

Reinventing Real Estate: Exploring the Dynamic Landscape of Prop-Tech driven Digital Transformation in the Residential Sector – Lessons for Sri Lanka

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Abstract — This article presents a comprehensive narrative review of published articles focusing on the digital transformation of the residential real estate sector driven by PropTech (Property Technology). The study aims to provide insights into the current state of digitalisation within residential real estate, examining the technological advancements and their impact on various aspects of the market. The review employed a narrative review approach, analysing scholarly articles, industry reports, and reputable online sources that explore the intersection of residential real estate and technology. The findings highlight the revolutionary effect of PropTech on the residential real estate sector, fundamentally changing traditional practices and enhancing operational efficiency. The study identifies key areas where PropTech has made significant strides in the residential real estate sector. These advancements have reshaped the market dynamics, fostering transparency, reducing energy consumption, and increasing access to information for all stakeholders. In conclusion, this narrative review underscores the transformative impact of PropTech on residential real estate, shedding light on its potential to reshape industry practices and improve overall efficiency for developing nations like Sri Lanka. The findings provide valuable insights for researchers, practitioners, policymakers, and industry players seeking to understand and leverage technology in the residential real estate industry.

Keywords — Prop-Tech, Smart Residential Sector, Smart Building Technologies, Internet of Things, Narrative Review.

I. INTRODUCTION

The global real estate industry has undergone a significant digital transformation, with PropTech, which refers to the use of technology to transform the real estate sector, emerging as a prominent contributor to the industry. PropTech encompasses a wide range of technological innovations. Smart residential is one of the emerging sectors of PropTech, which utilises advanced technologies such as Internet of Things (IoT) devices, sensors, and automation systems to enhance the quality of life for residents [1].

When considering the utilisation of the concept in the Sri Lankan context, a smaller number of projects incorporate Prop-Tech. Sri Lanka still has a huge potential to achieve in

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terms of smart technology. One pioneering example is the project TRIZEN by John Keells Properties, a prominent smart residential project located in Colombo that aspires to revolutionise the way people live in a residential community by integrating advanced technological features and elevating sustainable building practices. The project incorporates smart building technology components like IoT devices and home automation to give residents a modern and sustainable living atmosphere [2].

Despite the increasing interest in PropTech-enabled smart residential projects in Sri Lanka, comprehensive literature on the underlying factors, constraints, and impacts of digital transformation in the residential sector is scarce, and the literature on this topic is inadequate and fails to address the Sri Lankan scenario particularly [3]. Consequently, this research aims to fill that gap by investigating the digital transformation of the residential sector in Sri Lanka, with a particular focus on PropTech-enabled smart residential developments[4]. The study's findings are anticipated to add to existing knowledge on digital transformation and PropTech adoption in the Sri Lankan residential sector, giving significant insights to policymakers, practitioners, and scholars interested in the intersection.

This study provides an in-depth review of the dynamic landscape of PropTech-driven digital change in the residential sector by investigating the present situation and emerging trends in digital transformation in the world, with a particular emphasis on the use of PropTech solutions. Furthermore, the paper provides an overview of implementation issues, constraints, and alternative solutions globally to provide insights and recommendations for industry stakeholders, policymakers, and researchers for efficiently navigating and using the changing landscape of PropTech-driven digital transformation in the residential sector.

II. MATERIALS AND METHODS

A. Approach

Compared to systematic reviews, A narrative review does not require a specific procedure to be followed by the researcher. The review's author and aims will determine how the review is structured.

Even though there is currently no agreement on the typical structure of a narrative review, the IMRAD (Introduction, Methods, Results, and Discussion) methodology is the one that is most frequently used [5]. Aside from the author's preferences, a narrative review design must often adhere to journal style and norms in the relevant discipline. It is possible

TABLE 1
THE ASSESSMENT OF INDIVIDUAL EVIDENCE RESOURCE

Database	Characteristics
Scopus	Multidisciplinary database that provides in-depth coverage of scientific literature in various fields. There are a number of peer-reviewed journals, conference proceedings, and other academic sources included. Scopus' thorough indexing system, which enables efficient searching and retrieval of pertinent articles, is one of its assets [6].
Emerald insight	This database primarily focuses on research in business, management, and social sciences. It gives users access to a huge selection of academic books, journals, case studies, and conference proceedings. Researchers in business administration, marketing, economics, and related disciplines [7].
IEEE Xplore	Engineering, computer science, and technology research can be found in the premier database. It provides access to a sizable library of technical periodicals, conference papers, and standards produced by the Institute of Electrical and Electronics Engineers (IEEE) and its affiliated bodies. Electrical engineering, computer science, telecommunications, and other related topics are well-covered in IEEE Xplore, which is renowned for this [8].
ScienceDirect	A sizable database that includes information on a broad range of scientific fields, including the biological, physical, health, and social sciences. It gives users access to numerous peer-reviewed publications, including books and conference proceedings. Researchers can focus their searches and locate pertinent content by using ScienceDirect's extensive search tools and filtering features [9].
JSTOR	A digital library with a significant emphasis on the humanities and social sciences. It gives users access to a huge library of academic books, journals, and primary materials. JSTOR is renowned for having an extensive archive of previous papers, making it useful for looking backward and conducting retrospective research. However, compared to other databases, its coverage of current papers may be constrained [10].

to improve the quality of a narrative review by adopting systematic review methodologies that seek to reduce bias in selecting articles for review and by employing an effective bibliographic research strategy [5]. Accordingly, this study followed the general framework of narrative reviews proposed by Rossella Ferrari (2015) in conducting this study.

B. Information Sources

A rigorous and methodical strategy was used to find relevant papers from several electronic databases, including Scopus, Emerald Insight, IEEE Xplore, ScienceDirect, and JSTOR. The search approach used a combination of keywords

and controlled vocabulary terms that were customised for each database. A detailed description of the electronic databases used for the study is available in Table 1.

C. Eligibility Criteria

Studies published in peer-reviewed journals, conference proceedings, and dissertations between 2010 and 2023 were eligible for inclusion. Data extraction forms were developed and piloted to gather significant information, such as study characteristics, research aims, methods, and major findings. Furthermore, the findings were summarised and analysed using a narrative synthesis approach, with thematic analysis utilised to uncover emergent patterns throughout the selected research. The included studies' reliability was appraised using appropriate tools.

D. Search

A methodical approach was used in the search strategy for this literature review to find pertinent publications. Several electronic databases were searched using a mix of keywords associated with the subject of interest, including Scopus, Emerald Insight, IEEE Xplore, ScienceDirect, and JSTOR. Table 1 provides an assessment of above evidences resources. Boolean operators like "AND" and "OR" were utilised to expand the search phrases and widen the search's reach. Furthermore, a manual search of reference lists from identified publications and pertinent journals was also carried out to guarantee thorough coverage. The search was restricted to English publications between 2010 and 2023 to concentrate on the most recent and relevant literature. The search technique incorporated various viewpoints and thoughts on the topic while also ensuring the retrieval of high-quality scholarly sources. A total of 30 scholarly articles were utilised for the review. A detailed outline of the publication selection process is outlined in Figure I.

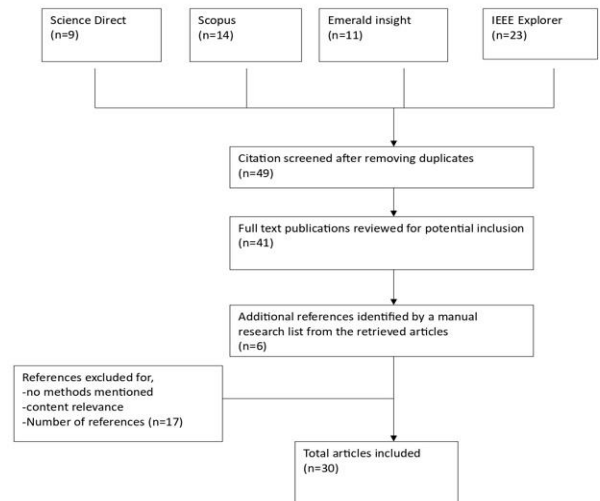


Figure I Flow chart of the literature selection process.

III. RESULTS AND DISCUSSION

PropTech's rapid growth has influenced the residential property industry, reforming how residential structures are constructed, delivered, and operated in the digital era. Smart building technologies offer numerous advantages, including energy conservation, enhanced safety and security measures, cost-effective maintenance methods, improved building comfort, increased productivity, and improved tenant

interaction. Despite that, there is insufficient adoption of Smart Building Technologies (SBTs) in developing regions. This is a challenging circumstance in the applicability of smart residential in such contexts, given the growing emphasis on energy efficiency and occupant comfort in buildings, which is fueling interest in smart building solutions in the construction industry [11]. Consequently, empirical research is required to acquire evidence that establishes the benefits of using SBTs for project execution to increase their utilisation in developing countries such as Sri Lanka. In the Sri Lankan context, promoting smart residential solutions is vital for achieving the growing demand for energy-efficient and appealing residences and using technology to improve the standard of living, sustainability, and resilience in the face of emerging urban challenges.

Fundamentally, smart infrastructure is defined as infrastructure that combines digital technology and a concept that

- (a) offers the values of self-monitoring and decision-making precision, efficiency and cost savings, reliability, safety, security, and perseverance, user interaction and self-empowering, long-term viability redundancy reduction, prompt reaction time, low environmental emissions, and quality of service.
- (b) functions on the principles of data acquiring, analysing data, continuous feedback upkeep, and adaptive structure.
- (c) performs at higher levels from semi-intelligent infrastructures and smart/semi smart infrastructure [1].

When considering the existing definitions, smart infrastructure refers to convenient living integrated with smart technical appliances and data analytics while enhancing the performance, sustainability and effectiveness of the infrastructure and the standard conditions of the occupants.

Smart residential solutions apply technology to improve and optimise different areas of residential living. Integrating Internet of Things (IoT) devices, sensors, automation systems, and data analytics to enable remote control, monitoring, and automation of various building functions is indicative of smart residential technologies. Smart home solutions generate more sustainable, efficient, and comfortable living environments that improve residents' quality of life while diminishing environmental impact and encouraging economic growth [12].

A. The Application of Technology in Real Estate Industry: An Overview of PropTech.

Real Estate 4.0, as it is developing and adapting to these rapid technological changes, necessitates that real estate professionals significantly enhance their knowledge of real estate as both a technology-driven and a people-driven industry. The future of the real estate industry's long-term prospects and sustainability will be primarily determined by how effectively it is perceived and actively integrates technological innovations to achieve a built environment which is more effective, economically viable, and secure [13].

PropTech is defined as the widespread application of emerging technology in the real estate sector. Virtual reality, Building Information Modelling (BIM), data analytics tools, artificial intelligence (AI), Internet of Things (IoT) and blockchain, smart contracts, real estate crowdfunding, financial technologies (FinTech) related to real estate, smart cities and regions, smart homes, and shared economy are a few

examples of this type of technology [14]. Each of these relatively novel innovations has the potential to increase productivity and competitiveness, increase energy and resource efficiency and effectiveness, and thus protect the environment while allowing developed and developing countries to achieve economic growth and sustainable development per the established Agenda for Sustainable Development [4].

The real estate industry needs to be able to switch technical tactics, embrace the opportunity for creativity, and adjust if it is to expand, succeed, and ultimately operate in this turbulent environment. Particularly in the aftermath of the COVID-19 epidemic, the industry must learn to experiment with developing and mature technologies and embrace flexible strategies that allow them to deal with uncertainty and overcome challenges to prosper. PropTech utilisation can be recognised as a prominent solution for the real estate sector to take turns and enhance the potential of constant development.

B. The Worldwide Dispersion of PropTech

As Figure II depicts, PropTech has a global presence, with start-ups located across different regions worldwide. Each dot on the map represents a PropTech company, and the size of the dot indicates the funding obtained by the respective firm. However, there are distinct clusters of PropTech activity in certain regions. The major hotspots for the PropTech industry include California and the US East Coast, Western Europe (mainly the UK), and metropolitan areas in Asia such as Delhi, Shanghai, Beijing, Seoul, and Singapore. In comparison, other regions around the world have less developed PropTech sectors [15].

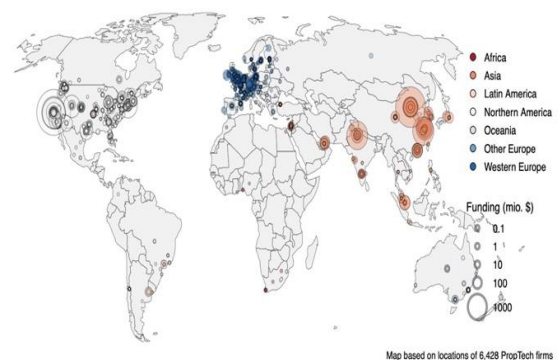


Figure II. The global dispersion of PropTech.
Source: [16]

The above factors clearly illustrate that PropTech is an emerging concept worldwide. Even though it has not been dispersed in every region, Figure II. The global dispersion of PropTech shows that some regions, predominantly Asian, Western European, and Northern American countries, have made significant progress with PropTech initiatives.

C. The Integration of Building Technology and Smart Infrastructure

Smart buildings, particularly in the context of COVID-19, provide several potentials for continually improving building performance. These advancements are critical for evaluating air quality, regulating building capacity to allow social distancing, and dealing with related issues. Initially, smart buildings were intended to save energy costs and incorporate sustainable technology, with the added benefit of improving

tenant experience by assuring air quality and safety. However, in light of the COVID-19 epidemic, building owners and employers are now primarily concerned with providing tenants with a safe environment. Buildings outfitted with technologies capable of properly responding to the pandemic's current and future difficulties are anticipated to provide substantial value to owners and occupants [13].

A digital twin combines Building Information Modelling (BIM) and smart building technology to provide a holistic overview of a building by combining numerous processes and occupant experiences. Building systems, enterprise, people, and physical assets are all interrelated levels in a digital twin. Subsystems, system integration, and two-way data flow, including automation, are all part of the building systems layer. The enterprise layer is concerned with operational and financial issues like data management, financial modelling, and strategic planning. The people layer considers occupant behaviour, productivity data, and overall occupant experience. BIM, operational data, life cycle management, and geolocation is all part of the physical asset layer. These concepts enable property owners to enhance asset performance, prolong the building's lifespan, and make informed investments in targeted improvement strategies. Additionally, smart buildings should be adaptable to connect with the outside world through emerging smart transportation initiatives, such as drones, autonomous vehicles, and related modes, despite the influence of COVID-19 and remote work trends [4].

Smart building has become an emerging requirement in recent years due to the COVID-19 pandemic. Due to the pandemic, a significant portion of the world's critical functions has undergone digitization. Consequently, various industries have embarked on the journey of incorporating digital technologies into their operations. As a result, the real estate sector has also embraced the PropTech movement, aiming to seamlessly integrate intelligent technologies within the industry. When referring to existing literature on smart building technology, it is evident that smart buildings have come to the spotlight since the pandemic.

D. The Emergence of the Smart Residential Sector

Presently, residential energy use accounts for approximately 30-40% of total global energy consumption. Residential loads are frequently important contributors to seasonal and daily peak demand. Residential consumption has been on the rise, increasing by 1% annually since 2000, driven by factors such as population growth, wealth, and the demand for more living space. This trend is particularly evident in developing economies, where per capita consumption is increasing alongside rising income levels. The electrical power demand is typically excessive in size and rapidly growing, especially in accommodating the peak time of energy use annually. Utility providers have always been compelled to improve their production capability to match the required demand to satisfy these infrequent peak needs. In general, 20% of power producing capacity is latently obtainable to fulfil peak requirements, which happens around 5% of the instances [17].

Environmental concerns have prompted new advances in construction technology to bridge the gap between the requirement for lower environmental consequences and ever-increasing comfort. These advancements were typically aimed at lowering energy use during operations. Sustainable development is defined as development that meets the

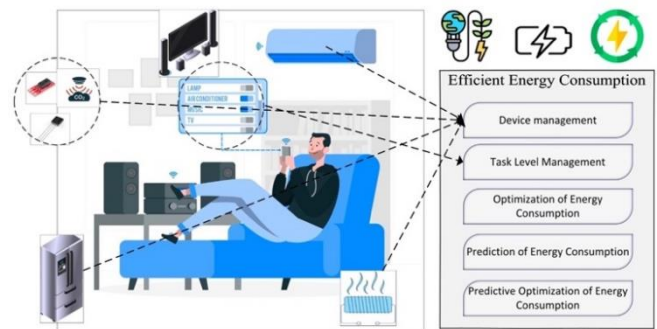


Figure III. Energy consumption mechanism in residential buildings

Source: [18]

requirements of the present without affecting future generations' ability to satisfy their own needs. While this initial step was required, a complete environmental life cycle study presents new problems. For example, the embodied energy of construction materials is now an essential component of the ecological footprint of a typical low thermal energy consumption building. Furthermore, the standard technique in life cycle analysis currently looks to require considerable adaptation due to changeable parameters in time to be successfully used in building analysis [19].

As depicted in Figure III, residential buildings occupy numerous energy consumption components and functions, but they can be optimized by implementing solutions to determine energy usage and improve energy efficiency. Sustainable Building Technology is a term frequently employed to describe the integration of four systems: a building automation system (BAS), a telecommunications system (TS), an office automation system (OAS), and a computer-aided facility management system (CAFMS). The most recent concept of building automation evaluates the building structure and technological systems as one cohesive unit and resolves disputes that frequently arise from the interaction of each separate process through integration. Home automation systems have remarkable effects on efficiency, waste reduction, accessibility, comfort, and safety, and every building is a node in a sharp network that can perceptively share data and information with the occupants and facilitators [20]. A user can remotely manage home appliances and equipment, allowing them to complete tasks in their absence within the house. Ambient intelligence technologies that monitor smart houses can occasionally optimise the household's electricity consumption. Smart homes use intelligent monitoring and access control to augment standard security and safety procedures [21].

Even though smart home systems offer multiple advantages, there are some challenges in the application, such as high system costs, inadequate object and installation management, and difficulties in providing flexibility [22]. According to the existing literature, the lack of information from the firms that constructed the electrical infrastructure hindered the process's functioning and quality. Users may experience long-term trust issues because of this event. Because of the interconnectedness, internet resources can be targeted anywhere, making cybersecurity a critical issue. Therefore, it is vital to examine elements such as the firms that install the system well, the technical dimension of the job, the commissioning procedure, and the project plan consistent with the client's requirements [12].

Despite the above-mentioned challenges, Smart residential solutions improve the quality of life by offering automated appliance control and assistance services. They enhance user comfort by utilising context awareness and predetermined limitations depending on home environment factors.

E. The Role of Internet of Things (IoT) Technology in Modern Smart Home Systems.

As citizens seek higher comfort levels and better-equipped dwellings, the demand for living space grows, contributing to further consumption growth. It is important to note that while per capita consumption in developing regions is increasing, the opposite trend can be observed in developed countries over the past decade. However, it should be highlighted that consumption figures in India are still only half of those in China and roughly one-fifth of those in the EU. In order to reduce energy consumption in residential buildings, it is imperative to establish global cooperation and implement effective policies. These efforts should aim to break the links between economic growth, urbanisation, and consumption while also addressing the rebound effect, where energy-saving measures may be offset by increased consumption in other areas [23]. Given these circumstances, developing regions have significantly considered promoting sustainable building practices rather than conventional constructions. Especially in the residential sector, considering economic, environmental, and social factors, developing economies are more likely to adopt smart home technologies.

The Internet of Things (IoT) has gotten much research attention recently. IoT is considered a future Internet component that will include billions of intelligent communicating “things.” The Internet of the future will be made up of inconsistently connected electronic devices that will further expand the world’s borders with physical entities and virtual components. The Internet of Things (IoT) will provide new capabilities for connected things [24]. The Internet of Things (IoT) is a system comprising various technical, dynamic, and innovative ideas ranging from computing to wireless sensors to nanotechnology. It is an Internet-based technological revolution that represents the future of businesses and people. The smart home automation system is an IoT-based concept that fosters collaboration in various engineering and science fields. With the growth of the concept of information and the advancement of technology, the architectural structure of smart home systems is constantly evolving. It is formed of a communication network that incorporates modern technologies to improve the living standards of occupants [12].

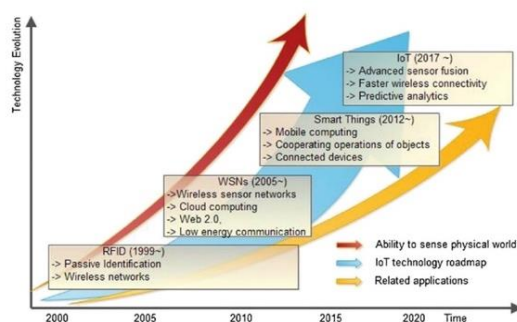


Figure IV The revolution of IoT
Source : [25]

To deliver better services to end users or applications, technological standards for IoT should be created regarding data exchange, processing, and communications within the network. The success of IoT is dependent on standardisation, which ensures global interoperability, compatibility, reliability, and efficacy of operations. IoT objects must be able to communicate and exchange data with one another independently. When multiple items can be easily and effectively merged. Both industrialised and developing countries have acknowledged the significance and promise of IoT and have established national policies for investigating IoT-enabling technologies. For example, the UK government has established a £5 million project on IoT technology and innovation and has financed various collaborative projects on fundamental research [24]. As shown in Figure IV, Over the years, the development of IoT has been aligned with human requirements, enabling individuals to explore emerging technologies that empower them.

IoT is one of the main components of smart home systems. IoT devices are often utilised even when smart building systems are not fully utilised. Especially in developing regions, many residential projects use IoT devices.

IoT devices can be utilised in various functions of a residential building. For example, home automation, intelligent energy management, home healthcare facilities, security and safety measures, etc. Recently, various inventions have been developed to implement IoT in residential buildings. A building can be remotely monitored and controlled by an intelligent IoT system. A cloud computing technology, an embedded web gateway, and an Android mobile application were developed and used to create this system. It is a smart control system based on IoT that monitors, controls, and manages the appliances in a home to maintain a safe and comfortable environment for its occupants. Intelligent energy platform based on IoT for appropriately managing and analysing energy data acquired from residential buildings, particularly large-sized structures. The platform was created to collect historical and real-time data for more accurate data analysis. A home care system based on an IoT platform has been developed to provide security and well-being for older persons. To analyse data and improve information transmission between IoT nodes, they created a three-level computational paradigm comprised of dew computing, fog computing, and cloud computing. An IoT system for houses that controls a health monitoring system using the Python programming language. The system collects tenant health data and remotely transfers it to a cloud layer (for storage and computing) as well as to health centres and their relevant guardians via email and message notifications. There is yet no comprehensive IoT-based framework unifying all components, technologies, and standards needed for IoT development.

Furthermore, new IoT-based technologies introduce additional concerns and challenges that might be added to those of existing technologies [26].

Even though IoT implementation in the residential sector has been improved throughout the years, there is still much potential for research and development. IoT development has a direct and a positive impact on service level of a building [Figure V] Smart buildings are innovative structures that employ intelligent automation in order to deliver efficient, convenient, and secure environments for their users. Building automation with the Internet of Things (IoT), as a prominent advanced technology, can provide innovative solutions for

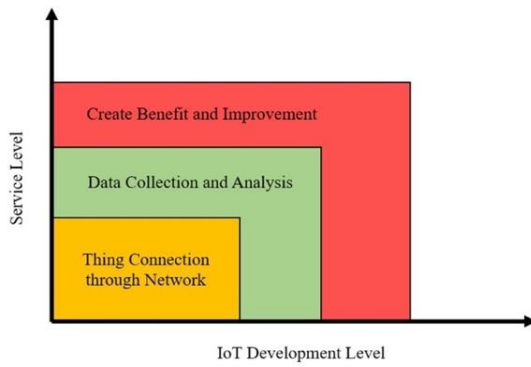


Figure V. Relationship between service and IoT development of a building
Source: [26]

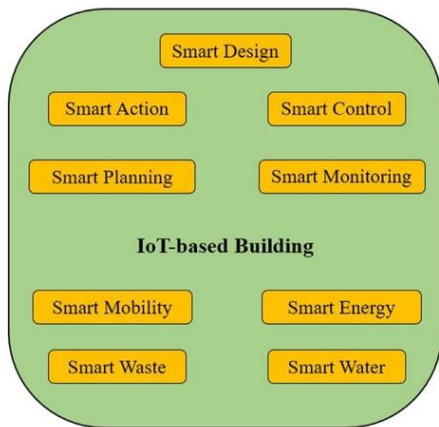


Figure VI. Key elements of an IoT-utilised building
Source: [26]

strengthening security and safety, offering remote control of appliances/systems, monitoring occupants, enhancing efficiency, and improving visual and thermal comfort. As shown in Figure VI, IoT has features such as linking disparate devices, managing and communicating information, tracking positions accurately, optimising energy usage, facilities management and protecting privacy and security, particularly using wireless communication technologies to ensure that every building function is smartly integrated.

F. A review on smart building construction practices in developing nations.

Between 2000 and 2011, there was a notable 14% increase in global energy demand within the residential sector, with developing countries accounting for most of this growth. The primary energy resources utilised in the residential sector include biomass and waste, electricity, natural gas, and oil products, collectively making up 90% of the total final consumption in 2011. The proportions of these energy resources used in the buildings sector have undergone changes, primarily influenced by factors such as the widespread adoption of electrical equipment and appliances, a shift away from coal and oil boilers for heating purposes in many developed countries, and a rise in the number of households in developing countries reliant on biomass as their primary energy source [27]. Given developing countries' present substantial energy use, it is critical to prioritise adopting smart

household technologies to improve energy efficiency and mitigate environmental concerns.

In the current context, the economic development of any nation is vitally dependent on several aspects, including economic growth, GDP, employment rate, industrial development, defence development, etc. Among these aspects, the development of smart building techniques has emerged as a critical factor in the development of a nation's economy as well as the living conditions of its residents. Smart building technologies are well-equipped with advanced resources and technology to improve people's living standards. Smart development is easier in developed nations since they have advanced technology, powerful resources, and excellent city-planning techniques. When contrasted to emerging countries, the situation changes considerably. The developing countries have made prior financial commitments to accomplish the fundamental requirements. In such instances, developing nations struggle to participate in smart building development projects. Developing countries attempt to follow developed economies' sustainable smart building development programs for greater efficacy. However, developed and developing countries cannot share a similar condition for settlement. As a result, developing countries must acknowledge the need for a framework that will assist them in effectively developing and utilising smart construction techniques and exploit the extreme potential of the implication of sustainable and smart business practices [28]. Therefore, researchers, marketers, and policymakers have shown great interest in implementing technologies that encourage sustainable behaviours within the residential sector, particularly in developing regions. A diverse range of smart home products, including thermostats, plugs, lights, switches, and appliances, offer energy-saving features. These products allow users to monitor and manage their resource consumption, such as energy and water, enabling efficient resource management within the home remotely or automatically. As a result, users can reduce the environmental impact of their resource usage at home. In support of this concept, argue for the existence of smart homes can largely contribute to the residential construction industry in such contexts. Smart thermostats, for instance, exemplify sustainable household technology, enabling users to control, monitor, and analyse their energy usage in relation to their heating and/or air conditioning systems [29].

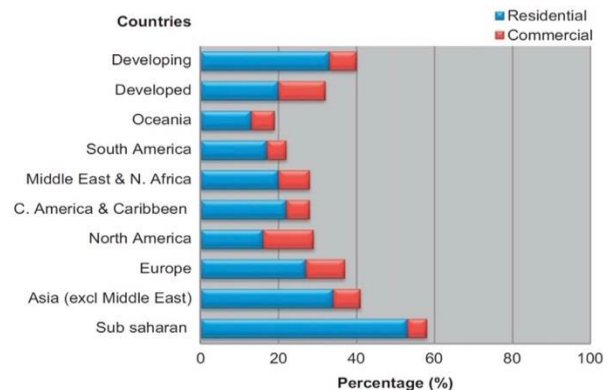


Figure VII. Energy consumption in the building sector
Source: [27]

The residential sector holds significant potential for improving energy efficiency, as it accounts for three-quarters

of total energy consumption in the building sector. Figure VII illustrates the varying percentage of total consumption attributed to residential usage in different regions of the world, ranging from an average of 20% in developed countries to over 35% in developing countries. Residential energy demand is both substantial in its current state and has the potential for further growth. Furthermore, buildings contribute to one-third of global energy-related greenhouse gas (GHG) emissions. Among GHG emissions, carbon dioxide (CO₂) is considered the primary gas responsible for climate change and is estimated to account for approximately three-quarters of global emissions. Therefore, this paper focuses specifically on CO₂ emissions. Given these factors, the residential sector is crucial in reducing global CO₂ emissions related to energy consumption [27]. Therefore, it is also vital to implement smart building practices in residential constructions in a developing context.

The number of newly constructed buildings is growing rapidly in developing nations, and energy pricing and markets frequently do not encourage the use of efficient technologies to improve building performance. As a result, building stock in developing countries is rapidly expanding, putting strain on electricity and other energy sources and influencing building performance [11].

The favourable outcomes of implementing smart buildings in the construction industry for both developed and developing countries are now bringing smart buildings into the limelight. As a result, the built environment's commodities are designed in the most practical methods toward efficient energy usage, raw material recycling, and realising a sustainable and carbon-free environment, which has proven the application of technology in the building sector [20]

There are numerous impediments and challenges for developing countries to overcome to achieve sustainable construction. For instance, the Ghana construction industry indicated the high cost of smart, sustainable materials and equipment, technical challenges during construction processes or a lack of technical knowledge regarding smart technologies and procedures, and unwillingness to move from conventional practices. The lack of regulations for adopting the concept of a smart building, a lack of finances and financial incentives for adopting SBT, and issues with the availability of skilled and specialised employment in smart building concepts, devices, and solutions have all been identified [11]

When considering developed countries, it is observed that achieving a smart home typically requires significant financial investment. This allows for the incorporation of numerous sensors and detectors within the home. However, despite having abundant renewable resources in developing regions like Africa, it becomes necessary to devise a new approach that simplifies the construction of "smart homes." In order to accomplish this, it is crucial to ensure widespread access to the fundamental energy required to power the various components and devices utilised in creating a smart building. It is worth noting that the greater the number and variety of components employed, the more extensive the house's capabilities, transforming it into smart. Consequently, utilising natural resources, particularly solar energy, plays a pivotal role in developing and constructing smart buildings in developing countries. It simply necessitates adapting this resource to existing technologies such as information and communication. There has been a decrease in solar energy production, which is an unfavourable factor for promoting the advancement of

smart building technology. Nonetheless, as the demand for automation components in buildings increases, the production costs decrease, reducing market prices of materials [30].

Implementing smart building technology in construction practice addresses the need to modify the built environment, particularly in developing countries. Implementing smart buildings improves professionals' practices in the built environment while also changing professionals' mindsets toward advancing technology in the construction industry. Professionals require new techniques and understanding to promote the adoption of SBT in the construction industry, particularly with the increasing concern about energy efficiency and occupant comfort in the building as the construction industry's attention shifts to smart building adoption [31].

It is a vital requirement for developing countries to take prompt and realistic solutions to implement smart building techniques in constructional practices rather than conventional practices to achieve the utmost potential of the real estate industry. Also, they should encourage and support existing and ongoing smart real estate projects. This will ultimately contribute to the development of key drivers of the overall development of these contexts, such as economic, social, and environmental.

G. Adaptability of PropTech and smart residential solutions in the Sri Lankan context

The concept of smart homes and research based on it is not particularly novel in Western countries. However, in South Asia, both usage and practice are not widely accepted [22]. Lasika has emphasised the importance of adapting technological, social and sustainability concerns in real estate development in Sri Lanka [32]. However, the existing literature reveals that a complete smart home automation system based on current technologies has yet to be established in Sri Lanka.

The Sri Lankan real estate business has drawn considerable attention over the past few years due to certain economic activities in metropolitan regions that have created a lot of prospects for significant market participants. Recent statistics on the real estate industry show that rising population growth, rapid urbanisation, and increased housing demand contribute considerably to the demand shift in the Sri Lankan real estate sector [33].

Statistical data on construction, construction outputs, and the construction sector's contribution to the Sri Lankan economy's gross domestic product (GDP), as well as additional measurements that characterise the construction industry, economic progress, and changes, describe the positive correlation between real estate development and economic growth of Sri Lanka [34]. Economic development directly and indirectly stimulates with construction and infrastructure-related improvements in the long run.

Therefore, it is imperative to familiarise modern global trends in Sri Lankan construction practices and enrich the residential sector in general with expertise in the industry. Including novel concepts such as PropTech and smart building techniques can greatly benefit the industry and country. Also, the Sri Lankan residential sector is presently experiencing an emerging demand for smart techniques, and potential occupants are more likely to consider convenience and comfort significantly. Hence, smart residential can be the ideal

solution to implement in residential building construction practices.

As the CEO of Prime Lands, Mr Ruminda Randeniya, stated in one of his interviews that, in the present state of the real estate market, developers must have a clear and distinct vision for their projects. With the ongoing national economic crisis, it becomes even more vital to explore strategies that guarantee a positive future. The aim should be to employ innovative construction technology that reduces environmental impact and facilitates sustainable property development. Additionally, to harness the power of digital technology to introduce fresh and unique ideas, like ‘Prime Hot Deals’—a groundbreaking e-commerce platform for online property transactions. Furthermore, the industry must be open to testing the implementation of artificial intelligence (AI) in forthcoming developments [35]. Following this statement, the importance of having a well-defined vision and a focus on sustainable and environmentally friendly approaches can be emphasised, particularly the residential sector’s desire to incorporate digital technology and explore the potential of smart technology in the real estate sector.

When considering the practical implications of smart homes and smart building technologies in the Sri Lankan context, TRI-ZEN is one of the pioneering smart residential projects. TRI-ZEN, an exceptional investment opportunity in the thriving capital of Sri Lanka, has been precisely designed to meet the needs of the future while effortlessly merging current technology and contemporary lifestyles. This profitable project promises a smarter living area that has been meticulously built to combine sophisticated technologies. TRI-ZEN, with its great location in the city’s centre, provides residents with an address that represents the future. The intelligently built living spaces have efficient layouts, and the entertainment deck has various recreational options. Furthermore, TRI-ZEN is conveniently located near major corporate locations, educational institutions, healthcare facilities, financial institutions, shopping complexes, and entertainment venues, providing a convenient and enriching lifestyle [36]. TRI-ZEN provides smart living spaces that integrate modern living with contemporary design, pioneering the concept of a connected smart home in Sri Lanka [37].

TRI-ZEN smart residential project by John Keells Properties combines smart technologies to provide occupants with an unprecedented modern and connected living experience. Every component of the development has been precisely designed to include modern automation and networking features. TRI-ZEN embraces the concept of a completely smart living space, from smart home systems that allow occupants to control lighting, temperature, and security through their smartphones to high-speed internet connectivity and integrated smart meters for efficient energy management. Residents can benefit from the convenience of a technologically integrated lifestyle in which daily tasks are simplified and tailored experiences are enhanced [2]. This project establishes a new benchmark for contemporary living by incorporating smart technologies, offering inhabitants a future-ready environment that improves comfort, convenience, and sustainability.

Adapting smart residential practices is of the utmost importance in Sri Lanka’s goal of sustainable development and enhanced quality of life. As cities grow and so does the population, adopting smart technologies becomes increasingly important for efficient resource management, improved

connection, and higher overall living standards [34]. Smart home solutions can optimise energy use through intelligent monitoring and control systems, lowering load on the national grid and improving energy efficiency. Furthermore, incorporating smart home technologies allows inhabitants to manage their living spaces more efficiently, increasing comfort, security, and convenience. Sri Lanka may develop a more sustainable and technologically sophisticated society by embracing smart residential approaches, contributing to economic growth, environmental conservation, and improved well-being for its citizens.

IV. CONCLUSIONS

This study, by reviewing existing studies in the domain of property technology, provides valuable insights into the untapped potential of property technology in transforming residential real estate development in developing nations such as Sri Lanka. Due to certain drawbacks, developing nations are reluctant to elevate their conventional building practices to smart practices. The study emphasises the potential benefits of PropTech in improving operational efficiency, customer experience, and long-term growth in Sri Lanka’s residential market. PropTech-enabled smart home developments provide benefits such as automation, energy efficiency, security, and higher property prices. The study underlines the importance of a supportive ecosystem that fosters collaboration, investment, and innovation, as well as safeguarding data privacy and security in undertaking such endeavours. Embracing PropTech and smart residential solutions significantly benefits Sri Lanka in terms of sustainable development, economic prosperity, and increased quality of life. Sri Lanka could emerge as an active participant in this digital revolution by tackling obstacles and utilising technology, attracting investments, providing job opportunities, and stimulating innovation in the residential real estate sector.

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