Silva, R.Y., Madhusanka, H.W.N. and Kahandawa, K.A.R.V.D., 2026. Enhancing building energy data management in Sri Lanka: Barriers, enablers, and strategic pathways. In: Waidyasekara, K.G.A.S., Jayasena, H.S., Chandanie, H. and Tennakoon, G.A. (eds). *Proceedings of the 14th World Construction Symposium*, 10-11 July 2026, Sri Lanka. pp. 628-641. DOI: https://doi.org/10.31705/WCS.2026.47. Available from: https://ciobwcs.com/papers/

ENHANCING BUILDING ENERGY DATA MANAGEMENT IN SRI LANKA: BARRIERS, ENABLERS, AND STRATEGIC PATHWAYS

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ABSTRACT

With the use of advanced technologies in the construction sector, buildings are producing numerous heterogeneous energy data, enabling more informed decision-making in energy management. However, Building Energy Data Management (BEDM) is vital to extract valuable and meaningful insights from building energy data. Therefore, several countries and energy-related institutes promote and regulate building energy data disclosure and management, aiming for energy data collection and advanced analytics for national, regional and international sustainability goals. However, Sri Lanka is still lacking research in BEDM. Therefore, this research focus to study barriers, enablers and strategies to strengthen BEDM in Sri Lanka. Along with an intensive literature review, 8 expert interviews were conducted with the qualitative approach adopted in this study. The experts were selected through a purposive sampling method to obtain more relevant insights. According to the findings, BEDM in Sri Lanka is in a primitive stage requiring considerable attention to collect and analyse building energy data for national-level energy policy formulation. Lack of consistent and accurate energy data and legislative support are the key barriers identified. Energy policies, building energy ratings and higher tariff rates were identified as key enablers in BEDM in Sri Lanka. Further, 13 strategies to promote BEDM were suggested using both literature findings and expert opinions. Introducing energy benchmarks, data disclosure laws and a centralised data collection platform were identified as promising strategies to promote BEDM. The findings of this research would be beneficial for the policy makers to develop a strategic framework to streamline BEDM in Sri Lanka.

Keywords: *Building Energy Data Management; Data-Driven Energy Management; Energy Data Barriers; Energy Data Enablers; Smart Energy Management.*

1. INTRODUCTION

Building energy consumption contributes a significant portion of the global energy supply and demand. With the rapid urbanisation due to population growth, building energy consumption has dramatically increased over the past few decades (Ali et al., 2020b). Buildings contribute to one-third of global energy consumption and 36% of global energy-related emissions (IEA, 2025). Further, building-related CO_2 emissions have increased by 1% since 2010 (Ali et al., 2020a). Therefore, energy consumption and its

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impact on climate change are critical challenges in the building sector. Improperly maintained and controlled building systems might be the reason for the higher energy consumption in buildings (Ali et al., 2020b). According to Li et al. (2024), 15% -30% energy is wasted in buildings due to poor maintenance and inefficient operational practices. By monitoring energy consumption in buildings, detailed information related to individual equipment can be identified (Hannan et al., 2018).

Predicting and forecasting building energy consumption is essential for energy planning, energy optimisation, and management (Runge & Zmeureanu, 2021). In addition, building energy forecasting is used to measure and confirm the effectiveness of energy-saving practices, to estimate energy needs using trend analysis, and to identify event-specific variations in energy consumption (Mariano-Hernández et al., 2020). Due to the massive amount of building energy data, data-driven approaches are used to understand the building performance (Li et al., 2024). Currently, building operational data has been more accessible due to the utilisation of advanced technologies such as smart meters and sensors (Billanes et al., 2025).

Data-driven energy management refers to the systematic use of energy-related data, digital technologies and analytical methods to monitor, analyse and optimise energy performance within buildings and facilities (Marinakis, 2020). Unlike conventional energy management approaches that rely on periodic document reviews and manual analysis, data-driven energy management enables continuous and evidence-based decision making through historical and real-time energy data analysis (Billanes et al., 2025). Recent studies highlight that the increasing availability of smart meters, sensors, Internet of Things (IoT) devices, Building Management Systems (BMS) and Artificial Intelligence (AI) technologies has significantly increased the adoption of data-driven energy management in buildings (Elnour et al., 2024). Typically, data-driven approaches consist of several stages such as data collection, monitoring, analysis, reporting and optimisation. Initially, data is collected from various sources such as smart meters, sensors, BMS and other operational systems (Mantha et al., 2016). Subsequently, the collected data is continuously monitored to identify energy consumption patterns and abnormalities. The monitoring data are then analysed using statistical, machine learning, or predictive techniques to generate meaningful insights for decision-making (Liu et al., 2023). The analysed information is communicated through reporting and visualisation platforms to building operators and policymakers in understanding building energy performance. Finally, optimisation strategies are implemented to improve operational efficiency and reduce energy wastage(Han et al., 2023).

However, collecting detailed information in different building systems has been challenging for years (Hannan et al., 2018). Especially, the lack of public energy databases limits the ability to collect data for macro-level building energy analysis (Kazmi et al., 2023). Further, unreliable and unrealistic data can cause deviations of actual energy consumption from the prediction. (Mariano-Hernández et al., 2020). Data collection is also difficult because of manual data collection methods and a lack of novel technical solutions for energy data collection, such as smart meters (Krishnan et al., 2022). Manual data collection is prone to human errors, making the collected data irrelevant, incomplete, inconsistent and redundant (Ali et al., 2020a). High dependence on large historical data demands large data backups which can handle a large amount of heterogeneous data and information (Ali et al., 2021).

However, several authors have identified a range of technical and systematic enablers for building energy data management (BEDM). Several information and communication technologies, such as wireless sensor networks, Internet of Things (IoT), and cloud-based communication infrastructures, enable real-time data collection and seamless integration across heterogeneous building systems (Akbulut et al., 2025). Machine Learning (ML) and Artificial Intelligence (AI) became critical enablers in empowering building systems to transform raw energy data into more insightful findings. Currently, these technologies are being considered for accurate demand forecasting, fault detection and diagnosis and adaptive controlling of building systems (Gao, 2025).

To strengthen BEDM, some strategies are being introduced by several governments and international organisations. Some buildings utilised advanced technical solutions such as Big Data, IoT sensors and smart meters for real-time data collection analysis for informed decision making in building energy management (BEM) (Billanes et al., 2025). In addition, several standardised reporting practices have been introduced to ensure data quality and interoperability (Morewood, 2023). Further, advanced data analytics, machine learning and AI are used to extract valuable information from available building energy datasets (Gao, 2025).

Even though buildings account for a substantial share of global energy consumption, considerable attention has not been paid in some countries. Some research indicates that building energy data quality and availability are still underdeveloped in many regions due to poor BEDM (Gao, 2025; Lee et al., 2022). Especially, studies regarding centralised building energy data governance are lacking in Sri Lanka due to the resulting ignorance of the importance of building energy data in achieving sustainable development and mitigating climate change impacts. It causes the absence of building energy data required for the national-level building energy policymaking. Simultaneously, barriers and enablers for BEDM have not been studied in the Sri Lankan context. Therefore, this study aims to study barriers and enablers in BEDM in Sri Lanka and finally suggest strategies to strengthen BEDM in Sri Lanka.

This study consisted of a comprehensive literature review and a series of expert interviews to identify barriers, enablers and strategies in BEDM. Initially, this paper describes the adopted methodology, followed by literature findings on barriers, enablers and strategies in BEDM. Next, the data analysis and findings section will describe the findings of the expert interviews. Finally, the discussion section will explain how the literature findings will apply to the literature findings, comparing them with expert opinions.

2. METHODOLOGY

A comprehensive literature review was conducted to identify barriers, enablers and strategies to implement BEDM. Peer-reviewed journal articles, conference proceedings, books, and websites were used for the literature review to ensure the quality of the literature findings. Expert interviews were conducted to identify the most significant barriers, enablers and strategies to implement BEDM along with the literature findings. Interviewees were selected using a purposive sampling method. Experts were selected based on their years of experience and their roles in BEDM. Eight interviewees who are currently involved in national-level energy policy making and regulating energy consumption were selected for this study to obtain valuable and comprehensive insights based on their experience. Eight experts were selected for interviews due to the highly limited population of professionals involved in building energy policy formulation in Sri Lanka. This limitation arises because the Sri Lanka Sustainable Energy Authority serves as the primary authority responsible for BEM and related policy development in the country. Consequently, the study targeted a substantial proportion of the available expert population, thereby ensuring the relevance and credibility of the collected insights. Even though the sample size of eight may appear limited, it is in line with the standards of the qualitative investigations, where quality is prioritised over the breadth of the study. Thematic saturation was reached by the sixth interview, and the seventh and eighth interviews confirmed that there were no new themes. Guest et al. (2020) confirmed that theoretical saturation is often reached by 6-12 interviews. The findings of the initial interviews were shared with followed by participants for further validation to ensure reliability. Finally, findings of interviews were validated through literature triangulation. Profiles of experts are shown in Table 1.

Table 1: Profiles of experts

Expert Name	Description	Years of experience
E1	Board member of the Sri Lanka Sustainable Energy Authority	18 years
E2	President of the Sri Lanka Energy Managers Association, board member of the Sri Lanka Sustainable Energy Authority	30+ years
E3	Director General of the Sri Lanka Sustainable Energy Authority	25 years
E4	Former president of the Sri Lanka Energy Managers Association, Former Director General of National Engineering Research and Development Centre (RERDC)	35 years
E5	Deputy Director (Energy Efficiency Improvement) in the Sri Lanka Sustainable Energy Authority	10 years
E6	Director (Energy Efficiency Improvement) in the Sri Lanka Sustainable Energy Authority	25 years
E7	Director (Demand Side Management) in the Sri Lanka Sustainable Energy Authority	25+ years
E8	PhD holder in BEM and a member of the Sri Lankan energy benchmarking portal development committee	8 years

A qualitative research approach was adopted in this study, which involves semi-structured interviews to examine experts' opinions and experiences more flexibly. The thematic analysis method was manually conducted to analyse data using pre-determined themes based on the literature review.

3. LITERATURE REVIEW

This section presents the findings of the literature survey conducted to study the existing knowledge in the field of data-driven BEM in the global context. Initially, an introduction to BEDM and the benefits of BEDM will be discussed. Subsequently, barriers and enablers in adopting BEDM will be discussed. Finally, strategies to overcome barriers and strengthen BEDM in the global context.

3.1 DATA-DRIVEN BUILDING ENERGY MANAGEMENT

Data-driven approaches are used in buildings to reduce energy consumption and to extract more practical energy-saving insights (Markus et al., 2022). Currently, several advanced technologies such as AI, Big Data, DT, and IoT are being used to strengthen the data-driven approaches in BEM (Adewale et al., 2024). To extract meaningful conclusions and insights, BEDM is imperative because an enormous volume of building energy data is generated from different data sources, such as smart meters, Internet of Things devices, and sensors (Billanes et al., 2025). Further to the authors, the building construction sector is shifting towards a smart building concept due to the rapid development of information and Communication Technologies such as AI, IoT, and blockchain. Several applications in data-driven approaches can be identified in the building energy sector, such as load profiling, energy forecasting, regional energy-consumption mapping, and energy performance benchmarking (Mariano-Hernández et al., 2020). Accurate prediction of building loads helps to identify future energy demands in buildings (C. Zhang et al., 2020). Building energy forecasting helps to confirm and measure the effectiveness of energy-saving initiatives (Mariano-Hernández et al., 2020). The effectiveness of energy saving initiatives can be measured by comparing the actual energy data with expected values ad take the necessary decisions based on minimum performance standards, energy policies and building energy codes. Markus et al. (2022) stated that various visualisations and Key Performance Indicators (KPIs) related to building HVAC systems, occupancy patterns and deficiencies in energy use can be produced using data analytics in buildings.

3.2 BARRIERS TO ADOPTING BUILDING ENERGY DATA MANAGEMENT

Building energy data disclosure and management has become challenging over the years due to several challenges associated with data collection, reporting, and analysis. Table 2 summarises the literature findings of challenges associated with BEDM.

Table 2: Barriers to adopting building energy data management

Barriers	Citations
Issues related to data quality, availability and reliability	1,2,3,4,7,8
Challenges in handling a large amount of heterogeneous data	5
Data security and privacy concerns	4,7,8
Challenges in balancing multiple objectives	5, 8
Changes in building operation	2,7
Resistant to taking a challenge	6,7
Lack of human adaptation	4,7
Incorrect feature identification	1,2,7
Lack of interpretability of data	1,2,3,7,8
Lack of expertise	1,3,4,5,6
Lack of research and development	7
Lack of interoperability with building systems	3,4,7
Complex technologies	1,5,7,8
Lack of policy support	1,4
Lack of standard methods	2,3,4

Barriers	Citations
Higher implementation costs	4,5
Lack of funding and incentives	9,10

1-(Clauß et al., 2024); 2-(Alrobaie & Krarti, 2022); 3-(Manfren et al., 2022) ; 4-(Adewale et al., 2024); 5-(Kiavarz et al., 2024); 6-(Markus et al., 2022); 7-(Krishnan et al., 2022); 8-(Zhang et al., 2022), 9-(Onile et al., 2021); 10-(Kazmi et al., 2023)

3.3 ENABLERS OF ADOPTING BUILDING ENERGY DATA MANAGEMENT

According to Shang et al. (2020), buildings that disclose building energy data are performing well in the real estate market. Further to the authors, the energy efficiency and marketability of buildings have substantially increased with the implementation of building energy data disclosure laws. In addition, BEDM enables sustainability certification and public policy adoption (Lee et al., 2022). Further, higher tariff rates encourage energy-conscious behaviour of building owners by monitoring real-time building energy (Nahiduzzaman et al., 2023). Especially, monitoring building energy demand helps to reduce the energy cost through demand response (Guo & Weeks, 2022). Further, some energy service providers have introduced dynamic tariff rates and incentives based on energy demand and consumption, encouraging building operators and facility managers to track their energy consumption. With the introduction of different rating scales, such as the star rating introduced by the mandatory building disclosure program (NABERS) in Australia, higher-rated buildings have delivered a higher investment return, demonstrating the impact of transparent energy performance on the market value of properties (Lee et al., 2022). Since buyers analyse energy data, energy performance certificates, and clear disclosure of energy performance increases property value and competitiveness in the real estate market (Wilhelmsson, 2023). A summary of enablers of adopting BEDM is shown in Table 3.

Table 3: Enablers of adopting building energy data management

Enablers	Citations
Increased Marketability of Buildings	(Wilhelmsson, 2023)
Improved energy efficiency in buildings	(Shang et al., 2020)
Sustainability certification requirements	(Lee et al., 2022)
National and international-level energy policies	(Lee et al., 2022)
Higher tariff rates	(Nahiduzzaman et al., 2023)
Easy identification of energy-saving opportunities	(Guo & Weeks, 2022)
Dynamic tariff rates and incentives	(Guo & Weeks, 2022)
Building energy ratings	(Lee et al., 2022)
Increasing public awareness	(Wilhelmsson, 2023)
Advancement in digital technologies	(Elnour et al., 2024)

3.4 STRATEGIES TO PROMOTE BUILDING ENERGY DATA MANAGEMENT

Das (2025) emphasised that strict building codes and mandatory disclosure of building energy efficiency data must be implemented as policy instruments to address constraints related to data and information to verify the policy outcomes. According to Jin et al.

(2023), energy data disclosure enhances the collaboration between scientific and policy fields, increasing productivity through collaboration and burden sharing. As a pioneer in promoting building energy efficiency, the US is rapidly passing laws to mandate the collection and disclosure of energy usage data. The energy consumption of the US building sector has reduced by 3-8% after energy disclosure. The energy consumption of large Australian buildings has decreased by up to 35% within 9 years after the introduction of building energy disclosure laws. Moreover, 14% of the energy consumption has been reduced within 4 years with energy disclosure along with the New York City benchmarking program. Some local governments in the US, such as New York, San Francisco and Seattle, have mandated Annual disclosure of total energy use and building characteristics as a benchmarking requirement by law or ordinance. Policies related to cybersecurity, privacy, confidentiality and ownership ensure reliable data flow and stakeholder trust in energy data sharing (Das, 2025). Energy performance standards and financial incentives play a crucial role in promoting energy-saving initiatives, where measurable indicators do not effectively impact (Morewood, 2023). Further, Mustapha et al. (2025) identified a few strategies to promote energy data disclosure and management in buildings, including supportive government policies, financial incentives, clear energy management goals, financial support, technological integration, stakeholder engagement, and practical policy frameworks. Iyer et al. (2016) demonstrated the need for a country-level data collection framework and identification of institutional roles and responsibilities in BEDM. In addition, Marinakis (2020) suggests a data-driven architecture for building energy data exchange, management, and real-time processing as a suggestion to promote BEDM.

4. DATA ANALYSIS AND FINDINGS

4.1 CURRENT STATE OF BUILDING ENERGY DATA MANAGEMENT IN SRI LANKA

According to the findings, Sri Lanka is in a preliminary stage of implementing BEDM. All professionals emphasised that Sri Lanka didn't use building energy data analysis for national-level policy making. Especially, E1 and E3 pointed out the lack of awareness and energy data required for BEDM in the Sri Lankan context. E1 stated, *"At least, many organisations do not maintain regular energy performance metrics in their buildings"*. In addition, E3 highlighted the absence of proper protocols or procedures to disclose and manage building energy data. However, it is noted that the Sri Lanka Sustainable Energy Authority is planning to promote BEDM, aiming at energy data collection and management for national-level energy policy making. E7 stated, "*Now, we are collecting building energy data from financial institutes and supermarkets and hope to expand to other sectors in future"* Substantially, the current focus is only to develop specific energy benchmarks using building energy consumption, floor area, product output, etc.

4.2 BARRIERS TO ADOPTING BUILDING ENERGY DATA MANAGEMENT

According to the findings, several barriers in BEDM were identified by the professionals. All professionals identified the issues in data availability, quality and reliability and lack of policy support as significant barriers in BEDM. E1 and E3 stated that even though they needed to access energy data in national building energy policy making, they didn't have a reliable data source to collect data. E3 mentioned, "*building energy disclosure and management has not yet been enforced in Sri Lanka, even though there are some statutory* *provisions* available *in the Sustainable Energy Authority Act, 2007"*. According to E2, Sri Lanka is facing a severe skill shortage due to a higher rate of migration of experts in BEDM. He further illustrated that *"it's very difficult to retain knowledgeable and skilled professionals to sustain national-level energy data disclosure initiatives"*. Moreover, seven professionals highlighted issues related to standardisation in BEDM. E4 mentioned that Sri Lanka didn't have a standardised data platform to collect building energy data. E3 stated, *"even though we are requested to provide data for energy census in buildings, building operators don't disclose their energy data due to data privacy concerns"*. Cost-related barriers, such as a lack of funding for BEDM and higher implementation costs, have also been highlighted by 6 and 5 professionals, respectively. E3 and E6 stated that Sri Lanka couldn't afford higher implementation costs and funding for BEDM projects with the prevailing economic crisis. Table 4 demonstrates the summary of the barriers identified.

Table 4: Summary of expert opinions regarding barriers in building energy data management

Barriers	E1	E2	E3	E4	E5	E6	E7	E8
Issues related to data quality, availability and reliability	✓	✓	✓	✓	✓	✓	✓	✓
Data security and privacy concerns			✓	✓	✓	✓		
Resistant to taking challenges			✓		✓			
Lack of technical infrastructure			✓		✓			
Lack of human adaptation	✓		✓		✓	✓		
Lack of expertise	✓	✓	✓	✓		✓	✓	✓
Lack of policy support	✓	✓	✓	✓	✓	✓	✓	✓
Lack of standard methods	✓	✓	✓	✓	✓	✓		✓
Higher implementation costs	✓	✓	✓	✓				✓
Lack of funding and incentives	✓	✓	✓	✓		✓		✓

4.3 ENABLERS OF ADOPTING BUILDING ENERGY DATA MANAGEMENT

Considering the enablers in BEDM, the highest number of professionals identified the policy adoption. According to A3, some buildings disclose energy data due to mandatory energy data disclosure regulations. Further, E1 stated, *"Currently, financial institutions and supermarkets are disclosing building energy data because of mandatory energy data disclosure regulations for benchmarks. Without regulations, they do not provide data voluntarily"*. Further, 6 professionals mentioned that sustainability certificates, higher energy tariff rates and building rating systems motivate building owners for BEDM. E3 stated that more building owners would tend to manage data if it could be considered as a plus point in obtaining sustainability certification. Moreover, E5 stated, *"if we can rate buildings based on their energy consumption considering reported energy data, companies will tend to voluntarily disclose and manage data because the energy rating can be used for marketing purposes"*. Additionally, E4 stated that some buildings tend to manage and report energy data, aiming for some incentives and tax reductions through energy saving. Simultaneously, five professionals identified incentives and rewards as enablers in BEDM. Four professionals identified the higher market value and competitive advantage of buildings due to their energy rating. E3 stated, *"buildings can use their energy ratings and attempts for energy conservation to promote their properties"*. Table 5 summarises the enablers of BEDM identified through expert interviews.

Table 5: Summary of Expert Opinions regarding Enablers in Building Energy Data Management

Enablers	E1	E2	E3	E4	E5	E6	E7	E8
Higher market value		✓	✓		✓	✓		
Sustainability certifications		✓	✓	✓	✓	✓		✓
Public policy adoption	✓	✓	✓	✓		✓	✓	✓
Higher energy tariff rates	✓		✓	✓	✓	✓		✓
Incentives and rewards		✓	✓	✓		✓	✓	
Building rating systems	✓	✓	✓		✓	✓	✓	
Building energy-saving	✓							✓
Company reputation and competitiveness			✓	✓		✓	✓	

4.4 STRATEGIES TO PROMOTE BUILDING ENERGY DATA MANAGEMENT

Based on the findings, introducing building energy benchmarks was mentioned by all professionals, highlighting its impact on strengthening BEDM. According to E3, energy benchmarks motivate building owners and operators to effectively utilise building energy data to identify energy-saving opportunities. Seven professionals mentioned that energy data disclosure laws regulate energy data reporting. Specifically, E3 stated, "*introducing mandatory energy reporting regulations is the only way of collecting required energy data for national-level energy policy making"*. Six professionals highlighted the need of centralized energy data platform and training industry professionals to manage energy data effectively. E2 stated that having centralized location ensuring data privacy and confidentiality to collect energy data of the Sri Lankan building stock was a preliminary requirement of national-level BEDM. E7 highlighted the training requirement of professionals to deal with advanced digital technologies in BEDM. Moreover, five professionals identified introducing rewarding systems and building rating systems. Further, E3 mentioned, *"we can obtain a significant participation of industry practitioners for BEDM through rewards, incentives and building ratings"*. In addition, experts suggested financial relief for buildings having an effective BEDM system, such as tax reduction and incentives. Finally, 2 experts mentioned the requirement of awareness programs to promote BEDM in the building sector. Table 6 illustrates the summary of the findings of expert interviews on strategies to strengthen BEDM.

Table 6: Summary of expert suggestions regarding Strategies in Building Energy Data Management

Strategies	E1	E2	E3	E4	E5	E6	E7	E8
Imposing energy data disclosure laws	✓	✓	✓	✓		✓	✓	✓
Developing a centralised energy data platform	✓		✓	✓	✓		✓	✓
Introducing a rewarding system	✓		✓	✓	✓	✓		

Strategies	E1	E2	E3	E4	E5	E6	E7	E8
Introducing tax reduction policies	✓		✓			✓		
Introducing energy performance incentives	✓		✓			✓		
Introducing a building rating system			✓	✓	✓	✓	✓	
Introducing energy benchmarks	✓	✓	✓	✓	✓	✓	✓	✓
Training industry professionals	✓	✓	✓		✓	✓		✓
Conducting awareness programs			✓					✓

5. DISCUSSION

Both literature findings and expert interviews confirmed that Sri Lanka is still in a preliminary stage in BEDM, whereas it is gaining considerable attention in the global context. Sri Lanka is focusing on collecting fundamental data points required for specific energy consumption, while the global context is thriving towards more advanced analytics and AI-driven decision-making in BEDM. Further, even though 17 barriers in BEDM were identified through the literature review, experts identified only the 10 most significant barriers for the Sri Lankan context. Issues related to heterogeneous data handling, balancing multiple objectives, model and parameter selection, operational changes, system interoperability, research and development, and technological complexity have been identified by none of the experts. Those barriers are associated with advanced BEDM systems, which involve advanced system integration and data analytics. Lack of data quality, availability and reliability and policy support are the highly noted barriers in both literature and expert interviews. Standardisation in BEDM is another highly notable barrier from expert interviews, while literature also emphasised the standardisation issues in BEDM in the global context. Similar to the global context, Sri Lanka is also facing a severe knowledge and skill shortage in BEDM. In addition, cost-related issues such as implementation cost and incentives were also verified in the Sri Lankan context through expert interviews due to the economic condition of the country. Issues related to confidentiality, lack of technical infrastructure, stakeholder resistance and adoption are the least mentioned barriers in Sri Lanka, although they were highly concerned in the global context. A summary of the findings is shown in Figure 1.

In addition, several enablers for BEDM were identified using both the literature review and the expert interviews. Both confirmed that higher marketability and property value due to sustainable efforts to conserve energy would encourage stakeholders to invest in BEDM. Currently, investors look for sustainable features due to a higher focus on sustainable development. In addition, due to higher energy tariff rates in Sri Lanka, people are motivated to be more concerned about energy consumption in buildings. Simultaneously, building management companies try to obtain different sustainability certifications and energy ratings to improve the market value of their property. Therefore, these factors enable BEDM in the Sri Lankan context to some extent. Nevertheless, expert interviews pointed out that some buildings are still not aware of the energy cost because that cost is incurred by the tenants or the residents in the building. In such cases, data disclosure laws must be enforced to influence stakeholders to disclose and manage data.

Considering both barriers and enablers, strategies to promote BEDM in Sri Lanka were identified. As mentioned in the literature, experts also confirmed that strong legislative provisions, such as laws and regulations, must be introduced to force stakeholders to disclose and manage building energy data. Further, experts emphasised that a building energy data platform must be introduced to standardise building energy data disclosure to enable data-driven decision-making in national energy policy formulation, which was also discussed in the literature. However, experts suggested introducing energy benchmarks to strengthen BEDM, allowing building stakeholders to analyse energy data for better energy efficiency opportunities, although this was not found in the literature. Experts agreed with providing incentives, rewarding systems and tax reductions to encourage BEDM as mentioned in the literature. However, it was found that novel suggestions from experts, such as providing training for building stakeholders, conducting awareness programs and introducing rating systems, are more effective strategies to promote BEDM in Sri Lankan buildings.

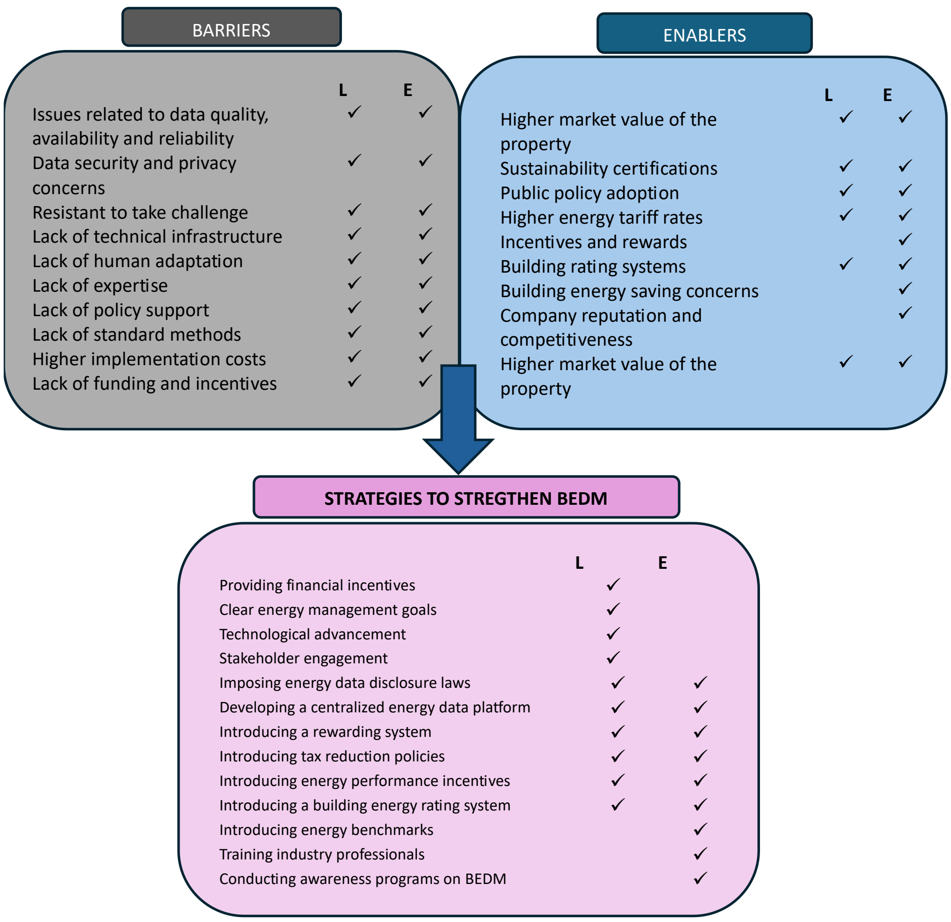

Figure 1: Summary of findings

[L- Literature; E *- Expert Interviews]*

Due to the number of constraints, Sri Lanka consists of a special setting for researching BEDM. While there is a growing tendency to adopt data-driven energy management in developed countries, Sri Lanka continues to face challenges in BEDM due to fragmented data collection, limited interoperability among stakeholders and low digital integration within building operations. Therefore, examining BEDM within the Sri Lankan context provides valuable insights into how developing economies can overcome institutional, technological, and operational barriers in achieving sustainability and low-carbonisation goals. Further, the study provides a broader contribution to BEDM by offering a framework that may support other developing countries experiencing similar constraints in BEDM.

6. CONCUSIONS

This study focused on identifying the barriers, enablers and strategies to strengthen BEDM in the Sri Lankan context. According to the literature review, advanced data analytics and technologies are used for BEDM and decision-making in BEM in the global context. Even though the literature review identified multiple barriers, enablers and strategies in BEDM in the global context, few of them are highly applicable in the Sri Lankan context. According to the findings of the expert interviews, even though a constructive attempt has been initiated to collect and manage building energy data, BEDM is still in the early stages in the Sri Lankan context. In addition, 10 barriers which hinder the approaches for a BEDM, 8 enablers which motivate BEDM and 9 strategies to promote BEDM, which are applicable for the Sri Lankan context. Lack of data availability, quality, reliability and policy support were the highly noted barriers in Sri Lanka. Data disclosure laws and building energy rating were the highly noted enablers in Sri Lanka. Further, introducing energy benchmarks and statutory provisions, such as laws and regulations, were highly suggested strategies to promote BEDM. The results provide important insights for policymakers regarding the need for national policies and regulatory frameworks for building energy data disclosure and reporting. Industry practitioners can use the identified strategies to improve internal energy data management practices. Finally, this study contributes to the growing knowledge on BEDM, particularly in the context of developing countries. Since this study is directly focused on the Sri Lankan context, the findings of this study might not be directly applicable to other developing contexts with different environmental, regulatory and market conditions.

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