2e = 3.326 (Metric Ton)			

Source: Author's Own Calculation (* indicates significance level at 5% level)

The table 5 shows the results of the regression analysis. Per capita GDP positively affects the carbon emission (Co2e). A one-unit increase in GDPpc is associated with an increase of 4.26 GHG emissions. The low p-value indicates that this coefficient is statistically significant. This relationship is highly significant. The squared term of GDPpc negatively affects the GHG emission, suggesting a non-linear relationship. This relationship is also highly significant. The findings show that both linear and non-linear terms of GDP per Capita show the existence of EKC in India. The results show the 'Inverted-U' relation between economic growth and CO2e emission. The coefficients of linear and non-linear terms are 4.26E-07 and -1.71E-14, respectively. The evidence confirms that CO2e emissions increase in the initial stage of economic development and eventually decline after reaching the threshold GDP per Capita (Turning point). The coefficient of industrialization is negative but statistically significant. This means that a one-unit increase in IND is associated with a decrease of 8.36 GHG emissions. The trade openness index has a statistically significant adverse impact on carbon emissions. A one-unit rise in the trade openness index (TOI) is associated with a fall in the GHG emission by approximately 0.006839 units. The empirical results demonstrate that the coefficient of FDI and GCF is favorable statistically insignificant at a 5% significance level. It implies that rises in investment will raise GHG emissions. These results suggest a robust model, where changes in per capita GDP, squared GDPpc, industrial production (IND), and TOI have significant impacts on GHG emissions, while others like GCF, FDI, and ESI may not be statistically significant. The high R-squared value (0.9925) shows the model explains 99.25% of the change in the dependent variable, suggesting a perfect fit.

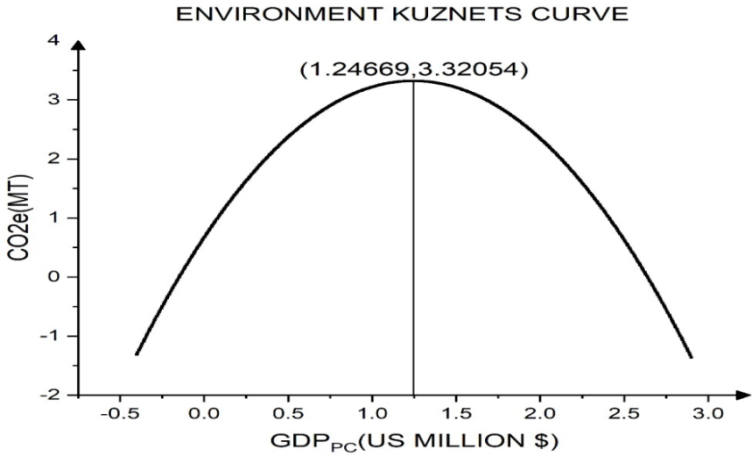


Figure: 1 Environmental Kuznets Curve For India

Source: Author's Own Calculation

The figure 1 shows the Environmental Kuznets curve for India. The results reveal an inverted U-shaped relationship for India. The results show that as GDP per Capita increases, greenhouse gas emissions initially rise due to increased economic activity, as indicated by the positive coefficient 4.26. However, the term −1.71, with its negative coefficient, implies that beyond a certain point, further increases in GDP per Capita lead to diminishing returns in terms of emissions reduction or even a decrease in emissions. This curvature reflects the idea that initial economic growth typically correlates with higher emissions due to increased energy consumption and industrial activities. However, improvements in technology, efficiency, and shifts toward cleaner energy sources can eventually mitigate and even reverse this trend. The turning point of the Inverted-U shape relationship (1.2465 US$, 3.326 Mt) signifies the point where greenhouse gas emissions attain their maximum value of 3.3263 (Mt), corresponding to GDP per Capita of approximately 1.2465 (US$). This point represents a critical balance between economic development and environmental impact. Beyond this turning point, further increases in GDP per Capita might still occur. However, emissions either stabilize or decrease due to technological advancements, policy interventions promoting sustainability, and shifts towards renewable energy sources.

5. CONCLUSION

Achieving stable economic growth and development is one of the leading purposes of countries, and increasing production can be attributed to being the engine of economic growth. Production is generally carried out with the acceleration of industrialization and the spread of international trade, which puts pressure on natural resources and causes nature to exceed the carrying capacity limit since the energy needed is predominantly obtained from fossil fuels. Therefore, countries' economic development and trade liberalization can disrupt the ecological balance if required improvements are not achieved in the medium and long term. The present study examined the Environmental Kuznets Curve's (EKC) for India. The study found the presence of an 'Inverted U' shaped EKC in India. This implies that GHG emissions increase in the initial stage of economic expansion and eventually decline after reaching the threshold of GDPpc (turning point). Industrialization's coefficient is statistically significant but negative. This means that a one-unit increase in IND is associated with a decrease of

8.36 GHG emissions. The trade openness index has a statistically significant adverse impact on carbon emissions. A one-unit rise in the trade openness index (TOI) is associated with a fall in the GHG emission by approximately 0.006839 units. The empirical results indicate that the FDI, GCF and ESI coefficients are positive but insignificant at a 5% significance level. It implies that rise in investment will raise GHG emissions. Based on empirical results, investment will increase GHG emissions due to weak environmental policy in India. Thus, these results suggest a robust model where changes in GDPpc, squared GDPpc, industrial production (IND), and TOI significantly impact GHG emission.

In contrast, others like GCF, FDI, and ESI may not be statistically significant. However, our finding suggests that growth and GHG emissions go together. Since economic growth cannot be compromised, particularly for emerging economies like India, governments must actively introduce policies that intervene to control environmental degradation. Hence, the Indian government should implement and enforce stricter environmental laws and regulations to mitigate the negative impacts of industrial activities. This could involve establishing emission limits for various industries and ensuring compliance through regular monitoring and penalties for violations. Encouraging the adoption of cleaner technologies in industries can significantly reduce GHG emissions. The government could provide incentives, such as tax breaks or subsidies, for companies that invest in sustainable practices and technologies. The government should promote sustainable industrial practices by offering training and resources for businesses to transition towards eco-friendly operations. This includes adopting circular economy principles, where waste is minimized, and resources are reused and recycled. To foster eco-friendly economic growth, India should attract foreign direct investment (FDI) that focuses on sustainable projects, such as renewable energy, waste management, and sustainable agriculture. Establishing a favorable investment climate for green projects can help align economic growth with environmental goals. Raising public awareness about the importance of sustainability in economic growth can encourage consumer behavior that supports environmentally friendly products and practices. Engaging communities in decision-making processes can foster a culture of environmental responsibility.

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Developmentalism & Environmentalism: A Critical Analaysis

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The concept of economic development in 20th century, paved the way for the emergence of a theory of progress which had an urge for uni-lineal and undifferentiated growth. In this process there emerged a close nexus between modern science and the theory of development which catered to the needs of the emerging capitalist system or capitalism vis-a-vis industrial society or industrialism. The reductionist world-view and the industrial revolution provided a framework with a set of values which were compatible with the needs of commercial capitalism. It was this conceptual framework which articulated the basic ethos of modem day developmental ethos based on "the great promise of unlimited progress- the promise of domination of nature, of material abundance, of the greatest happiness for the greatest number, and of unimpeded personal freedom"[1]

It was during 1960s and 70s, an emerging ecological consciousness started to question the postulates of the "great promise of unlimited progress". In the beginning, much of the concern was centered on the rapid resource depletion, population growth and environmental pollution. It was predicted that a continued population growth and resource depletion would lead to the ecological imbalance and would set "limits to growth"[2].

Most of the early literature analyzed the situation from a neo-Maltusian[3] perspective and held the population growth in the Third World responsible for gradual resource depletion and subsequent ecological crisis. But these studies with their arguments solely based on the question of population growth ignore the reality of contemporary environmental crisis which is actually a multi-dimensional problem. This negation of the other related aspects leads to the de-politicization and a subsequent mystification of the environmental question by treating it simply as a local issue. It is true that the population size also contributes to the ecological imbalance because greater the population, the more the resources that are required to sustain it. But this does not mean that population is the sole cause of ecological degradation. It has been proved by the demographic studies that population growth is inherently related to socio- economic factors and an answer to the population explosion in the Third world should emanate from this broader perspective because "this is essentially a political question no more capable of being resolved within the framework of the status quo that of resource depletion"[4].

Therefore, an environmental perspective that does not take into account the various factors responsible for the emergence of the contemporary ecological crisis as a global phenomenon distorts the reality, hence lacks credibility. The environmentalism that has emerged in the developed industrial countries and does not refer to the underlying causes of the contemporary ecological crisis has "characteristics that cannot be extended to the Third World and might be considered ethnocentric". Therefore, the Third World environmental crisis should be analyzed from a perspective which deals with the underlying causes and the various interlocking processes which have led to the emergence of the contemporary ecological imbalance.

While dealing with the concept of development and environmentalism one finds that there exists an intricate relationship between the two; because, "the fate of the eco system is closely related to the nature of the system of production which in turn is firmly linked to the economic system". Development requires manipulation of resources-both natural and human. Its impact is felt on both. Therefore, our perception of contemporary environmentalism is essentially related to our perception of development. Thus to understand contemporary ecological crisis it becomes inevitable to analyze the postulates of development under the context of global economic system.

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Development as a slogan of global aspiration and efforts has its ideals in a theory of progress which advocates unlimited growth. This uni-lineal approach to development sees it as a process passing through "successive stages"[7]; within which all societies in their economic dimensions lay. This uni-lineal view presents development as "a post-colonial project, a choice for accepting a model of progress in which the entire world remade itself on the model of the colonizing modern west, without having to undergo the subjugation and exploitation that colonialism entailed"[8]. This approach to development calls to imitate the historical model of the countries that for various reasons happens to be rich today. Development is, therefore seen as advancement towards certain well defined general objectives to be found in the most advanced countries. Underdeveloped countries advancement towards this model is possible only if they eliminate certain political, social, cultural and institutional obstacles.

Such an approach to development has given it highly political connotations because under this perspective whenever we look at the backward societies we do so with the example of West firmly in our mind. We equate the pre-conditions of modernization, the path by which societies would somehow through a neat succession of stages, arrive at the desirable state of being modernized, industrialized and implicitly westernized.

This explanation of development ignores the reality because it does not take into account the underlying historical causes and consequences of the developmental process. Underdevelopment which under this perspective is seen merely as an absence of development is basically "a discrete historical process through which economies that have already achieved a high level of development have not necessarily passed"[9]. Underdevelopment is, therefore, not a necessary stage in the process of formation of the modern capitalist economies as has generally been suggested. Instead, underdevelopment is a "special process due to the penetration of modern capitalist enterprise into archaic structure"[10].

Therefore, a concept that does not take into account the historical process of development misses the vitals of explanation. A uni-dimensional approach to development based on the pre-conditions of the stages of growth presents a western colonial model of development ignoring the corresponding historical process of underdevelopment in the Third world. Considering these drawbacks, the efforts should be made to formulate a theory of development which takes into account "the process of development in its various historical and concrete manifestations"[11].

A historical perspective on development demonstrates that underdevelopment and development are not successive stages instead these are the products of one single process that is the historical process of capitalist development. Under-development in the non-western countries has developed simultaneously with the development in the west. One findssuch a historical explanation in classical Marxist literature [12], but more lucid and elaborate analysis has come from the neo-Marxist stream. While the classical Marxists acknowledged that the colonialism was the necessary condition of capitalist development in the West, but they also maintained that it was necessary to put the traditional societies on the path of capitalist development. Contrary to this a new perspective that emerged during the 1960s starts with a different note and regards underdevelopment, not the development as the direct outcome of the spread of international capitalism.

The historicity of the process of the capital accumulation in the west during the colonial period makes it evident that "there was a uni-lineal transfer of wealth from the non- European countries to those of the Western Europe"[13]. To sustain this uni-lineal transfer of wealth it was in the interest of the capitalist west to keep the Third World as an indispensable hinterland. Advanced countries unwillingness towards the industrialization of the underdeveloped countries manifested itself in the fact that the underdeveloped world provided them raw material and a market for investment outlets. The dependency status of the underdeveloped countries in an international economic system rigged the show in favor the industrialized countries.

Therefore, underdevelopment of the Third world can be seen as a logical outcome of the expansion of the capitalist system to the colonial areas". Capitalism as a process covering more than three centuries has penetrated into the very structure of the economy and has created a world system maintained through a chain of "metropolitan-satellite" relations which transcends national boundaries. Within a country, the hinterland supplies the city and is exploited by it: in turn the cry is dependent on the metropolitan countries of the west. This dependency relationship has led to the continued exploitation of the satellites by the metropolis causing underdevelopment in the former and development in the later.

The history of underdeveloped societies therefore, has not been and could not possibly have been a duplication of the capitalist west. These dependency relations in the post-colonial era can be explained in terms of "unequal exchange" which can be seen as the most elementary transfer mechanism. It allows developed countries to begin and to maintain uneven development and asymmetrical trading relationship. It is evident, therefore, that why despite centuries of capitalist penetration majority of the Third World countries are still underdeveloped. Underdevelopment, thus cannot be visualized as a necessary stage towards the high mass consumption societies, instead it is an outcome of a historical process which has led to the development of few and underdevelopment of many.

Hence, analyzing the relationship between development and ecological crisis welcome across a dualism which is manifested in the contemporary ecological consciousness. Roots of this dualism are in the existing ecological crisis which is an outcome of markedly different processes in the two worlds. While the environmental crisis in the west has directly resulted from three centuries of development, contrary to subsequent underdevelopment in this span of time in the Third World. In the process of capitalist development, the west not only appropriated the wealth of its colonies but also created there a culture of poverty', In this sense, as a process of capital accumulation and the subsequent commercialization of economy for surplus generation, development has evolved "the reproduction not merely of a particular form of creation of wealth but also of the associated creation of poverty and dispossession"[15].

The environmental crisis in the Third World, henceforth, is built up through long periods of environmental degradation created by wide range of interlocking processes. The various causes of the Third World environmental crisis are structural with roots in the unequal economic relationships. It is because the "accumulative drive that is necessary to satisfy the consumer demands of the North's population and that part of the South's population which has become accustomed to the similar consumption habits, exerts a high price in terms of the depletion of resources and the creation of waste"[16].

Environmental implications in the Third world are directly related to the livelihood system of the people affected in these areas. While in the developed industrialized countries, environmental crisis is an outcome of overdevelopment, overconsumption and affluence leading to a wasteful production, in the developing countries; it is an outcome of underdevelopment. This is evident in the fact that in the developed countries, the lower priority needs, such as freedom from pollution or planning blight, assume importance because higher priority needs such as housing and food have already been satisfied for majority groups. In developing countries highest priority needs retain priority and constitute the battle ground for environmental politics"[17].

In this sense, environmental crisis in the Third World means basically a crisis of survival for the majority of people who depend on environment for their livelihood. Therefore, "the peasant movements that resist land engrossment by agribusiness corporations and the urban squatters who seek titles for their homes are the closest approximation to environmental action groups in the South"[18]. This marked difference between the causes of environmental degradation that has led to a dualism in the ecological consciousness manifests itself in the sense that "the Third World environmentalism is qualitatively

different in its origin and emphasis from the western counterpart. One is an environmentalism of survival and subsistence; the other of access to a clean and beautiful environment for the enhancement of the quality of life"[19]. Therefore, during these years of emerging ecological consciousness the doom's day predictions have played a minor role in the Third world criticism of the models of development. Rather their criticism has been centered on "economic, social and political considerations, as these are actually experienced in those countries"[20].

This dual character of the contemporary ecological crisis demands a serious rethinking of the conservationists' thesis. The United Nation's definition of conservation put forward by UNESCO and FAO demands rational use of earth's resources to achieve the highest quality of living for mankind. But it must be recognized here that the connotations of 'quality of life' vary with the differences in the cultural and economic systems of the societies. The same is true of 'rational use' because "it may seem entirely rational for one group of people to mine an area even if this means the sacrifice of all other values, whereas to others rational use would call for the exclusion of mining in order to protect other resources or values"[21]. In this context, an integrated environmentalist approach appealing for conservation techniques without taking into account the structural inequalities at global level often follows the class lines both at international as well as at national levels. This is because the surplus appropriation by the class elites allows them to indulge in creating an artificial and pleasant environment giving rise to "a state of affairs in which the environmental concern of the affluent sectors vests on the quality of life, which is threatened by atmospheric pollution, noises, congested transport etc.; whereas the environmental concern of the poor- water pollution, distance from places of work, pre-consciousness and crowding of houses etc. threaten their very lives"[22].

Such an integrated environmental conservation approach which stresses the objectives of resource conservation, maintenance of essential ecological process and life support system. This approach is also associated to preservation and sustainable utilization of species and ecosystem. Notwithstanding, its basic tenets, there are chances of its fake credibility as it does so without examining the necessity of economic and political changes, because even if conservation practices developed in the North have a role to play in developmental process "the structural binds that link the developing countries to industrial societies are such that tinkering with the environment cannot reverse long term-trends"[23].

The contemporary Third world environmental crisis, thus, has been an outcome of a historical process of the surplus accumulation drive of the West under the world capitalist system and majority of its environmental problems are stemming from the inadequate development and are developmental problems.

But the developmental model that has been postulated in the West is not a desirable choice to the Third World countries because this model is based on the perpetuation of the structural inequalities and is dependency promoting. The western industrial society which propagates this developmental model has "contempt for nature as well as for all things not machine made and for all people who are not machine makers"[24]. The inherent nature of production under the capitalist system is wasteful production which is possible only through sustained surplus appropriation. Its emphasis on measuring growth with the GNP[25] has been destructive, both ecologically and for the Third World development. Development as a western model is based on the notion of undifferentiated growth which does not direct itself towards the well-being of people in general but is directed towards maintaining the capitalist status quo.

The wasteful production in which the capitalist system indulges finds an outlet in the creation of "false needs"[26], which are superimposed upon individual by particular social interests in his suppression. This suppressive capitalist apparatus is held together by a system based on mechanistic technology and a concept of unilineal growth and is severely detrimental to the environment. The adaptation of a faulty technology which is anti- ecological because of its mechanistic attitude has intense impact on

environment but at the same time is compatible with the needs of the capitalist production system because of its fragmented approach towards the natural environment, which justifies the specialized commodity production. Thus, the crucial link between pollution and profits appears to be modern technology which is both the main source of recent increase in productivity-and therefore, of profits; and of recent assaults on the environment[27]. The contemporary environmental crisis is, therefore, an inevitable result of the counter ecological technology which perpetuates a counter ecological pattern of growth.

The specific social wants of the capitalist system to which the modern technology responds help in sustaining the unequal relationship between the Third world and the West. Modern technology is catering to the demands of those who can purchase it, and ignoring those who cannot afford it[28]. This is evident in the fact that in advanced countries the environmental issue takes the shape of reducing energy use per capita which is difficult to enforce. While in the Third World countries the issue is not energy intensive technology but one of primitive industrial technology which pollutes the environment.

It is clear, therefore, that capitalism in the process of maintaining its own status-quo having "itself perpetuated the twin crisis of human ecology and world poverty, cannot now shake them off without ceasing to be what it has always been: a system genetically conditioned to thrive on nothing but exploitation not only of man but of nature as well"[29], It can be socially and ecologically benign only in the case if it abandons "nothing less than accumulation itself"[30], which will mean the collapse of the capitalist system itself because exploitation and repression are the very basis of its existence.

But neither a socialist model of development as it has emerged in the erstwhile U.S.S.R. is ecological and anti-human traits with the capitalist system. Both are dedicated to unlimited industrial growth. Their obsession with growth has resulted in remarkable similarities between the two. The catching up syndrome has marked a quick change in socialism from a "movement whose aim was a new society and a new man into one whose ideal was a bourgeois life for all the universalized bourgeois as the men and women of the future"[31]. A major drawback which the socialist revolution has suffered is that it has simply addressed itself at the question of a more equitable and just distribution of wealth, while other relationships are neglected or underestimated. In this context a socialist revolution can be successful only if it addresses itself to "totally revolutionized relationship between men and between men and things-that is to say it must revolutionize the whole production of their lives"[32].

In such a scenario, a solution to the Third World environmental crisis with reference to its developmental problems does not lie either in a capitalist model of development or in a socialist model of development. Instead a Third world perspective should evolve a new framework to its development demands because a western model of development which has been shaped by a theory of progress which is both alienating and dependency promoting, is neither desirable nor feasible in the Third World countries. In this case a Third World environmental perspective has to be "a part of programmeof more general social change"[33], Such a perspective demands the reexamination of the development process which has encouraged overproduction and over consumption in the North at the expense of South and has created there serious developmental as well as ecological problems. In this context, an alternative path of development becomes a necessity for the Third World because under the unfavorable conditions in relations to a global political economy; a western model of development will convert them into "cultural and political appendages of the metropolises"[34].

The alternative path of development, contrary to the capitalist production systemwhere the majority is marginalized in the process of production should be based not on a system of mass production but on a system which is sustained by production by masses, as opined by the Father of Nation-Gandhi. This alternative perspective should be based on the postulates of decentralization, less capital intensive production system, relatively simple or "intermediate technology"[35] do. Here demands for high skills

are minimized and production is made mainly from local materials and for local use. It should emphasize "satisfaction of basic needs, a self-reliance which grows from within" and "harmony with the environment to ensure the sustainability of development over the long run"[36]. Thus, a Third World environmental perspective should address itself to a new reality which should be ecologically benign with a human face of development and which should be 'need based' instead of 'demand oriented'.

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Trade Dynamics between India and Selected Latin American Countries: Implications for Sustainable Development

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Abstract

This research paper investigates the evolving trade dynamics between India and Latin American countries, focusing on trade patterns, growth trajectories and Revealed comparative advantage (RCA) to evaluate their implications for sustainable development. The study identifies a significant uptrend in bilateral trade, facilitated by strategic partnerships and complementary economic structures. RCA analysis indicates that India has a comparative advantage in pharmaceuticals, information technology services and automotive components, while Latin American countries hold a comparative advantage in agricultural products, minerals and energy resources. Appropriate tools such as Revealed Comparative Advantage (RCA) Index for empirical analysis from 2001 to 2022 are applied. The study underscores that these trade patterns and growth have significant implications for both regions. Economically, the trade relationship has contributed to GDP growth and technological advancements. Socially, it has the potential to reduce poverty and promote inclusive growth, particularly through rural development in Latin America and industrial growth in India. Environmentally, the trade presents both opportunities and challenges.

The findings highlight the need for comprehensive and sustainable trade policies that balance economic growth with environmental stewardship and social equity. The study advocates for collaborative efforts to enhance resource management and ensure fair distribution of trade benefits. By leveraging their comparative advantages and aligning trade practices with sustainability goals, India and Latin American countries can strengthen their economic partnership and can contribute to long-term sustainable development and the achievement of global sustainability objectives.

Keywords: Trade Pattern, Revealed Comparative Advantage, India and selected Latin American countries.

1. INTRODUCTION

India and Latin America are the two fastest-growing economies. India and Latin American region stand at opposite ends of the globe, yet view each other with friendship and warmth. India shares a common history of colonialism and struggle for independence with the region. Latin America is a far remote country but it has to explore its resources. India should make the strategic cooperation and bilateral trade relationships with Latin American countries so that in future the prospects for the trade between two countries can increase. Latin American exporters are concentrating on exploiting the opportunities of the large and growing market of India. The main factors affecting our trade with this region are: distance, language barriers, inadequacy in the exchange of information and the absence of direct shipping.

Trade dynamics between India and selected Latin American countries assesses the sustainability implications by offering insights into how these countries can work towards achieving the Sustainable Development Goals (SDGs). The trade dynamics between India and selected Latin American countries present significant opportunities for sustainable development. By focusing on economic growth, environmental sustainability and social inclusion, both regions can forge a path towards a more sustainable future.

Latin American countries like Argentina, Chile, Colombia, Venezuela, Brazil, Mexico and Peru have

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increased the ties with India in the most recent years. Latin America has become an important epicenter of trade across the globe due to its several factors like opening up or exposure of its economy to the world economy, development of infrastructure, decrease in tariffs and non-tariff barriers, liberalization and privatization of financial markets. The trade relationships between India and Latin American countries are increasing. Latin America should take the advantage of the opportunities offered by India to maximize its international trade. Brazil, Venezuela, Bahamas, Chile, Argentina, Colombia, Peru, Ecuador, Panama, Trinidad & Tobago are India's top ten trading partners.

2. REVIEW OF LITERATURE

Balassa (1965) established the concept of "Revealed Comparative Advantage" (RCA). The term RCA clarifies the possibility that nations practice and disseminate those items which they can create at lower cost in contrast with the world. As asserted by Balassa that 'Comparative Advantage' position, a nation adores to a great extent relies upon its physical and human capital settlements.

Karakaya and Ozgen (2002) considered "the effects of trade creation and trade diversion" on the EU market by using RCA index. It was concluded that Turkey and EU were having different export structures. This study also examined, "whether trade accession would make the trade vulnerable for other southern members i.e. Spain, Portugal, and Greece?".

Hinloopen and Marrewijk (2004) examined the method of Chinese Revealed comparative advantage relating to competitiveness for nations which are doing exports from the period 1950 to 2000. This study used "Balassa Index of RCA". It thus, analysed the dynamics of revealed comparative advantage for China, Hongkong and Taiwan.

Lederman, Olarreaga and Soloaga (2007) examined the relationship between the rapid growth

of China and India in world trade and the Latin American and Caribbean trade movements (LAC) from the perspective of China and India as growing export markets and as the basis for imports for Latin America and the Caribbean. This paper analyzed the importance of the growth opportunities for China and India to Latin American and Caribbean exporters during 2000-2004. They concluded that the growth of India and China was an opportunity for exporters and importers in Latin America and the Caribbean.

Burange (2008) studied the framework of comparative gains for India and the variations over a

period from 1996 to 2005. The "Index of Revealed Comparative Advantage (RCA)" was used for numerous stages of combination for exports as well as imports. It was concluded that India adores a comparative advantage in the export of labour intensive products like textiles and scale intensive items like chemicals, iron and steel.

Ohlan (2012) enumerated "India's trade projections with ASEAN countries by examining the patterns and trends in India's bilateral merchandise trade with ASEAN countries and their Revealed Comparative Advantage (RCA) in diverse goods". The outcomes disclose that during the last three decades "India's portion in ASEAN countries' merchandise trade has amplified but

India runs a huge and deteriorating trade deficit with ASEAN countries".

Kim (2019) analyzed the competitiveness of Indian exports in the US textile and clothing sector by using the Balassa Comparative Advantage Index (RCA). This study uses the data obtained from UN COMTRADE for the period from 1991 to 2017.The study concluded that there is a need to improve the quality of textiles and clothing products in India as there is the emergence of low-cost producing

countries like Vietnam, Bangladesh and Honduras who can threaten India's export competitiveness in the global market. Therefore, technological development related with manmade fiber and fabrics is essential for the future policy development.

3. RESEARCH GAPS

Identifying research gaps in the trade dynamics between India and selected Latin American countries related to sustainable development can provide valuable insights for policymakers. Further research is needed for the following extents:

- **Limited Data Availability**: Existing trade data between India and selected Latin American countries may be fragmented. Research could focus on compiling comprehensive and current trade statistics to better understand trade flows and trends.

- **Sector-Specific Studies**: Detailed analysis of specific sectors like agriculture, technology and textiles can uncover unique opportunities and challenges for sustainable trade.

- **Evaluating Existing Agreements**: There is a need for detailed assessments of existing trade agreements between India and selected Latin American countries to determine their impact on sustainable development indicators.

- **Exploring New Agreements**: Research could explore potential future trade agreements and their implications for social, economic and environmental outcomes.

4. HYPOTHESIS

H0: There is no significant relationship between India's revealed comparative advantage in specific sectors and the volume of sustainable exports to Latin America.

H1: India’s revealed comparative advantage in specific sectors is positively related to the volume of sustainable exports to Latin America.

5. RESEARCH METHODOLOGY

To study the concept of Revealed Comparative, Data is collected from various sources as:

- UN COMTRADE database
- UNCTAD Statistics
- The World Bank Database
- World Development Indicators (WDI)
- World Integrated Trade Solution, World Bank)

The index of RCA is calculated using the data on exports for both India and Latin American Countries from UNCOMTRADE database at HS-2 digit. The RCA indices have been calculated for India and selected Latin American countries like Argentina, Brazil, Mexico, Venezuela and Peru in all the chapters of the Harmonized System (HS) classification for the year 2001 and 2022.

The index for country i and commodity j is calculated as follows:

$RCAij= (X_{ij}/X_{it})/(X_{wj}/X_{wt})$

Where:

X_{ij}=Values of country i's exports of product j

X_{wj}= World exports of product j

X_{it}= Total exports of country i

X_{wt} = World exports of product j

Range of the RCA Index

1. **RCA < 1** indicates that the country has a **disadvantage** in exporting that particular good compared to the global average for the product

2. **RCA = 1** indicates that the country has **no comparative advantage.**

3. **RCA > 1** Shows that the country has a **comparative advantage** in exporting that good.

Table – 1 Economic Profile of India and Selected Latin American Countries: A comparison of Macroeconomic Variables in 2022

Sr. No.	Macro Variables	India	Argentina	Brazil	Mexico	Venezuela	Peru
1	GDP (PPP) ($Billion)	9447	911.5	3219	2406	389.4	424.6
2	Inflation Rate (Consumer Prices)	3.80	26.90	3.70	5.90	652.70	3.20
3	Exports ($ Billion)	299.3	59.69	215.4	406.5	29.16	42.47
4	Imports ($ Billion)	426.8	60.78	151.9	417.3	17.75	38.8

Source- CIA World Fact book

Broad trends from Table – 1 suggest that there is a strong potential for trade between India and selected countries of Latin America like Argentina, Mexico, Brazil, Venezuela and Peru.

Revealed Comparative Advantage (RCA) Analysis

In this paper Revealed Comparative Advantage (RCA) analysis has been undertaken at the product level. RCA indices have been calculated for India and selected Latin American countries in all the 97 chapters of the Harmonized System (HS) classification for the year 2001 and 2022. Various attempts have been made to analyze the systematic evaluation of the similarities of the patterns of revealed competitive advantage for India and the selected Latin American countries like Argentina, Mexico, Brazil, Venezuela and Peru.

This study calculates the RCA of India with respect to world and similarly the RCA of the selected Latin American countries like Argentina, Mexico, Brazil, Venezuela and Peru with respect to world by using the Balassa`s index.

India's Top Ten Sectors

In 2022 the maximum revealed comparative advantage has been noticed in chapter 52 for cotton. The value of the index of RCA for this chapter is 7.46 in 2022.India enjoyed maximum comparative advantage in HS-50 i.e. Silk in 2001. The value of the index of RCA for Silk (HS- 50) is 16.13 which is closely followed by Lac; gums, resins and other vegetable saps and extracts (13) with RCA15.15 in 2001 and 7.22 in 2022. Carpets and other textile floor coverings (HS-57) with RCA 10.01 in 2001 and 7.21 in 2022 which indicate that its ranking is same at 3 but RCA has decreased from 10.01 to 7.21. In 2001 Coffee, tea, mate and spices (HS – 09), Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad, Cotton and Other made-up textile articles.

Table – 2 Comparison of India's Top Ten Sectors based on the RCA Index (HS-2 Digit)

Rank in 2001	Rank in 2022	HS code	Industry	India's RCA with respect to world in 2001	India's RCA with respect to world in 2022
1	14	50	Silk	16.13	2.58
2	2	13	Lac; gums, resins and other vegetable saps and extracts	15.15	7.22
3	3	57	Carpets and other textile floor coverings	10.01	7.21
4	8	09	Coffee, tea, mate and spices	9.45	3.84
5	7	71	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad ...	8.22	4.04
6	1	52	Cotton	8.21	7.46
7	6	63	Other made-up textile articles; sets; worn clothing and worn textile articles; rags	8.06	4.63
8	4	53	Other vegetable textile fibers; paper yarn and woven fabrics of paper yarn	7.54	4.95
9	5	14	Vegetable plaiting materials; vegetable products not elsewhere specified or included	5.71	4.95
10	23	42	Articles of leather; saddlery and harness; travel goods, handbags and similar containers; articles ...	5.07	1.94

Source: UNCOMTRADE database and Author's calculations

Invertebrates, Salt; Sulphur; earths and stone; plastering materials, lime and cement, Special woven

fabrics; tufted textile fabrics; lace; tapestries; trimmings; embroidery, Cereals, Articles of apparel and clothing, accessories, knitted or crocheted Sugars and sugar confectionery, Residues and waste from the food industries; prepared animal fodder, Ores, slag and ash and Man-made staple fibers was at the number 20 in 2001 with HS code 55 and rank 10 in 2022. India is having an RCA of 2.82 from man maid staple fibers in 2001 and 3.42 in 2022. These are the sectors that appear in the top 20 Sectors in the year 2001.India should export the products with RCA>1 because India is having comparative advantage in these commodities.

It has been noticed that the products with quite good RCA in 2001 have noticed a steep downfall in the year 2022. Out of top 20 sectors at HS two-digit level, the RCA has decreased for almost all the sectors in the economy except chapter 55 in which RCA has increased from2.82 in 2001 to 3.42 in 2022.

Argentina's Top Ten Sectors:

The index of RCA is greater than one for 29 sectors indicating that Argentina holds comparative advantage in these sectors in the world market in 2001. The value suggests that Argentina enjoys comparative advantage in 28 commodities in 2022. Table 3 represents Argentina's RCA with respect to world in 2001 and 2022. There have been so many changes in the calculations for the year 2001 and 2022 for almost all 20 sectors. Argentina`s RCA with respect to world in 2022 has increased as compared to RCA in 2001. Argentina enjoys maximum comparative advantage in HS 23 in 2001 where Residues and waste from the food industries; prepared animal fodder is the highest rank in 2001 as well as in 2022. The value of the index of RCA for this sector is 28.72 in 2001 and 43.22 in 2022. This is closely followed by Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal and RCA for this is 19.68 followed by Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal as 15.84, Raw hides and skins (other than furskins) and leather as 7.99,Products of the milling industry; malt; starches; inulin; wheat gluten as 6.02 and Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral as1.73.

Table-3 Comparison of Argentina's Top Ten Sectors based on the RCA Index (HS-2 Digit)

Rank in 2001	Rank in 2022	HS code	Product Description	Argentina's RCA with respect to world in 2001	Argentina's RCA with respect to world in 2022
1	1	23	Residues and waste from the food industries; prepared animal fodder	28.72	43.22
2	3	15	Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal ...	19.68	15.65
3	2	10	Cereals	16.38	20.52
4	4	12	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal ...	15.84	11.85
5	6	41	Raw hides and skins (other than	7.99	7.46

			furskins) and leather		
6	5	11	Products of the milling industry; malt; starches; inulin; wheat gluten	6.02	7.76
7	9	03	Fish and crustaceans, molluscs and other aquatic invertebrates	5.11	4.18
8	15	08	Edible fruit and nuts; peel of citrus fruit or melons	4.25	2.6
9	19	26	Ores, slag and ash	3.79	1.7
10	7	20	Preparations of vegetables, fruit, nuts or other parts of plants	3.72	5.43

Source: UNCOMTRADE database and Author's calculations

Cocoa and cocoa preparations are having RCA 1.62 in 2001 and 0.5 in 2022 which shows a decline in RCA in 2022. In 2001 Argentina RCA with respect to world was 23.72 for chapter 23 which increased to 43.22 in the year 2022 and the rank is same at 1. At HS 2 – digit, Argentina enjoyed comparative advantage in chapter (23,10,11,20,04,51,07,24,5 and 17) in 2022 with RCA 43.22,20.52,7.76,5.43,3.1,5.1,2.87,2.65,2.42 and 1.96 respectively. It means that Argentina should export those products which are having RCA>1. The above table explains the RCA of top 20 products for Argentina from 2001 and 2022.Argentina should export these products to world because it is having comparative advantage in the production of these commodities.

Mexico's Top Ten Sectors

Based on the RCA index at HS 2-digit level we study the RCA of Mexico with respect to world in 2001 and in 2022. Then we can see that edible vegetables and certain roots and tubers were having rank 1 in 2001.Therefore various changes have occurred in the RCA of Mexico with respect to world in 2022 as compared to 2001 for the various products. when we compare the RCA of 2022 with RCA of 2001 then we can say that for almost 9 sectors the RCA has increased in 2022 as compared to 2001.

Table – 4 Comparison of Mexico's Top Ten Sectors based on the RCA Index (HS-2 Digit)

Rank in 2001	Rank in 2022	HS code	PRODUCT	Mexico`s RCA with respect to world in 2001	Mexico`s RCA with respect to world in 2022
1	3	07	Edible vegetables and certain roots and tubers	4.07	4.09
2	9	83	Miscellaneous articles of base metal	2.29	1.57
3	5	14	Vegetable plaiting materials; vegetable products not elsewhere specified or included	2.2	2.48

4	7	94	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; ...	2.08	1.87
5	4	87	Vehicles other than railway or tramway rolling stock, and parts and accessories thereof	1.94	2.78
6	11	85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television ...	1.92	1.39
7	12	01	Live animals	1.8	1.38
8	8	22	Beverages, spirits and vinegar	1.74	1.8
9	2	86	Railway or tramway locomotives, rolling stock and parts thereof; railway or tramway track fixtures	1.74	4.12

Source: UNCOMTRADE database and Author's calculations

The first is for chapter 7, edible vegetables and certain roots and tubers the rank was 1 in 2001 and in 2022 it went to 3rd and for chapter 83 the RCA was 1.57 in 2022 and 2.2 9 in 2001 and for chapter 14 Vegetable plaiting materials; vegetable products not elsewhere specified or included RCA was 2.48 in 2022 while for 2001 it was 2.2. For chapter 90 Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical, the RCA increased to 1.28 in 2022 as compared to 2001. It means that if the RCA is greater than 1 for these products then Mexico is having a specialization for this product and Mexico should export these products to the world. But for some products RCA has decreased and if it is less than 1 then there is no use of exporting these products to the various countries of the world

Brazil's Top Ten Sectors:

When we compare Brazil's RCA with respect to world for the year 2022 to 2001 then we see that as compared to 2001 for chapter 17 the highest rank is 1 in 2022 as well as in 2001 for sugar and sugar confectionary. For chapter 12 the rank is same 2nd in 2001 and 2022 while RCA has increased to 18.82 in 2022 as compared to 14.26 in 2001. For chapter 26 the rank in 2001 was 3 but in 2022 it changed to 6 while RCA has decreased from 13.28 to 8.53 in 2022 for Ores, slag and ash.

Table – 5 Comparison of Brazil's Top Ten Sectors based on the RCA Index (HS-2 Digit)

Rank in 2001	Rank in 2022	HS code	PRODUCT	Brazil`s RCA with respect to world in 2001	Brazil`s RCA with respect to world in 2022
1	1	17	Sugars and sugar confectionery	15.28	21.15
2	2	12	Oil seeds and oleaginous fruits;	14.26	18.82

			miscellaneous grains, seeds and fruit; industrial or medicinal ...		
3	6	26	Ores, slag and ash	13.28	8.53
4	5	09	Coffee, tea, maté and spices	11.53	9.46
5	7	23	Residues and waste from the food industries; prepared animal fodder	10.81	6.92
6	3	47	Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or ...	6.89	11.08
7	4	02	Meat and edible meat offal	6.54	9.56
8	12	20	Preparations of vegetables, fruit, nuts or other parts of plants	4.87	3.22
9	9	24	Tobacco and manufactured tobacco substitutes	4.71	4.42
10	8	41	Raw hides and skins (other than furskins) and leather	4	6.61

Source: UNCOMTRADE database and Author's calculations

Again, for Chapter 23 Residues and waste from the food industries; prepared animal fodder the rank has changed from 5 to 7 while the RCA has decreased to 6.92 in 2022 from 10.81 in 2001. For chapter 47 the rank has changed from 6 to 3 and RCA increased to 11.08 in 2022 from 6.89 in 2001. For chapter 68 Articles of stone, plaster, cement, asbestos, mica or similar materials rank has changed from 20 to 19 and the RCA is 2.02 in 2022 from 2.14 in 2001. It shows that Brazil has a comparative advantage for almost 19 products out of these 20 products for which RCA is greater than 1 and Brazil should export these commodities to world except for chapter 64, Footwear, gaiters and the like; parts of such articles for which the RCA has decreased to 0.74 in 2022 from 3.74 in 2001.

Venezuela's Top Ten Sectors:

When we study the RCA for Venezuela in Latin America in the year 2022 and compare it with the year 2001, then we can say that the maximum rank is one for chapter 27 in both the year 2022 as well as 2001 that is mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral. After analyzing we can say that for almost 5 products the RCA has increased in 2022 as compared to the year 2001. The RCA increased for chapter (27,78,31, 26 and 41) while for all other 14 products the RCA has decreased. It means that if the RCA is less than 1 then Venezuela should not export these products to the world and should import the products from rest of the world.

Table – 6 Comparison of Venezuela's Top Ten Sectors based on the RCA Index (HS-2 Digit)

Rank in 2001	Rank in 2022	HS code	PRODUCT	Venezuela`s RCA with respect to world in 2001	Venezuela`s RCA with respect to world in 2022
1	1	27	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral ...	8.44	8.59
2	7	76	Aluminium and articles thereof	3.17	0.81
3	16	25	Salt; sulphur; earths and stone; plastering materials, lime and cement	1.69	0.19
4	12	72	Iron and steel	1.61	0.49
5	8	28	Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, ...	1.28	0.72
6	4	26	Ores, slag and ash	1.03	1.22
7	5	78	Lead and articles thereof	0.96	1.15
8	3	31	Fertilisers	0.76	2.19
9	9	03	Fish and crustaceans, molluscs and other aquatic invertebrates	0.75	0.6
10	10	29	Organic chemicals	0.6	0.59

Source: UNCOMTRADE database and Author's calculations

For chapter 76 (Aluminium and articles thereof), RCA in 2022 decreased to 0.81 as compared to 3.17 in 2001. Venezuela should export the products with RCA >1 as in the case for chapter (27, 76, 25, 72, 28, 26) in 2001 and for the year 2022 chapter (27, 26, 78, 31) should be considered for exports.

Peru's Top Ten Sectors

When we study the RCA for Peru in Latin America in the year 2022 and compare it with the year 2001, then we can say that the maximum rank is one for chapter 23 in 2001 and for chapter 26 in 2022. When we compare the RCA of Peru in the year 2022 with RCA of Peru with the world for the year 2001 then we can say that for 6 sectors, the RCA has increased for chapter (14, 26,80,25 and08). The RCA has increased from 31.01 in 2001 to 33.92. For chapter 51 the RCA has increased from 4.44 to 4.96 and for chapter 80 (Tin and articles thereof) it has increased to 29.97 in 2022 as compared to 4.11 in 2001 and for chapter 25 the RCA has increased to 4.41 in 2022 as compared to 1.44 in 2001. Thus Peru should export those products for which RCA is greater than one.

Table – 7 Comparison of Peru's Top Ten Sectors based on the RCA Index (HS-2 Digit)

Rank in 2001	Rank in 2022	HS code	PRODUCT	Peru`s RCA with respect to world in 2001	Peru`s RCA with respect to world in 2022
1	7	23	Residues and waste from the food industries; prepared animal fodder	36.61	7.75
2	27	78	Lead and articles thereof	33.28	0.87
3	1	26	Ores, slag and ash	31.01	33.92
4	3	79	Zinc and articles thereof	30.43	17.76
5	8	74	Copper and articles thereof	20.04	6.37
6	6	09	Coffee, tea, maté and spices	14.54	8.17
7	4	14	Vegetable plaiting materials; vegetable products not elsewhere specified or included	11.86	16.57
8	10	71	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad ...	10.35	4.7
9	12	20	Preparations of vegetables, fruit, nuts or other parts of plants	5.01	4.22
10	13	07	Edible vegetables and certain roots and tubers	5.01	4.21

Source: UNCOMTRADE database and Author's calculations

Peru should export these commodities to the world and otherwise import the commodities for which RCA is less than one that is Peru has a specialization for which RCA is greater than one, while if we see the ranking for these products then for chapter 78 Led and articles thereof the RCA has decreased to 0.87 from 33.28 in 2001 and for chapter 74, Copper and articles thereof the RCA has decreased to 6.37 in 2022 as compared to 20.04.

Sustainable Development Implications

Economic Growth

Trade between India and selected Latin American countries can enhance economic growth by creating jobs, improving infrastructure and fostering innovation. However, this growth must be inclusive, ensuring that marginalized communities benefit. Initiatives like digital trade and e-commerce can empower small and medium-sized enterprises (SMEs) in both regions, helping to drive innovation and

economic diversification.

Environmental Sustainability

The extraction of natural resources in Latin American countries raise concerns about environmental degradation. Sustainable methods must be embraced, emphasizing responsible sourcing, waste reduction and conservation efforts. India can play a role by promoting green technologies and practices in agriculture and industry.

Climate Action

Both regions are affected by climate change and can benefit from shared strategies to mitigate its impacts. Trade in green technologies and sustainable products such as organic agricultural products can help reduce carbon footprints. Joint research and development initiatives can also focus on climate resilience and adaptation strategies.

Social Inclusion

Trade relations should prioritize social equity by addressing inequalities between countries. Collaborative efforts can enhance labour rights and improve working conditions in both regions.

Conclusion

The Implications of enhancing trade relations between India and Latin American countries extend beyond mere economic benefits. By fostering a mutually beneficial partnership, both regions can work towards achieving sustainable development, ensuring that trade contributes positively to the well-being of their populations and the health of the planet. Moving forward, it is essential for policymakers and stakeholders to collaborate closely, creating an environment conducive to sustainable trade practices that will pave the way for a prosperous future for both regions. India and Latin American countries should export the commodities in which they are enjoying comparative advantage and import the commodities in which they face comparative disadvantage. **To better integrate trade with sustainable development, consider the strategies of Green Trade Policies to implement policies that encourage trade in environmentally friendly products and technologies and Provide assistance to developing countries to help them benefit from trade while also pursuing sustainable development goals.** Overall, while trade has the potential to support sustainable development, it requires careful management and policies to ensure that it benefits both the economy and the environment in a balanced way.

This research paper has explored the intricate trade dynamics between India and selected Latin American countries, highlighting both the potential benefits and challenges that arise from this partnership. The analysis has demonstrated that trade relations between India and these nations can serve as a catalyst for sustainable development, promoting economic growth, job creation, and technological exchange. The findings indicate that sectors such as agriculture, pharmaceuticals, and renewable energy present significant opportunities for collaboration. By leveraging India's strengths in technology and innovation alongside the rich natural resources and markets of Latin America, both regions can enhance their economic resilience and foster inclusive development. However, to fully realize these opportunities, several challenges must be addressed. These include tariff barriers, logistical constraints, and the need for stronger institutional frameworks to facilitate trade. Furthermore, ensuring that trade practices are aligned with sustainable development goals is crucial. This includes prioritizing environmental protection, social equity, and ethical labor practices in trade agreements.

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Appendices: Information on Latin American countries

Country	Capital	Area (km²)	Currency	Language
Argentina	Buenos Aires	2,780,400	Peso	Spanish
Brazil	Brasília	8,515,770	Real	Portuguese
Venezuela	Caracas	912,050	Bolivar Fuerte	Spanish
Colombia	Bogota	1,138,910	Peso	Spanish
Peru	Lima	1285216	Nuevo Sol	Spanish
Mexico	Mexico City	1,964,375	Peso	Spanish