Rajapaksha, E.G.L.S., Rathnayake, U. and Karunarathna, A.S.W., 2024. Feasibility assessment of smart grid technology for the Sri Lankan urban areas. In: Sandanayake, Y.G., Waidyasekara, K.G.A.S., Ranadewa, K.A.T.O. and Chandanie, H. (eds). *Proceedings of the 12th World Construction Symposium*, 9-10 August 2024, Sri Lanka. pp. 481-494. DOI: https://doi.org/10.31705/WCS.2024.38. Available from: https://ciobwcs.com/papers/

FEASIBILITY ASSESSMENT OF SMART GRID TECHNOLOGY FOR THE SRI LANKAN URBAN AREAS

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ABSTRACT

This study examines the viability of using smart grid technology in the urban areas of Sri Lanka as a solution to the electricity sector's challenges. Considering the elevated energy costs and reliance on costly fossil fuels, there is an urgent require for inventive alternatives. Smart grids have the potential to yield several advantages, including enhanced efficiency, seamless integration of renewable energy sources, and improved control of demand-side operations. The article assesses the viability and constraints of smart grids by conducting expert interviews and reviewing relevant existing literature. The development of an implementation framework is guided by insights provided by ten professionals from diverse sectors of the power sector. This study aims to identify the essential elements of smart grid systems that can be related to the Sri Lankan context including Advanced Metering Infrastructure (AMI), distributed energy resources, and demand response systems. Challenges including initial capital expenditures and risks related to cybersecurity are highlighted, with experts providing solutions for mitigation. A staged strategy for implementation, focusing on cost-effectiveness and cross-border cooperation is advocated. Methodologically, the study utilises qualitative analytic tools and semi-structured interviews to collect and analyse data. Findings from this study underscore the possibilities of smart grid technologies to enhance grid stability, reduce fossil fuel consumption, and improve dependability. Despite challenges, the study shows the necessity of smart grid deployment for attaining a more efficient, dependable, and sustainable energy system in Sri Lanka's urban areas.

Keywords: *Electricity; Feasibility Assessment; Renewable Energy; Smart Grid.*

1. INTRODUCTION

Sri Lanka is experiencing industrialisation, urbanisation, and rapid growth, resulting in a continuous increase in energy demand, and consequently, power consumption is rising every year (Asalanka, 2017). “Ceylon Electricity Board (CEB) is the government-owned electricity provider in Sri Lanka, which is struggling to cater to the increasing demand at an affordable cost. Overall, 10%-15% of electricity is wasted due to technical and non-technical losses in the national grid in Sri Lanka as in CEB Annual Reports 2013–2017”

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(Jayaratne et al., 2021). Farmanbar et al. (2019) argue that the current energy distribution system is one-way, with static consumer rates and simple meters that cannot transmit data in both directions. This limits utilities' ability to collect real-time data and provide consumers with information about their energy usage, hindering efficient grid management and personalised services.

In developing countries, recurrent electricity failures result in extended periods without power, limiting utilisation and benefits for industries, businesses, and households. This unreliable service poses a greater risk as dependency on electricity grows (Nduhuura et al., 2021). However, Sri Lanka is regarded as one of the least urbanised countries in the world. The majority of people in the nation about 81.7% remain concentrated in rural and plantation areas supported by the agricultural and Agri-based industries (Gasimli et al., 2019). Still, smart energy solution requirements have arisen in Sri Lanka aiming for the Colombo district as it acts as the heart of the Sri Lankan economy, and most of the socially and economically important places are located in the Colombo district (Asian Development Bank, 2023; Hamilton et al., 2010). Because energy is becoming more and more essential to modern living, complex distribution systems that provide two-way power flow and enhanced communication across microgrid components are required (Suryadevara & Biswal, 2019). The need for a smart grid emerges from this point, and it can deliver power in more effective ways and respond to a wide range of conditions and events by using two-way flows of electricity and information to create an automated and distributed advanced energy delivery network (Fang et al., 2012).

Within the Sri Lankan context, the pressing issue of electricity supply reliability and efficiency emerges, epitomised by technical and non-technical losses within the national grid (Amarasinghe & Perera, 2021; Jayaratne et al., 2021). Witharama et al. (2023) identified several factors that influencing the challenges of electricity market in Sri Lanka. This includes the high capital cost required to develop the necessary infrastructure, technical incapability, regulatory restraints, and limited infrastructure and resources within the country. As the country struggles to overcome these obstacles, the research question becomes clear as to how smart grid integration can be feasibly realised in Sri Lankan urban areas to improve smart city features, optimise energy consumption, and address the special difficulties associated with a developing country's urbanisation process. This research attempts to pave the path for supporting energy efficiency goals by examining the applicability, advantages, and limitations of smart grid adaption within Sri Lanka's urban fabric. Thus, this research aims to assess the feasibility of application of smart grid technology to Sri Lankan urban areas to contribute to energy efficiency approaches.

2. LITERATURE REVIEW

2.1 SMART GRID TECHNOLOGY

Hertzog and Stuart (2010) defines Smart Grid as a “bi-directional electric and communication network that improves the reliability, security, and efficiency of the electric system for small to large-scale generation, transmission, distribution, and storage”. In order to comprehensively monitor and regulate energy consumption on an extensive level, the Smart Grid system smoothly merges power system architecture and cutting-edge computer technology. Khan et al. (2020) and Jaber et al. (2023) identified that the concept of a smart grid refers to an evolving electrical network that encompasses many components including transmission lines, switches, transformers, protective equipment, sensors, and information technologies. Therefore, to make the most of the available resources, the smart grid network employs a transactive power structure together with techniques for predicting the medium- and short-term electricity demand (Haq et al., 2023).

2.2 SMART GRID TECHNOLOGY AND ARCHITECTURE

The key mechanism that allows smart grids is smart meters which are also referred to as AMI, enabling bi-directional, two-way communication between the consumer and the utility (Abrahamsen et al., 2021). Power Quality (PQ) monitoring features on AMI smart meters allow for quick detection, diagnosis, and resolution of PQ issues (National Energy Technology Laboratory, 2008). Demand response (DR) is a crucial feature of smart grid technology that helps utilities manage peak demand and reduce energy consumption through mechanisms like dynamic pricing, direct load control, and incentive programs (Bakare et al., 2023). Renewable energy sources are gaining popularity due to the potential to meet half of global energy demands by 2050, with smart grid systems offering energy security, environmental benefits, and conservation (Islam et al., 2014). The integration of renewable energy sources into the grid requires a more flexible and responsive system, which can be achieved through smart grid technology, enabling real-time power flow management and better supply-demand balance (Pragash et al., 2023). Smart grid dependability relies on control and communication systems, necessitating increased network connectivity and advanced security mechanisms to address cyber security flaws and breaches (Ghelani, 2022). Here it will require a proactive threat identification automated security analysis and dynamic measures should be taken to provide security and resilience for the system (Faquir et al., 2021).

2.3 NEED OF SMART GRID FOR SRI LANKA

The Sri Lankan power generation infrastructure has struggled to keep up with the nation's peak electrical consumption for the past 20 years (Nagahawatte, 2020). Kataray et al. (2023) identified that nearly 8% of the output of the conventional electrical grid is lost due to transmission lines, and 20% of its capacity is mostly used to fulfil peak demand. Sri Lanka's electricity distribution system has inefficiencies causing power outages, high bills, and environmental issues. CEB generates electricity from thermal, hydro, and renewable sources however the outdated distribution system lacks the infrastructure to meet growing demand (Asian Development bank, 2022). The current system faces high transmission and distribution losses in Sri Lanka, estimated at 10% in 2019. These losses result from technical inefficiencies (outdated equipment, poor maintenance) and non-technical issues (theft, illegal connections) (Hansika et al., 2021). Smart grid technology enables the active participation of both producers and consumers in network operation. Producers engage by utilising methods like time of use rate, real-time pricing, and direct load control to minimise energy usage and incentivise consumers to do the same (Young, 2017).

2.4 TECHNOLOGICAL, ECONOMIC, AND ENVIRONMENTAL ASPECTS OF IMPLEMENTING SMART GRID TECHNOLOGY

2.4.1 Technological Feasibility

As underlined by Alotaibi et al. (2020) the integration of smart grid technologies improves system resilience, improves energy efficiency, and facilitates real-time control and monitoring. However, as highlighted by Moreno Escobar et al., (2021) the deployment of such advanced technology demands a meticulous assessment of technical complexity, cybersecurity risks, and thorough legal frameworks. Fernando et al., (2017) declare that while Sri Lanka has made achievements in upgrading its energy infrastructure, concerns such as grid stability, interoperability, and workforce skill development still require special attention.

2.4.2 Economic Feasibility

The widespread adaption of Information and Communication Technology (ICT) in both the economic and social sectors has generated optimistic expectations regarding the potential reduction of energy consumption and emissions (Lange et al., 2020). On the contrary, Dorji et al., (2023) argue that the deployment of smart grid technologies encounters notable economic limitations, encompassing substantial initial expenditures, regulatory restrictions, and uncertainty regarding the profitability of the initiative. Here The economic feasibility of smart grids is contingent upon the capacity of stakeholders to effectively navigate the complicated socio-technical systems associated with them (Kumar, 2019).

2.4.3 Environmental Aspects

The environmental feasibility of implementing a smart energy system in Sri Lanka is crucial for sustainable energy development (Fernando, 2020). Smart grids can integrate renewable energy sources, reducing greenhouse gas emissions (Erickson & Brase, 2019). Ministry of Environment (2012) highlights that Sri Lanka's abundant renewable energy potential, including solar and wind resources, aligns with the country's commitment to climate change. Balancing intermittent renewable sources requires sophisticated grid management strategies. The life cycle environmental impact of smart grid components, such as advanced metering infrastructure, requires careful consideration (Aleksic & Mujan, 2016).

2.5 TECHNOLOGICAL INNOVATIONS AND INTERNATIONAL BEST PRACTICES IN SMART GRID APPLICATION

Table 1 illustrates the technology innovations and best practices in smart grid applications. It further discusses the usage of each innovation technology and best practice.

Table 1: Technology innovations and best practices in smart grid applications

Innovation/ Best Practice	Usage
Self-Healing Ability	Self-healing in smart grids involves distinguishing normal and abnormal functioning, enabling prompt fault detection through real-time monitoring. Objectives include swift fault detection, resource redistribution for reduced

Innovation/ Best Practice	Usage
	congestion, service continuity assurance under any condition, and minimising service restoration time (Thentral et al., 2019).
Integration of Electrical vehicle with SG	The rise of electric vehicles (EVs) necessitates a shift in the Transmission Network (TN) and Power Distribution Network (PDN) to manage dynamic charging demands, requiring smart grids for optimal load distribution and synchronised management in the evolving energy distribution landscape (Majeed Butt et al., 2021).
Distributed energy resources (DERs)	Distributed energy resources (DERs) are small-scale energy resources commonly positioned near areas of electricity demand, such as rooftop solar panels and battery storage. Their rapid expansion is revolutionising not merely the way electricity is generated, but the way it is traded, distributed, and utilised (International Energy Agency, 2022).
Usage of Big Data	Big data is crucial for smart grid decisions and autonomy, overcoming challenges in storage, visualisation, and security. Using diverse data, algorithms predict power patterns, enhancing smart energy management (Majeed Butt et al., 2021).
Use of data analytics and AI techniques	Data analytics and AI techniques, including machine learning and deep learning, optimises smart grid operations by analysing large datasets and automating tasks like load forecasting, demand response, fault detection, and grid stabilisation (Pullum et al., 2017).

2.6 IMPLEMENTATION CHALLENGES

The implementation of Smart Grid technology encounters various obstacles, such as the absence of regulatory frameworks, the vulnerability to cyber-attacks, the substantial expenses associated with installation, and the volatility and congestion within the network (Abdullah & Hassan, 2022). Technical limitations comprise an important factor in the implementation of smart grids, presenting issues (Voima & Kauhaniemi, 2012). Dhara et al. (2022) and Faquir et al. (2021) highlighted the importance of cybersecurity in smart grids, highlighting the vulnerability of their interconnected structure to cyber-attacks.

3. METHODOLOGY

A thorough investigation using the literature review was carried out in order to examine the smart grid technology, its application, suitability, and limitations using journals, books, conference proceedings, reports, government publications magazines, and dissertations. This study has used semi-structured interviews for the data collection process to allow the experts in the field to provide in-depth conversations for preset questions. Semi-structured interviews allowed to adapt questions based on the respondent’s context and experiences. It makes the interview encouraging respondents to share more openly. This qualitative research method involves in-depth discussions with specialised experts in a specific field or subject area, chosen based on their expertise, professional background, and familiarity with the subject matter under investigation. Hence, this study used purposive sampling method to select experts to get the data on their specified filed. Here mainly ten experts in the electricity fields have been interviewed to gather data. There are limited people who has experienced the real smart grid initiation. As a result, this study limited to ten expert interviews and respondents were selected based on their experience and contribution in Smart grid sector. These experts cover mainly three areas of the profession including experts from the electricity supply side (CEB), researchers, and energy consultants. The selection of these professions is based on the fact that CEB is the primary licensed entity in Sri Lanka responsible for supplying power. In the energy industry, researchers have opted to explore innovative concepts and characteristics that may be included in the SG system. Energy consultants must decide and select the aforementioned technology to obtain the necessary instructions for its actual implementation. When determining the years of service, individuals with over 10 years of competence are interviewed, presuming that they have accumulated a significant level of ability and knowledge in the relevant subject. The profiles of experts are shown in Table 2. To conduct a comprehensive analysis process Nvivo 12 has been used and based on the inputs gained from the expert's feasibility of implementing smart grid features within the Sri Lankan context and areas that need to be developed have been discussed and an implementation guide has been developed accordingly.

Table 2: Profiles of experts

Code of the Expert	Current Designation	Experience
E01	Grid System Analyst & Researcher	12 Years
E02	Deputy General Manager– Training	32 Years
E03	Post Doctoral Researcher	10 Years
E04	Project Director Power System Reliability Strengthens Project	22 Years
E05	Renewable Energy Consultant	11 Years
E06	Senior Power System Engineer & Researcher	12 Years
E07	Electrical Consultant	17 Years
E08	Electrical Engineer	11 Years
E09	Lead Electrical Engineer	12 Years
E10	Senior Electrical Engineer	14 Years

4. DATA ANALYSIS AND FINDINGS

4.1 CURRENT STATUS OF POWER SECTOR

A significant number of respondents perceived that the present energy supply system as having several favourable attributes, despite its expensive generation costs. Additionally, E01 and E04 stated that the main underlying issue is lagging in the implementation of low-cost or cost-efficient power plants. E01 further elaborated that *"this results in a significant gap between electricity demand and supply, making electricity supply in Sri Lanka most expensive"*. Accordingly, Sri Lankan electricity consumers bear a heavy burden due to the increased electricity price and inadequate low-cost electricity generation methods must be the underlying causes for current power sector issues.

4.2 ALTERNATIVE SOLUTIONS FOR CURRENT POWER FAILURES

The responses taken from the interviews mainly highlighted that the prime solution is to the achieve least cost generation and fill electricity demand enabling novel technologies. Using existing power plants for improved power generation is the main solution according to E04 and E02. Expert E04 proposes liquified natural gas (LNG) as a possible alternative to coal due to its reduced environmental effect and low cost. As the second solution experts underlined the potential of renewable energy sources. To support this E03 highlighted that solar power incorporated microgrid with battery storage is an optimal alternative. Moreover, E02 stresses that pump storage hydroelectricity is another viable option for load balancing that storing energy in the form of water gravitational potential. While these alternatives provide promise, experts also note that effective management of electricity infrastructure will be required to deliver the generation, transmission, and distribution capabilities. E03 stated that the smart grid will be a solution with their superior communication and control capabilities allowing integration of renewable energy and efficient distribution.

4.3 SMART GRID AS A VIABLE OPTION

E02 stated that "*Smart grids enable greater flexibility in managing electricity flows and balancing supply and demand*". E01 highlighted that with economic constraints developing new power plants is infeasible and "*we can achieve a solution based on implementing a smart grid to utilise available energy generation options and infrastructure to gain efficient energy distribution and consumption using smart features*". Furthermore, E05 elaborated the way smart grid features can be used to address the highlighted issues in the previous chapter by stating "*through technologies like demand response and distributed energy resources (DERs), such as solar panels and battery storage, utilities can dynamically adjust electricity generation and consumption to maintain grid stability, especially during periods of high demand using renewable energy output*". Further, E02 highlighted that smart grids facilitate interconnectedness between different parts of the grid, enabling electricity to flow between regions and reducing dependency on specific generation sources or transmission lines. Accordingly, this interconnection promotes grid stability by giving backup options in localised power disruptions.

4.4 FEASIBLE SMART GRID FEATURES IN SRI LANKA

4.4.1 Advanced Metering Infrastructure

AMI is one of the most important components of any smart grid system. E02 stated, *"AMI is another feature that can be used in urban areas and some pilot projects are testing its feasibility in the present"*. Both E02 and E04 established that AMI has a role in reducing power theft, one of the persistent issues in electricity distribution. Furthermore, E04 highlighted that *"Smart metering does not just provide metering capabilities, it works like a smartphone where we can obtain individual voltage profiles, current profile load curve consumption, drop time, and fail time proving controllability over the system"*. E05 presented an alternative option that can be implemented along with the AMI to facilitate a prepaid metering system where that eliminates the use of the meter readers and allows consumers to use electricity according to their prepaid balance and shut the electricity down until they top-up their account.

4.4.2 Distributed Energy Resources

In the foreign renewable energy sector, consumers increasingly choose solar and battery projects, becoming independent from grid connections. They prioritise solar, and battery while using the grid supply as a backup. E05 elaborated that this can be comprehensively achieved within the Sri Lankan context and P01 confirms this by stating *"DER makes customers energy independent using solar and battery storage systems"*. Further, the respondent declared that the integration of renewable energy sources is a significant challenge, as many PV and solar systems operate independently of the national grid. To effectively monitor and manage this supply, it is crucial to integrate solar project supply with the national control system.

4.4.3 Demand Response and Load Management

E09 mentioned that *"DR initiatives encourage users to shift their power usage during peak demand periods. Smart grids can convey real-time grid status to end-users, allowing them to get involved in DR programs by moving non-critical energy usage to off-peak hours"*. E05 further highlighted that building management systems with automation technologies integrated with demand response initiatives offer further benefits by automating lighting HVAC and other systems, enhancing power quality and system security within the buildings.

4.4.4 Other Features

Peer-to-peer energy sharing feature was revealed by the E01 and he mentioned "*one option includes scheduling and sharing surplus loads generated by PV systems with other neighbour buildings. This needs connection with building management systems, to optimise energy distribution and consumption"*. E05 presented the power wheeling practice where customers can buy electricity from alternative generators and pay only for government-provided transmission line supply, which can be implemented in Sri Lanka with the right policy framework. E02 and E06 described the self-healing grid operations as smart grids that enable interconnectedness across the grid, allowing electricity to flow across regions and reducing dependence on specific sources or transmission lines. Experts highlighted cyber security as another required feature in the smart grid system for the security and integrity of the system. As a result, it was introduced as a necessary evil to protect consumer data and against cyber-attacks.

4.5 FEASIBILITY ASSESSMENT

4.5.1 Technological Assessment

According to E02 as the basic adaptation, it may follow a comprehensive guide including, equipping current grid components with new metering and communication technologies to enable real-time data collecting. Second, integrating distribution automation will boost grid control and efficiency. Third, incorporating renewable energy sources like solar into the grid would diversify the energy mix and encourage sustainability. Lastly, increasing cybersecurity measures is vital to defend against future cyber-attacks. As the smart grid is a wide concept including different segments E03 introduced a divisional procedure for integration as follows,

- **Generation -** Achieving 70% renewable energy generation is already a target at the national level. To get their solar systems, wind turbines can be used and create a microgrid using the projects.
- **Storage -** Batteries, flywheels, and thermal storage mechanisms can be used here.
- **Delivery & Transmission -** The communication network should be strengthened. Different types of sensors should be used to detect faults and grid management.

- **Consumption level -** AMI initiation and demand response and load scheduling practices.

Enabling these features is based on the financial and economic capabilities of the country and E04 stated that *"smart grid initiation should be started in a region where mostly smart features are required. For industrial zones, airport zones, hospital zones, etc. from there, we can expand the system to other areas as well"*.

4.5.2 Economic Assessment

Most of the experts held that the main barrier to the smart grid initiation lies in the economic constraints. E07 stated that "*while most smart technologies are available in commercial-level projects, the primary concerns rise from economic viability and adaptability issues"*. Focusing on regions with higher energy usage provides the greatest economic advantage for the initial launch of smart grid technology in Sri Lanka. According to E05, it is recommended to prioritise areas including Central Business Districts (CBDs), industrial zones, and high-density residential regions. E01 presented the main categorisation and areas where cost can be accumulated. This includes, Designing & Planning, Equipment purchasing, Architecture development, IT and software integration, labour and interest or financing cost project loans. As aforementioned the early expenses related to the adoption of smart grids can be substantial, and many experts argue that the long-term economic advantages may surpass these initial financial outlays. According to E01 *"quantifying the benefits of smart grid implementations can have challenges, However, the possibility of achieving long-term economic benefits by implementing smart grid technology is undeniable"*. It is evident that the Sri Lankan government with its economic capabilities cannot bear the investment value of a mega project. As a solution, experts have provided many options including, public private partnership, grants, and loans from the Asian Development Bank and World Bank, USAID, and foreign investors.

4.5.3 Regulatory Assessment

As the smart grid is a continuously evolving system, regulatory policies should be updated to accommodate new changes and trends. E05 highlighted that the current system discourages renewable energy investments due to limitations in selling excess electricity back to the grid at a fair price. Further, he elaborated on the necessity of policy revisions for the power wheeling mechanism, allowing surplus renewable energy to be purchased by other users. E03 introduced the Energy Independence and Security Act 2007 as a guiding regulation to improve the Sri Lankan regulatory framework on the energy sector. Furthermore, E01 and E06 identified that robust security and confidentiality of data policies are necessary to preserve customer details against cyberattacks and illegal access in modernised grid.

4.6 IMPLEMENTATION PRACTICES

As the first step, E10 advised to conduct a detailed feasibility analysis to evaluate the alternative options based on available technologies, funding options and legal considerations. And as the next step it is required to select the most financially and technically feasible option from them after conducting cost benefit analysis. According to E01 "*we need to prioritise considering the available features in the industry*". Before starting with a large-scale project E02, E09 and E04 explained conducting a pilot project as the initial step. E07 stated that, as the next step "*we have to obtain relevant institutional* *approvals, legal approvals and permits, before proceeding with project implementation*". According to E02, tendering and contractor selection and identifying potential funders and investors is a major step of the implementation process. Further to E02, the next step action plan is required in expansion processes and needs to gather information and observe the new trends in the global context for upgrades. E10 highlighted the equipment design based on the scope and scale and executed the project with the proper project team. E03 expressed that in each stage of the project continuous monitoring and evaluation is an essential step.

5. DISCUSSION

Sri Lanka's power industry confronts issues, including high energy rates and dependence on expensive fossil fuels. The literature study highlighted smart grids as a viable option, including benefits such as higher efficiency, greater renewable energy inclusion, and improved demand-side management. Interviews with specialists support these potential advantages, stressing the possibilities of smart grids to increase grid stability, and dependability, and minimise dependency on fossil fuels. Experts question smart grids' ability to reduce energy expenses directly, however their long-term economic benefits through improved efficiency and reduced losses appear promising.

Expert interviews revealed numerous smart grid aspects especially applicable to Sri Lanka's urban setting. These include AMI, distributed energy resources, peer-to-peer energy sharing, demand response and load management, power wheeling, self-healing grids, real-time grid monitoring, and interaction with electric car technology. Additionally, experts offered possibilities including prepaid billing mechanisms, smart meter connection with building management systems, and microgrids for energy-independent clients.

In the smart grid adaptation, a layered approach that includes integration is suggested, focusing on generation by boosting renewable energy sources like solar and wind through microgrids. Storage alternatives should be considered through batteries, flywheels, and thermal storage devices Delivery and transmission enhancements require upgrading the communication network and employing multiple sensors for real-time grid management. At the consumption level, AMI deployment alongside demand response and load scheduling strategies will be required.

Economic feasibility is crucial because experts underline the necessity to prioritise low-cost electricity production and manage energy consumption and delivery through smart features. International financial help from agencies like the World Bank, ADB, and USAID can be sought, along with possible partnerships with organisations like NREL for specialist technical assistance. Adapting the legal framework to support smart grids is necessary. This involves modifications to the power wheeling process to promote renewable energy integration. Robust data security and confidentiality standards are necessary to secure customer information. Additionally, implementing interoperability standards would guarantee compliance with the current grid code and PUCSL general policy guidelines. Figure 1 illustrates the guideline that can be used to implement the SG technology in Sri Lanka.

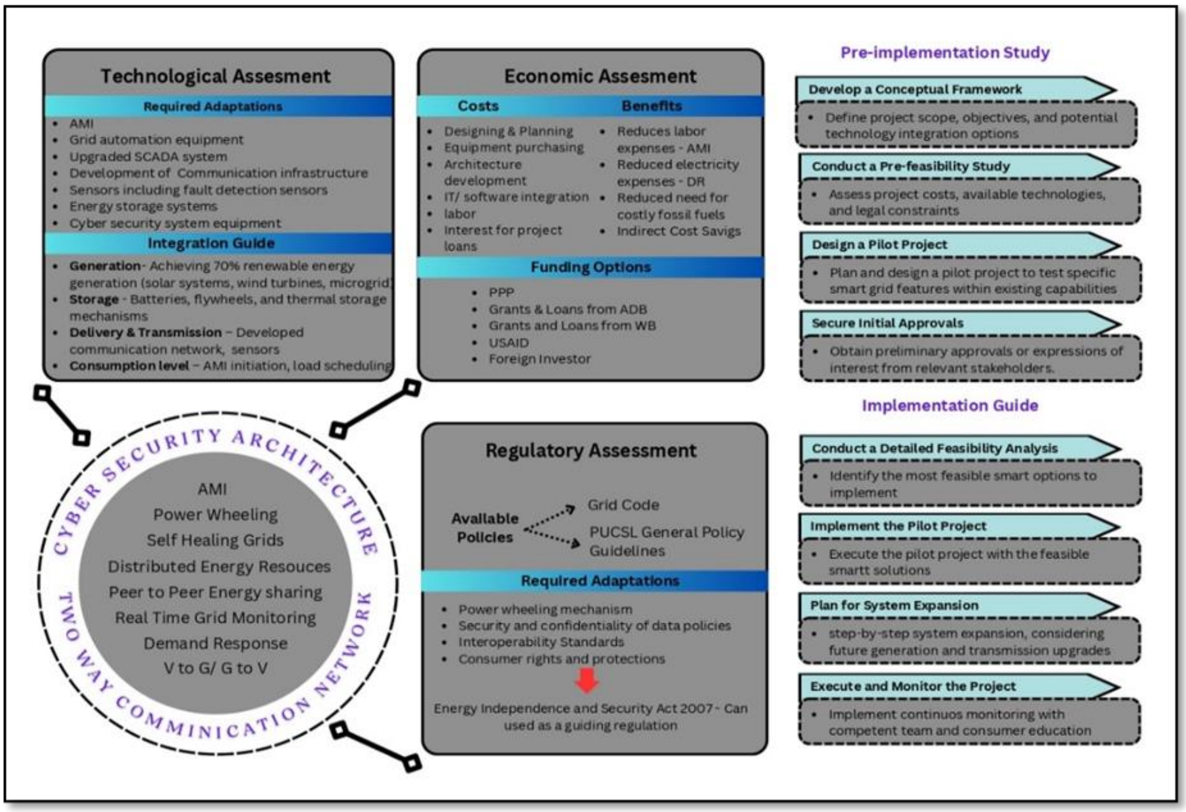

Figure 1: Feasibility assessment and implementation guide

6. CONCLUSIONS

Study aim was achieved by conducting literature review in the initial stage and then conducted semi-structured interviews with the experts in the electricity filed to gather the data relevant to Sri Lankan context. Literature findings identified smart grids as a viable option for Sri Lanka and it provides benefits such as higher efficiency, greater renewable energy inclusion, and improved demand-side management. The literature information for the Sri Lankan context was validated through expert interviews. Further, key benefits of smart grids were identified during the expert interviews. Findings emphasised how smart grids can reduce reliance on fossil fuels and improve grid stability and dependability. Considering the economic background, it was notable that experts have considered the initial investment involved with the smart grid adaptation including infrastructure changes, smart meter installations, and communication networks. Further, it was identified that economic feasibility is crucial due to the necessity of low-cost energy production. As the funding options, International financial agencies like the World Bank, ADB, and USAID can be supportive. When considering the technological background, it was identified that technological constraints can be overcome through a proper financial investment and the use of IT and other available technical expertise. Considering the limitations, focus area of this research is limited to Sri Lankan context because of the lack of smart features in power distribution sector. And it is suggested to conduct further researches on the effect of smart grid integration with building energy systems. Ultimately this research has provided feasible guide for the implement.

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