EMPOWERING SUSTAINABLE URBAN DEVELOPMENT IN INDIA: A CONCEPTUAL FRAMEWORK LINKING SDG 7 AND SDG 11 THROUGH LIQUEFIED PETROLEUM GAS (LPG)

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ABSTRACT:

This study focuses on how the use of Liquefied Petroleum Gas (LPG) in Indian cities can promote clean energy and support the development of more sustainable cities. With the increase in urbanisation and population growth, there is an increasing demand for cleaner energy solutions. Traditional fuels such as firewood and coal contribute to indoor air pollution and health problems. LPG offers a clean alternative that can reduce these issues and improve public health. A narrative review was conducted using peer-reviewed research papers published between 2020 and 2024, gathered from the Google Scholar and Semantic Scholar databases. This review focuses on key topics such as the use of LPG in urban areas, access to clean cooking fuel, health and environmental problems, and government schemes such as the Ujjwala Yojana, which aim to make LPG affordable for more families. The study grouped the findings under themes such as urbanisation and population growth, environmental and health concerns, government schemes, access and affordability, and social and economic factors. Based on these themes, a conceptual framework is developed to show how these factors influence the use of LPG and how it can contribute to reducing pollution, improving public health, and supporting the Sustainable Development Goals 7 (SDG 7) (clean energy) and Sustainable Development Goals 11 (SDG 11) (sustainable cities). Overall, this study demonstrates that LPG adoption can be a key step toward cleaner, healthier, and more sustainable urban living.

Keywords: LPG adoption, clean energy, urban development, sustainable development goals, urbanization and health

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1. INTRODUCTION

Urbanisation is growing rapidly in India, creating opportunities and challenges. People are moving to cities, increasing their demand for energy, infrastructure, and better living

conditions. The United Nations has introduced Sustainable Development Goals (SDGs) to guide countries such as India. SDG 7 (Affordable and Clean Energy) and SDG 11 (Sustainable Cities and Communities) were the most relevant for urban development. Clean energy sources play a key role in building safe, healthy cities. Liquefied Petroleum Gas (LPG) is emerging as a cleaner alternative to traditional fuels, such as firewood and kerosene. LPG reduces indoor air pollution, improves public health, and supports household and business energy security. It helps reduce carbon emissions and build urban resilience (Katoch et al., 2022; Sinha et al., 2024). India's Smart Cities Mission (SCM) emphasises integrating clean energy with urban planning to meet sustainability goals (Parekh 2024). However, LPG adoption in urban areas depends on socioeconomic conditions, infrastructure, and governmental policies. Financial constraints, supply chain issues, and a lack of awareness affect many urban communities. Policies such as Ujjwala Yojana and urban energy subsidies have shown that LPG can reach low-income households when implemented well (Kazançoğlu et al., 2023). This study proposes a framework that links LPG adoption with sustainable urban development in India. It explores how LPG supports clean energy access (SDG 7) and sustainable cities (SDG 11) by focusing on key factors (income levels, infrastructure, policy support), outcomes (energy access, affordability, environmental impact), and urban development benefits (resilience, health, and socioeconomic progress). By reviewing the literature from 2020 to 2024, this study identifies the enablers and barriers to LPG adoption in urban settings and offers policy insights for India's journey towards clean, inclusive urban environments.

2. RESEARCH OBJECTIVES

[1] To explore the relationship between LPG adoption and sustainable urban development in India.

[2] Identifying key factors influencing LPG adoption in urban areas.

[3] To examine how LPG adoption contributes to achieving SDG 7 (Affordable and Clean Energy) and SDG 11 (Sustainable Cities and Communities).

[4] To develop a conceptual framework that links LPG adoption with urban development.

3. REVIEW OF LITERATURE

Switching to LPG is vital for achieving Sustainable Development Goals (SDGs) in urban India, particularly SDG 7 (Affordable and Clean Energy) and SDG 11 (Sustainable Cities and Communities). Research has shown that LPG improves health, promotes gender equality, and reduces environmental damage. Socioeconomic status influences LPG adoption among urban households. Gould et al. (2020) and Patel (2020) found higher education leads to increased awareness of LPG's benefits, prompting shifts from biomass to clean fuels. Low-income

households face economic barriers, including equipment costs, refill expenses, and deterring adoption (Rao et al., 2020; Kar et al., 2020). This necessitates targeted financial intervention for equitable access. Government programs, such as Pradhan Mantri Ujjwala Yojana (PMUY), have expanded LPG coverage among disadvantaged households (Akter & Pratap, 2020; Akter & Pratap, 2022). PMUY has been successful in subsidising LPG connections. Studies by Harrell et al. (2020) and Kumar et al. (2020) revealed gaps in the availability of LPG refill centres in dense urban settlements. Exposure to household air pollution from traditional fuels is critical. LPG adoption has health benefits including reduced respiratory and cardiovascular diseases (Yang et al., 2023; Irfan et al., 2021). Conibear et al. (2020) emphasised that clean energy transition could reduce the disease burden from particulate pollution. This impact is notable for women and children who spend more time indoors (Araune et al., 2020; Araune et al., 2024). LPG adoption reduces emissions and improves urban air quality. Durand et al. (2024) and Ogunmola et al. (2022) found reduced biomass use leads to less deforestation and lower emissions. Nadaf (2020) highlighted LPG's role of LPG in environmental sustainability while supporting the SDG 11 targets. LPG adoption saves time for women who are responsible for fuel collection and cooking (Kar et al., 2020). Akter and Pratap (2022) note that this time can be used for educational and economic activities, promoting SDG 5 (Gender Equality). Cultural preferences, safety misconceptions, and limited awareness hinder adoption (Rao et al., 2020; Rose et al., 2024). Infrastructural gaps in distribution networks remain a challenge (Pye et al., 2020; Harrell et al., 2020). Literature emphasises the need for information campaigns and improved supply chains.

4. METHODOLOGY

This conceptual paper is based only on research papers, and does not include field surveys or direct data collection. The main aim was to understand how the use of Liquefied Petroleum Gas (LPG) in Indian cities can help promote clean energy (SDG 7) and support the development of sustainable cities (SDG 11). A narrative review of peer-reviewed research papers published between 2020 and 2024 was conducted using Google Scholar and Semantic Scholar, focusing only on research papers and not on reports or policy documents. This study examines important topics such as the use of LPG in urban areas, adoption of clean fuel, health and pollution problems, access to energy in cities, and government programs such as Ujjwala Yojana. This study used keywords such as "LPG in urban India", "clean cooking fuel", "SDG 7", "SDG 11", "urban energy access", and "sustainable development. The collected papers were grouped under themes such as urbanisation and population growth, environmental and health concerns, government schemes, access and affordability, and social and economic factors.

Based on these themes, a conceptual framework was developed to show how different factors influence LPG adoption, and how it helps create cleaner air, improve public health, and improve life in Indian cities.

5. CONCEPTUAL FRAMEWORK

This framework shows how adopting Liquefied Petroleum Gas (LPG) in urban India can help achieve the goals of SDG 7 (Affordable and Clean Energy) and SDG 11 (Sustainable Cities and Communities). It covers key factors such as enablers and barriers, the outcomes of LPG adoption, and its impact on urban development (see Figure 1).

5.1 Input Factors (Enablers)

5.1.1 Socio-Economic Conditions

- ✓ **Income levels**: Families with higher incomes can afford LPG regularly and are more likely to continue using it (Kar et al., 2020).
- ✓ **Education and awareness**: People who know about the health problems associated with using wood or kerosene and understand the benefits of LPG are more likely to switch (Gould et al., 2020).
- ✓ **Fuel needs**: Households and small shops with high cooking needs prefer faster, cleaner fuels, such as LPG (Rao et al., 2020).

5.1.2 Infrastructure Readiness

- ✓ **Gas pipelines**: Areas with pipeline connections make LPG easily available and reduce the waiting time (Gill-Wiehl et al., 2020).
- ✓ **Nearby LPG centres**: If the refill centre is close, people save time and transport costs, so they continue using LPG (Kumar et al., 2021).

5.1.3 Policy & Institutional Support

- ✓ **Government subsidy (like Ujjwala Yojana)**: Helps poor families obtain LPG connections at low cost, encouraging adoption (Selvam et al., 2022; Suman, 2024).
- ✓ **Good urban energy planning**: Supportive rules and better coordination make LPG more accessible and usable for all (Sharma, 2022).

5.2 LPG Adoption Outcomes

5.2.1 Clean Energy Access (SDG 7)

- ✓ **Shift from biomass**: LPG helps people stop using polluting fuels, such as firewood and kerosene (Kar et al., 2020).
- ✓ **Better air inside homes**: Because LPG produces less smoke, indoor air becomes safer, especially for women and children (Jindal et al., 2020).

- ✓ **Energy availability**: LPG provides a stable energy source for daily use (Gould et al. 2020).

5.2.2 Affordability & Reliability (SDG 7)

- ✓ **Subsidies keep costs low**: With price support, families can keep using LPG regularly (Gill-Wiehl et al., 2020).
- ✓ **Supply in poor areas**: In slums and informal areas, a consistent LPG supply ensures that everyone receives clean cooking fuel (Selvam et al., 2022).

5.2.3 Environmental Sustainability

- ✓ **Lower pollution**: Compared to wood or coal, LPG produces much less carbon and finer particles (Sakariya et al., 2024).
- ✓ **Cleaner cities**: Using LPG supports greener and healthier urban living (Sharma, 2022).

5.3 Urban Development Outcomes (SDG 11)

5.3.1 Urban Resilience

- ✓ **Useful in emergencies**: LPG is reliable even during floods or storms, helping people to continue cooking (Rao et al., 2020).
- ✓ **Fuel diversity**: Having LPG as part of a city's energy options makes cities less dependent on one fuel source (Nadaf, 2022).

5.3.2 Health & Well-being

- ✓ **Fewer respiratory issues**: LPG reduces smoke-related diseases and improves health (Jindal et al. 2020).
- ✓ **Safe for women**: Women face fewer accidents and smoke less while cooking with LPG (Selvam et al., 2022).

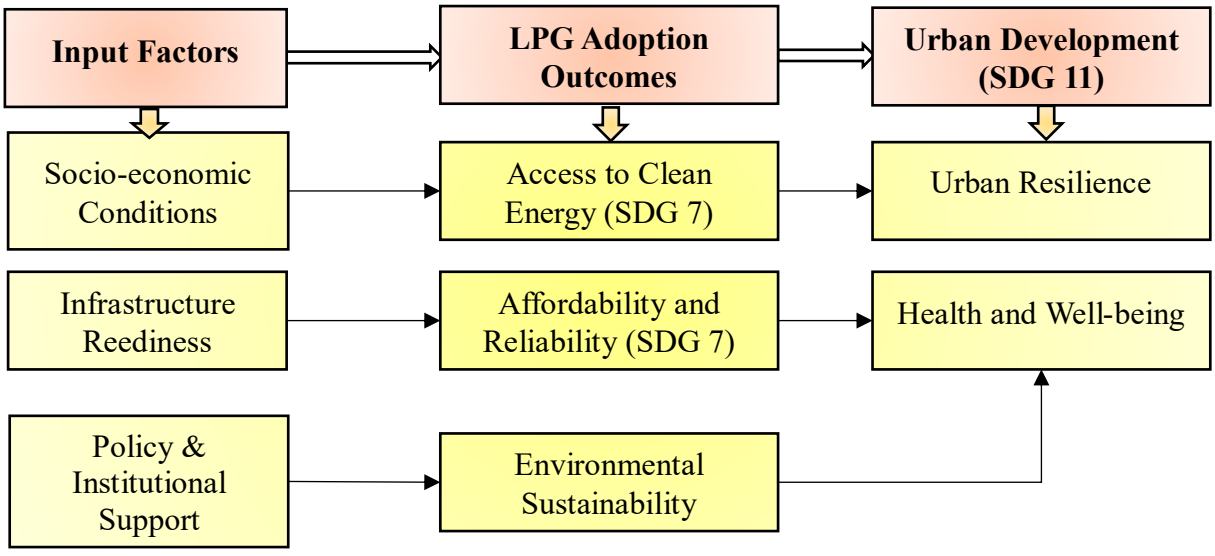

Figure 1: Proposed Conceptual Framework

6. RESULTS

6.1 Socio-Economic Factors and LPG Adoption

The study revealed that socioeconomic factors, such as income and education, significantly influence LPG adoption in urban India. Higher income and better education levels are correlated with increased awareness of LPG's benefits of LPG. On the other hand, lower-income households face barriers, such as the high upfront cost of LPG equipment and recurring refill expenses, which hinder adoption (Gould et al., 2020; Kar et al., 2020).

6.2 Government Initiatives and Infrastructure Support

Government initiatives such as Pradhan Mantri Ujjwala Yojana (PMUY) have been successful in expanding LPG access to economically disadvantaged households (Akter & Pratap, 2020; Akter & Pratap, 2022). Additionally, infrastructure such as LPG refill centres and gas pipelines have facilitated easier access to LPG, reducing waiting times and transport costs for consumers (Gill-Wiehl et al., 2020; Kumar et al., 2021).

6.3 Health and Environmental Benefits

Switching to LPG has significantly improved indoor air quality, reducing health risks, such as respiratory and cardiovascular diseases, especially for women and children who spend more time indoors (Jindal et al., 2020; Yang et al., 2023). Environmentally, LPG adoption has contributed to reducing emissions and improving air quality in urban areas, thereby making cities more sustainable (Durand et al., 2024).

6.4 Urban Resilience

LPG adoption also enhances urban resilience by ensuring a reliable and clean energy source, even during emergencies such as floods or storms (Rao et al., 2020). This contributes to the sustainability of cities by diversifying their energy sources and reducing their dependency on traditional fuels (Nadaf, 2022).

7. DISCUSSION

7.1 Contribution to SDG 7: Affordable and Clean Energy

These findings underline the vital role of LPG adoption in achieving SDG 7, as it provides clean and affordable energy, helping to reduce indoor air pollution and associated health risks (Gould et al., 2020). The study emphasises that socioeconomic factors, particularly income and education, are crucial in determining LPG adoption rates. Targeted interventions, such as financial subsidies and awareness campaigns, are essential for promoting LPG use in lower-income households (Selvam et al., 2020; Selvam et al., 2022).

7.2 Contribution to SDG 11: Sustainable Cities and Communities

This study also highlights LPG's contribution of LPG to SDG 11, demonstrating its role in environmental sustainability by reducing carbon emissions and promoting cleaner urban living (Durand et al., 2024). LPG adoption supports urban resilience by providing a reliable and sustainable energy source that can withstand emergencies, reduce dependence on traditional fuels, and enhance city infrastructure (Rao et al., 2020; Nadaf, 2022).

7.3 Policy and Infrastructure Challenges

While government programs such as PMUY have been successful in increasing LPG access among low-income groups, challenges such as inadequate distribution networks in informal settlements persist. These gaps hinder widespread adoption, and there is a need for better urban energy planning and infrastructure to ensure a consistent LPG supply in all urban areas (Harrell et al., 2020; Kumar et al., 2020).

7.4 Health and Societal Implications

LPG adoption has notable health benefits, particularly in reducing the respiratory diseases caused by traditional cooking fuels (Jindal et al. 2020). Moreover, it helps reduce the burden of fuel collection, particularly for women, and frees up time for educational and economic activities, thus promoting gender equality (Selvam et al., 2022). These societal benefits further reinforce LPG's potential to support sustainable and inclusive urban development.

CONCLUSION

This study highlights the important role of Liquefied Petroleum Gas (LPG) in achieving Sustainable Development Goals (SDGs) 7 (Affordable and Clean Energy) and 11 (Sustainable Cities and Communities) in urban India. By using LPG, India can improve public health, protect the environment, and make cities more resilient. The findings show that factors such as income and education strongly affect the number of people using LPG, especially among lower-income households. Government schemes such as Pradhan Mantri Ujjwala Yojana (PMUY) have helped increase LPG access for poor families. However, challenges, such as poor infrastructure and distribution networks in informal areas still exist. To solve these problems, better policies, financial support, and awareness programs are needed to make LPG available to everyone. LPG also has major health benefits such as reducing lung diseases caused by traditional fuels. It helps women by saving time spent collecting fuel, which can be used for education or work, promoting gender equality. Additionally, LPG helps reduce pollution and improve air quality in cities. LPG adoption is the key to India's sustainable urban development. By removing barriers to accessing and promoting the use of LPG, India can build

cleaner, healthier, and more resilient cities. This conceptual framework offers helpful insights for policymakers, city planners, and other stakeholders to make India's urban areas cleaner and more sustainable in the future.

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