Economic Sciences
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ES (2026) 22, 4(S), 594-602 ISSN:1505-4683

Rural Household LPG Energy Consumption in Sri Rangam Taluk of Tiruchirappalli District

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ABSTRACT

This study examines the transition from traditional solid fuels to clean energy in the rural blocks of Manikandam and Andanallur within the Sri Rangam Taluk of Tiruchirappalli District. Amidst global energy market volatility and supply chain disruptions in West Asia as of March 2026, the research investigates the socio-economic factors influencing Liquefied Petroleum Gas (LPG) adoption and the impact of price fluctuations on refill frequency. Utilizing a multistage random sampling method with 380 respondents, the study reveals a population primarily composed of lower-income, medium-sized households. Statistical analysis using Pearson Correlation and Chi-Square tests indicates that neither family size ($p = 0.882$) nor family income ($p = 0.678$) serves as a significant predictor for LPG adoption or cost. Furthermore, the impact of price changes due to supply disruptions showed a borderline significance ($p = 0.051$), leading to a notable "fuel stacking" trend where 44.47% of households reverted to firewood as a primary energy source. The findings conclude that while demographic factors are secondary, immediate market costs significantly dictate fuel choices, necessitating policy interventions focused on price stability and targeted subsidies to prevent a total regression to hazardous traditional fuels

KEY WORD: *Rural Household Energy, LPD Consumption, Supply Chain Disruption & Fuel Stacking.*

Introduction

The economy and social development of households largely depend on energy which is the backbone of the economic growth and social development of households. Access to affordable and reliable energy in rural India is important in the cooking, lighting, education, and livelihood activities. Historically, rural families have relied on solid fuels like firewood, agricultural byproducts, charcoal, and dung cakes as cooking fuels. Such fuels are locally sourced, and can be cheap, but their sustained use poses severe health and environmental issues. The emission of smoke during the traditional cooking practices is a contributor to indoor air pollution, respiratory illnesses, eye irritation, and other health risks, especially to women and children who spend more time near the cooking places.

As a reaction to these problems, Liquefied Petroleum Gas (LPG) has become an essential clean cooking fuel and a viable alternative of the traditional source of biomass energy. LPG has a number of benefits including cleaner burning, quicker cooking, less smoke generation and more convenient to the household. On the basis of these advantages, the Government of India has implemented a number of schemes to spread LPG coverage, such as the Pradhan Mantri Ujjwala Yojana (PMUY), which has already contributed to a great increase in the number of LPG connections among the economically disadvantaged families. Such programmes have benefited millions of rural households in the country as of the recent years. Yet, despite the fact that physical access of LPG has been enhanced significantly, frequent and continuous use continues to be a challenge in most rural locations because of cost factors and refill expenses.

The recent dynamics in the world energy market and in the supply chain have further added the burden of LPG prices to the consumers. Increased prices of cylinders and frequent delays in deliveries have rendered low-income families in the rural areas to solely depend on LPG as a source of cooking fuel. Consequently, most families still engage in the fuel stacking habit where LPG is consumed together with the more traditional forms of fuel like firewood and

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ES (2026) 22, 4(S), 594-602 ISSN:1505-4683

crop waste to save on costs. This suggests that the problem is no longer access, but also encompasses affordability, consumption behaviour, and the long-term sustainability of clean energy uptake among rural communities.

The Tiruchirappalli District in Tamil Nadu provides a valuable environment to study the pattern of rural household energy consumption. Despite the district having educational institutions, industries and urban development, some of the rural blocks like Andhanallur, Manikandam, Musiri and nearby villages still have highly reliance on agriculture based livelihoods. Firewood and agricultural residue are readily available in these areas and they often present cheaper alternatives to LPG. As domestic LPG cylinder prices have continued to rise steadily in Tamil Nadu, the economic burden on families with lower incomes has risen, impacting the rates at which they will buy refill units, as well as their choice of clean cooking energy.

Although LPG connections have been extensively penetrated in Tiruchirappalli District, there are still some obstacles to its exclusive use and constant utilization. Rural households are challenged threefold by the affordability, availability and awareness. The high refill costs discourage constant usage, whereas the last-mile issue of delivering the cylinders to the remote villages tends to postpone the delivery of the cylinders. Simultaneously, older generations still have traditional cooking traditions, the preference of food taste with the use of wood-fired cooking and safety issues regarding LPG. Thus, the rural household LPG energy consumption in Tiruchirappalli District requires detailed investigation to comprehend current trends, find limitations, and propose appropriate policy options that could help to encourage the clean energy use. The findings of this study will provide localized insights into the effectiveness of clean energy policies in Tamil Nadu. By understanding the specific challenges faced by the sample respondents in the study area.

Research Questions

1. What are the socio-economic factors influencing LPG adoption in the study area?
2. How have recent fluctuations in price affected the frequency of refills among the sample respondents in the study area?

Objective of the Study

1. Identifying the socio-economic factors influencing LPG adoption in the study area.
2. Evaluating the impact of recent price fluctuations on the refilling frequency by the sample respondents in the study area.

Literature Review and Hypotheses

An overview of the previous literature shows that the energy transition process in rural Indian households is determined by economic, social and behavioural aspects. Despite the fast growth in the LPG coverage due to the government programs, a large portion of rural households still relies on the use of traditional fuels like firewood and crop residue. Kumar et al. (2020) discovered that the key factors influencing LPG adoption in rural India are affordability, accessibility, and awareness. They concluded that increasing household income and education, and convenient presence of biomass negatively affected the intention to switch to LPG (Kumar et al., 2020). On the same note, Asharaf and Tol (2024) found that, despite the increase in access to LPG connections, sustained use was low since some poor households could not afford frequent cylinder refills. These results imply that access is not enough to ensure exclusive use of clean fuel.

The family nature is also a significant factor in the household energy use. The bigger the family is, the higher the cooking fuel requirement, as more food preparation is necessary however actual adoption of LPG may be influenced by the level of income, the cost of refills, and the availability of other fuels. According to some studies, even large households do not abandon the use of mixed fuel, instead they use LPG as the sole fuel. Thus, the family size might not necessarily correlate directly and significantly with the LPG uptake in the rural economy. Following these observations, the hypothesis developed to be used in the present study is the following one:

Hypothesis 1: There is an insignificant relationship between family size and adoption of LPG in the study area.

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The level of income is well known to be one of the best predictors of clean energy usage. According to Kumar et al. (2020), household income was statistically significantly positively correlated with LPG adoption because financially more strong families could afford the cost of refilling. The PMUY studies also show that a significant proportion of beneficiary households acquired LPG connections and though the frequency of the refills has decreased due to the increase in the price of the cylinder and inconsistent income stream. Therefore, the issue of affordability persists even then it has been adopted. Given that the cost of refill directly relates to the rural household budgets, the study should test whether the cost burden of LPG is correlated with family income in the study area.

Hypothesis 2: There is an insignificant relationship between family income and cost of LPG in the study area. The other significant problem pointed out in new literature is the impact of exogenous supply shocks and international market upsets on local LPG prices. The LPG prices and uncertainty in delivery in India are most of the times caused by international crude oil volatility, geopolitical instabilities and dependence on imports. The rural consumers during these times are likely to decrease the use of LPG and revert back to some extent to biomass fuels, a phenomenon often termed as fuel stacking. Recent reports and evidence show that in 2026 supply crises in West Asia generated apprehensions over delays and price rise in Indian LPG markets. Thus, the question arises as to whether there is any significant change in the prices of LPG before and after crisis period in the study area.

Hypothesis 3: There is no significant relationship between pre and post cost of LPG due to Middle East Supply Disruption Crises in the study area.

Methodology

The The current research is based on descriptive and analytical research design approach to study the rural household LPG energy consumption in Tiruchirappalli District, Sri Rangam Taluk. The study has used both primary and secondary sources of data. Primary data were gathered using a structured interview schedule/questionnaire directly to rural households, which was aimed at gathering data concerning the socio-economic profile, LPG adoption, refill pattern, expenditure, and usage behaviour. To enhance the conceptual and empirical background of the study, secondary data were collected through different sources of authentic data, which included government reports, census publications, district statistical handbooks, journals, books, research articles, and websites. A multistage random sampling method was used in the selection of the respondents. Tiruchirappalli District is constituted of 11 taluks with Sri Rangam, Lalgudi and Manapparai being the most populated rural taluks. Sri Rangam Taluk was chosen intentionally in the first stage as it is the rural area with the greatest population (2,10,361) in the district. The second stage involved the subdivision of Sri Rangam Taluk into two development blocks (Manikandam and Andanallur) and each of the blocks was selected to be included in the study. At the third phase, the top five most populated villages were selected out of the blocks. Afterward, simple random sampling was used to select 38 sample households per village that was selected. Therefore, the study ended up having a final sample of 10 villages and 380 rural households. Appropriate statistical tools such as percentage analysis, correlation, and chi-square test were applied for data analysis and interpretation.

Analysis and Interpretations

Table – 1: Total Family Income of the sample Respondents in Sri Rangam Taluk.

	Below Rs. 15,000	Ra. 15,001 to Rs. 25,000	Rs. 25,001 to Rs. 35,000	Rs. 35,001 to Rs. 45,000	Rs. 45,001 to Rs. 50,000	Above Rs. 50,001	Total
Manikandam	50 (26.32)	52 (27.37)	33 (17.37)	22 (11.58)	22 (11.58)	11 (05.78)	**190**
Andanallur	55 (28.95)	53 (27.89)	31 (16.33)	21 (11.05)	20 (10.52)	10 (05.26)	**190**
Total	**105 (27.63)**	**105 (27.63)**	**64 (16.84)**	**43 (11.32)**	**42 (11.05)**	**21 (05.53)**	**380**

Source: Computed from Primary Data

Note: Percentages are in Parenthesis

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Table -1 shows the distribution of sample households based on their monthly family income in the study area. The results vividly indicate that most of the respondents are covering the low-income groups, which reflects the low economic profile of the rural households. The exact percentage of those who earn less than Rs.15,000 monthly is 27.63 and the next 27.63 fall within the income bracket of Rs.15,001 to Rs.25,000 per month. This implies that the majority of the total number of respondents (55.26) make less than Rs.25,000 per month. Conversely however, a very small percentage of 5.53% of the respondents have a greater monthly income of above Rs.50,001 per month, which makes up a very small percentage of higher-income households in the study area. The other respondents are in the middle-income ranges. The pattern of income shows that a high proportion of rural households lack access to financial resources and this could influence their living standards, their ability to save and the way they spend their income. It can be deduced that these homes might not have an easy time with the routine LPG refill costs and might still have to rely partially on more affordable traditional energy sources like firewood or farm waste to cook with.

Table – 2: Family Size of the Sample Respondents in the study area.

	2 Members	3 Members	4 Members	5 Members & Above	Total
Manikandam	10 (05.26)	74 (38.95)	85 (44.74)	21 (11.05)	**190**
Andanallur	11 (05.78)	73 (38.42)	84 (44.21)	22 (11.59)	**190**
Total	**21 (05.53)**	**147 (38.68)**	**169 (44.47)**	**43 (11.32)**	**380**

Source: Computed from Primary Data

Note: Percentages are in Parenthesis

Table -2 shows the sample household distribution that exists within the study area in terms of family size. The results show that the sample population is dominated by the medium-sized families, meaning that the nuclear and moderate-sized families are predominant in the rural region. Most of the households have 4 members, which represents 44.47 percent of the total respondents, then 3 members (38.68). These two types of households make over 83% of the total sample, indicating that the majority of families have a moderate family size. On the other hand, small families consisting of 2 members are the least prevalent with 5.53% whereas large families with 5 members or more are the most common with 11.32%. This trend indicates that the family size within the study area is largely manageable, which can potentially have a positive impact on household expenditures planning, fuel used in cooking, and LPG adoption since medium-scale households have a better chance to harmonise energy demands with accessible income resources.

Table – 3: Cost of LPG at pre Middle East Supply Disruption Crises in the study area.

	Rs.904	Rs.950	Total
Manikandam	85 (44.74)	105 (55.26)	**190**
Andanallur	86 (45.26)	104 (54.74)	**190**
Total	**171 (45.00)**	**209 (55.00)**	**380**

Source: Computed from Primary Data

Note: Percentages are in Parenthesis

Table -3 indicates the price paid by the respondents in the study area during the pre-crisis period of LPG cylinders. The respondents were largely split into two dominating price points, that is, Rs.904 and Rs.950 per cylinder. Most of the total sample, 55 percent, was already paying the new price of Rs.950 and the rest of the respondents paid Rs.904. Price trend was nearly the same in the chosen blocks showing homogeneity in the pricing of the LPG in the study area. In Manikandam Block, 55.26% of the respondents were paying the higher rate compared to 54.74% who were paying the same higher price in Andanallur Block. This shows that the rural households were already experiencing the upper range of the current price bracket of LPG way before the crisis. This implies that the affordability of LPG has been on the agenda of many households even

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before the disruption, particularly to the lower-income families, and that any further rise in price would probably aggravate the economic burden and motivate more households to rely on the other traditional cooking fuels.

Table – 4: Cost of LPG at post Middle East Supply Disruption Crises in the study area.

	Rs.964	Rs.1010	Total
Manikandam	85 (44.74)	105 (55.26)	**190**
Andanallur	86 (45.26)	104 (54.74)	**190**
Total	**171 (45.00)**	**209 (55.00)**	**380**

Source: Computed from Primary Data

Note: Percentages are in Parenthesis

Table -4 shows how the LPG prices were structured after the crisis by the respondents in the study area. The results indicate that all the respondents had a consistent rise in the cost of the cylinders by Rs.60, which implies that consumers in all categories were equally charged. The low category raised its price from Rs.904 to Rs.964 and the high category raised its price to Rs.950 to 1,010 per cylinder. It is interesting to note that the percentage of the respondents in each price bracket did not alter after the increment. The 171 (45) who had been in the lower price bracket were still in the same relative bracket and the 209 (55) in the higher bracket were also in the same relative bracket. On the same note, the two blocks of Manikandam and Andanallur registered an equal proportion of 55 percent in the higher cost category indicating that the price increment was uniform in the two areas without any disproportionate weight on a particular area. The above findings suggest that the crisis did not change the allocation of prices categories among households; instead, it increased the minimal cost level among all consumers. This indicates that it would put a strain on the rural families, particularly the lower-income families, because all respondents would have to pay more to obtain the same basic cooking fuel.

Table – 5: Shifting towards to traditional energy for cooking in the study area.

	Fire Wood	Dung Cake	Brine	Total
Manikandam	85 (44.74)	74 (38.95)	31 (16.31)	**190**
Andanallu	84 (44.21)	73 (38.42)	33 (17.37)	**190**
Total	**169 (44.47)**	**147 (38.68)**	**64 (16.85)**	**380**

Source: Computed from Primary Data

Note: Percentages are in Parenthesis

Table -5 indicates that there has been a transition of households living in rural areas to use traditional energy sources to cook in the study area. The results show that a significant percentage of the respondents have switched to the use of alternative fuels due to an increase in the price of LPG and their affordability. 44.47% of the respondents have changed their primary source of alternative cooking fuel to firewood thus making it the most preferred substitute because it is locally available and cost-effective in terms of money. Moreover, 38.68 percent of the respondents use dung cake as cooking fuel, which is an indication of the still usage of traditional rural sources of energy. A lower percentage, 16.85, have taken up briquettes/brine as an alternative source of energy. These findings are clear indications that many rural families still rely on conventional fuels when LPG is costly or even cheaper. The increasing reversion to biomass-derived fuels signifies the continuation of the fuel-stacking behaviour and it shows the economic difficulties of rural consumers in maintaining the use of LPG exclusively.

Illustration – 1: Correlation

H0: There is an insignificant relationship between family size and adoption of LPG in the study area.

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		Family Size	Adoption of LPG No of Cylinders
Family Size	Pearson Correlation	1	-.008
	Sig. (2-tailed)		.882
	N	380	380
Adoption of LPG No of Cylinders	Pearson Correlation	-.008	1
	Sig. (2-tailed)	.882	
	N	380	380

Source: Computed from Primary Data

Statistical Illustration -1, describes the correlation between the family size and the adoption of LPG among the sample respondents within the study area using Pearson correlation analysis. The value of Pearson Correlation of -0.008 achieved shows a very weak negative association between the family size and LPG adoption, implying that the variation in the number of family members has practically no impact on the use of LPG among rural families. The correlation value is very close to zero indicating that there is no significant linear relationship between the two variables. Also, the P-value 0.882 is higher than the normal significance level of 0.05. Hence, the null hypothesis is accepted and the alternative hypothesis is rejected. The conclusion is that family size and adoption of LPG do not significantly relate in the study area. The implication of this finding is that the income level, fuel price, availability of traditional fuels and household preferences might have a more compelling influence than family size in influencing the adoption of LPG.

Illustration – 2: Correlation

H0: There is an insignificant relationship between family income and cost of LPG in the study area.

		Family Income	Post LPG Price of Middle East Supply Disruption Crises
Family Income	Pearson Correlation	1	.021
	Sig. (2-tailed)		.678
	N	380	380
Post LPG Price of Middle East Supply Disruption Crises	Pearson Correlation	.021	1
	Sig. (2-tailed)	.678	
	N	380	380

Source: Computed from Primary Data

Statistical Illustration -2 indicates the connection between the family income and the cost of LPG in the area of study using the Pearson correlation analysis. The derived Pearson Correlation value of 0.021 shows a very weak positive relationship between family income and LPG cost and this implies that there is no significant increase in the cost burden of LPG as family income increases. The correlation coefficient is near to zero and this is an indication that there is no strong linear relationship between the two variables. Further, the P-value of 0.678 is greater than the standard significance level of 0.05. Therefore, the null hypothesis is accepted and the alternative hypothesis rejected. We conclude that there is no statistically significant correlation between family income and post crisis cost of LPG in the study area. This observation shows that the price of LPG increased had a similar impact on households of various income groups and that the pricing of LPG is influenced more by market and policy factors rather than household income levels.

Illustration – 3: Chi-Square Test

H0: There is a no significant relationship between pre and post Cost of LPG due to Middle East Supply Disruption Crises in the study area.

Pre LPG Price of Middle East Supply Disruption Crises			
	Observed N	Expected N	Residual
904	171	190.0	-19.0
950	209	190.0	19.0
Total	380		

Source: Computed from Primary Data

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Post LPG Price of Middle East Supply Disruption Crises			
	Observed N	Expected N	Residual
964	171	190.0	-19.0
1010	209	190.0	19.0
Total	380		

Source: Computed from Primary Data

Test Statistics		
	Pre LPG Price of Middle East Supply Disruption Crises	Post LPG Price of Middle East Supply Disruption Crises
Chi-Square	3.800[a]	3.800[a]
df	1	1
Asymp. Sig.	.051	.051
a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 190.0.		

Source: Computed from Primary Data

Statistical Illustration-3 describes the Chi-Square test that was to be applied to test the difference between the pre and post cost of LPG because of the Middle East supply disruption crisis in the region under study. The Chi-Square value is calculated as 3.800 and the P-value 0.051. This finding is a borderline case, with the P-value obtained being very near the standard level of significance of 0.05. But the P-value of 0.051 is a little more than that of 0.05, so the null hypothesis is accepted and the alternative hypothesis is rejected at 95% confidence level. Thus, it is concluded that the LPG price in the study area is not statistically different between the pre-crisis and post-crisis. In spite of the fact that the increase in price was observed in real life situation, the test statistic reveals that the difference was not so considerable to prove the existence of a significant difference. The implication of this finding is that there was a relative homogeneity in the change in price among respondents instead of that change skewed towards particular groups or localities.

Results And Discussion

The study results clearly show that most of the respondents are represented by the economically weaker groups with most of the households earning less than Rs.25,000 per month with only 5.53% earning more than 50,001. This is a depiction of the simple income level of rural families in the region of study and indicates that they have little purchasing power to buy vital commodities like cooking fuel. The data on the family composition also indicate that the prevalent family structures in the area are the medium-sized families since the family with 3 to 4 members constitutes over 83 percent of the total sample. This trend suggests that nuclear or medium-sized family set-ups are common and this is likely to affect planning household expenditure and fuel consumption behaviour.

The paper also identifies the economic cost generated by the escalating LPG prices following the crisis of the supply disruption. After the crisis, it was evident that there was a noticeable trend of moving towards higher price bracket where 55 percent of the respondents were paying Rs.1,010 per cylinder and 44 percent were paying Rs.964 per cylinder. This rise in fuel price would have added further strain to already low-income families, compelling many families to re-evaluate their energy options when cooking. Consequently, households might switch to less frequent refilings, delay purchases, or rely partially on more traditional fuel sources like firewood, dung cake and agricultural waste. These results highlight the importance of affordability as a key obstacle to the continued use of LPG in rural locations.

The statistical analysis gives valuable information on the determinants of LPG adoption and cost burden. The Pearson correlation value of -0.008 shows that there is an inconsequential negative relationship between family size and LPG adoption and the P-value of 0.882 affirms that the correlation is not statistically significant. This indicates that the family size does not have a decisive factor in the adoption of LPG in the study area. In the same vein, Pearson Correlation of 0.021 indicates very weak positive association between family income and

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LPG cost and the P-value of 0.678 indicates that there is no significant association between them. Hence, it is found that house holds (both high and low income) are similarly impacted by the price of LPG instead of being directly correlated to family income.

Moreover, the result of the Chi-Square test (X^2 = 3.800; P = 0.051) does not show a statistically significant difference between the prices of LPG before and after the crisis at the level of 95% confidence, yet, the outcome is quite close to the critical level. Based on these findings, policy measures are necessary to protect vulnerable rural households from fuel price shocks. Affordability and continuous use can be enhanced by increasing LPG subsidies to the lower income groups, maintaining on-time supply of cylinders and making subsidy delivery systems easier. Moreover, Sustainable rural energy development can be achieved by encouraging the use of Improved Cook Stoves (ICS) and frequent awareness campaigns on clean energy sources like LPG, biogas and energy-efficient stoves to create less reliance on the use of polluting traditional fuels.

Conclusion

The research finds that economic conditions, affordability of LPG by households, and increasing fuel prices are the most powerful factors that affect rural household LPG energy use in the study area. Most of the respondents are in the lower income bracket, thus restricting their capacity to afford the regular costs of refilling LPG. Despite the broad adoption of LPG as a cleaner cooking fuel, the sustained and exclusive use is a challenge because of rising costs of cylinders and financial limitations. The prevalence of the medium-sized families means that the household energy demand is moderate but income constraints still determine the consumption pattern more than family size. The increased price after the crisis increased the pressure on rural families, prompting some families to partially switch to traditional fuels like firewood and dung cake.

The statistical results support the fact that family size and family income do not play a significant role in the adoption of LPG and the post-crisis LPG cost in the study area. This implies that the wider market forces, state pricing, subsidy and local availability of alternative fuels have a more critical role in shaping household energy behaviour. This study thus highlights the necessity of more aggressive policy intervention like increased subsidies on low-income families, stable pricing, ensuring timely availability of cylinders and encouraging alternative clean cooking technology. There should also be continuous awareness programmes of the health and environmental advantages of clean energy in order to ensure long-term shift towards sustainable energy consumption in rural areas.

Future Implications

Future implications of the study suggest that greater attention should be given to strengthening rural clean energy policies that ensure affordability, accessibility, and sustained usage of LPG among low-income households. Policymakers may focus on dynamic subsidy systems, price stabilization measures, and improved last-mile delivery networks to reduce the burden of rising fuel costs. Future research can expand the scope by comparing multiple districts, examining long-term behavioural changes in fuel consumption, and assessing the role of renewable alternatives such as biogas, solar cookers, and improved cook stoves. In addition, digital monitoring of subsidy benefits, awareness campaigns, and women-centered energy programmes may further accelerate the transition from traditional biomass fuels to sustainable and healthier cooking energy sources in rural India.

Reference

1. Aggarwal, S., & Chandel, S. S. (2023). *Rural energy dynamics in India: Transitions from biomass to clean fuel*. Springer Nature.
2. Anithabose, S., & Gnanaraj, G. (2023). Financial Performance of Indian Public Sector Banks Before and During COVID-19 Pandemic. *A Journal of Management*, 1, 19.
3. Anithabose, S., & Gnanaraj, G. (2020). Financial performance analysis based on economic value added: An empirical study. *International Journal of Management (IJM), 11(9)*.
4. Anithabose, S., & Gnanaraj, G. Financial performance evaluation based on economic value added (EVA): A study of steel authority of India ltd listed in Bombay Stock Exchange

(BSE). *International Journal of Management (IJM)*, *11*(9), 1903-1913.
5. Anithabose, S., & Gnanaraj, G. (2020). Financial performance evaluation based on economic value added and financial ratios: An empirical study. *International Journal of Management (IJM), 11(10)*, 2278-2289
6. Anitha Bose, S. (2025). Influence by design: How content format affects consumer perception and behavior on Indian social media. *International Journal of Research in Commerce and Management Studies (IJRCMS), 7*(3), 401–413.
7. Anitha Bose, S. (2025). Organisational agility as an HR competitive advantage in the age of AI: A systematic literature review with insights from ChatGPT. *Asian Journal of Management and Commerce, 6*(1), 1320–1333.
8. Barnes, D. F., Openshaw, K., Smith, K. R., & van der Plas, R. (1994). *What makes people cook with improved biomass stoves? A comparative international review of stove programs*. World Bank.
9. Bhattacharyya, S. C. (2012). Energy access programmes and sustainable development: A critical review and analysis. *Energy for Sustainable Development, 16*(3), 260–271.
10. Gould, C. F., & Urpelainen, J. (2018). LPG as a clean cooking fuel: Adoption, use, and impact in rural India. *Energy Policy, 122*, 395–408.
11. Gupta, A., & Jain, A. (2020). *Energy access and indoor air pollution: The health burden on rural women*. Oxford University Press.
12. IEA. (2024). *World energy outlook 2024*. International Energy Agency.
13. Jain, A., Ray, S., Ganesan, K., Aklin, M., Cheng, C. Y., & Urpelainen, J. (2018). *Access to clean cooking energy and electricity: Survey of states 2018*. Council on Energy, Environment and Water (CEEW).
14. Kar, A., Zerriffi, H., & Shahidi, S. (2019). Why can't we stop it? A review of factors affecting the persistence of traditional cooking fuels. *Energy Research & Social Science, 58*, 101266.
15. Kumar, P., Singh, R., & Devi, M. (2021). Determinants of LPG adoption among rural households in South India. *Journal of Rural Development, 40*(2), 145–162.
16. Lewis, J. J., & Pattanayak, S. K. (2012). Who adopts improved fuels and cookstoves? A systematic review. *Environmental Health Perspectives, 120*(5), 637–645.
17. Masera, O. R., Saatkamp, B. D., & Kammen, D. M. (2000). From linear fuel switching to cooking strategies: Why multiple fuel use patterns predominate. *World Development, 28*(12), 2083–2103.
18. Ministry of Petroleum and Natural Gas. (2026). *Monthly readiness report: LPG penetration and PMUY beneficiaries as of March 2026*. Government of India.
19. Pachauri, S., & Jiang, L. (2008). The household energy transition in India and China. *Energy Policy, 36*(11), 4022–4035.
20. Petroleum Planning & Analysis Cell (PPAC). (2025). *Snapshot of India's oil & gas data*. Ministry of Petroleum and Natural Gas.
21. Rajagopal, D., & Sudarshan, A. (2023). Rural energy transitions in Tamil Nadu: A case study of the Tiruchirappalli district. *South Indian Journal of Economics, 15*(4), 210–225.
22. Reddy, B. S. (2003). Overcoming the energy efficiency gap in India's household sector. *Energy Policy, 31*(11), 1117–1127.
23. Sharma, V., & Karthikeyan, P. (2022). Fuel stacking behaviour and LPG refill constraints in Tamil Nadu villages. *Indian Journal of Energy Economics, 9*(1), 55–72.
24. Smith, K. R. (2000). National burden of disease in India from indoor air pollution. *Proceedings of the National Academy of Sciences, 97*(24), 13286–13293.
25. Van der Kroon, B., Brouwer, R., & van Beukering, P. J. (2013). The energy ladder: Theoretical myth or empirical reality? *Renewable and Sustainable Energy Reviews, 20*, 504–513.
26. World Bank. (2023). *Tracking SDG7: The energy progress report*. World Bank Publications.