



A Review of Sustainable Development Practices in Malaysia's Real Estate Sector

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Abstract

This study highlights the issues encountered by the real estate sector in Malaysia when it comes to the implementation of the sustainability development strategies for achieving Net Zero Carbon emissions by 2050. The emphasis is primarily laid on ESG compliance, green building certifications, and stakeholder engagement. In order to understand the extent to which sustainable development principles have been applied in real estate as a tool not only for supporting environmental conservation but also for achieving urban sustainability goals, the paper has utilized the most advanced sustainability frameworks, namely Corporate Social Responsibility (CSR), the Triple Bottom Line (TBL), and Sustainable Strategic Management (SSM). The study identifies profit-driven development models, the absence of regulations, and lack of engagement of end-users as the major barriers for greening the real estate sector in Malaysia. The paper deliberates the significance of Environmental, Social, and Governance (ESG) compliance as a factor that facilitates sustainable urban development and thereby illustrates that ESG compliance results in environmental resilience, social responsibility, and governance transparency in real estate planning and investment. Besides, the study pledges to green the role of green financial instruments and policies in making sustainability transitions easy in emerging markets. The issue of end-user engagement and market behaviour, which comprises public understanding and changes in attitude and behaviour that lead to the demand for sustainable housing, is also discussed by the research. Furthermore, the study talks about how Malaysia implements global sustainability standards and the effects thereof on policies and industry practices.

Keywords: Net zero carbon emission; ESG compliance; green building design; end-user; Urbanisation

1. Introduction

The Malaysian real estate industry's transition to net-zero carbon emissions is a major hurdle that requires a diversified strategy comprising ESG compliance, environmentally-friendly practices, as well as the engagement of end-users. This report examines the problems and the sustainable development frameworks, and determines how factors like green building design, ESG framework implementation, end-user engagement, and profitability versus sustainability strategies can contribute to the net-zero carbon emissions goal by 2050. By revealing gaps in policy enforcement, industry practices, and consumer behaviour, this report provides the Malaysian real estate sector with the insights that can be converted into actions, as a response

to the urgent need for sustainable development due to the sector's significant carbon emissions and resource consumption.

Despite that, global frameworks such as the Brundtland Report and ESG standards set a foundation for sustainability, the execution of these frameworks in Malaysia is challenged by sizable economic, regulatory, and behavioural roadblocks. The review takes a critical look at these obstacles in implementing the frameworks and lays down a roadmap for the real estate sector to integrate ESG principles, with the end-users being the most engaged and active participants. Currently, Malaysia continues to face issues related to sustainable development, primarily as a result of policy inconsistencies, lack of finances, and limited knowledge of the developers and end-users, as well as the slow implementation process. It is essential for Malaysia to devise solutions to these problems that not only address the issues but also make rapid urban growth environmentally and socially sustainable.

This research considers various sustainability frameworks from both global and local perspectives, recognises major obstacles, and plans out the actionable recommendations that can facilitate the bridging of the gap between global sustainability objectives and the Malaysian real estate sector. The review tries to understand these problems systematically by going through a sequence of topics: it first deals with the key sustainability frameworks applicable to the real estate industry, such as CSR, TBL, and SSM.

After that, the review identifies weak points in regulatory enforcement, disincentives in the economy, and very few participants who really care. At the end of the day, we talk about how government policies and measures can heighten ESG regulation, refresh the building industry, and create a new flow of users who are engaged in carbon-free initiatives to a larger extent.

Sustainable development is not only essential in the case of the real estate industry, but it is also a must in most of the sectors and activities that have a significant impact on the environment and society (Gerasimova, 2017). As defined in the Brundtland report, "sustainable development" is all about not jeopardising future generations' ability to meet their needs while satisfactorily meeting the needs of the present ones. It achieves this by tackling critical problems such as global warming, depletion of natural resources, and social inequality (World Commission on Environment and Development, 1987). In 2022, the global fossil CO₂ emissions were up by 1.15% compared to the previous year, totalling 38.52 billion tons. This indicates that the problem of climate change is still hard to resolve. Within this global framework, Malaysia's CO₂ emissions went up by 6.5%, from 260.59 million tons in 2021 to 277.53 million tons in 2022. Also, the per capita emissions went up by 5.2% from 7.60 tons to 8.10 tons (WMO, 2024). These numbers shed light on the necessity for Malaysians to live a sustainable life since the material sector is the main culprit of the emission of greenhouse gas via high energy consumption and resource use.

The energy transition to the uptake of the real estate sector in Malaysia is not just a global trend but also a necessity due to the high energy and resource consumption-intensive nature of the sector. The goal of net-zero carbon emissions should be realized through a holistic approach that involves morally ethical practice, stakeholder engagement, and resource sharing and management (World Commission on Environment and Development, 1987).

Data on recent worldwide emissions present the trend for country-specific CO₂ emissions, in this case, Malaysia, and as such, localised and sustainable solutions are the only answer to the problem, and they cannot wait any longer (WMO, 2024). The foregoing is a perfect setup for making room for the discussion of CSR, TBL, and SSM as frameworks that provide feasible and practical strategies to overcome the challenges of sustainability while being conformant with the ESG standards. The passage gives the reasons behind the necessity of shaping of the differing economic, environmental, and social sustainability challenges of Malaysia. It also

prepares the reader to delve into the local barriers to sustainability and real estate practices in Malaysia and how they can be aligned with the global benchmarks.

2. Literature Review

2.1 Frameworks and Strategies for Sustainable Development

After the Brundtland Report (World Commission on Environment and Development, 1987) was released, various frameworks such as CSR, TBL, and SSM were created to structure industries like real estate that can economically progress and, at the same time, be environmentally responsible. These structures play an important role in achieving zero-carbon goals (Gerasimova, 2017). The diagram highlights the interconnections of concepts and their significance to the Brundtland Report.

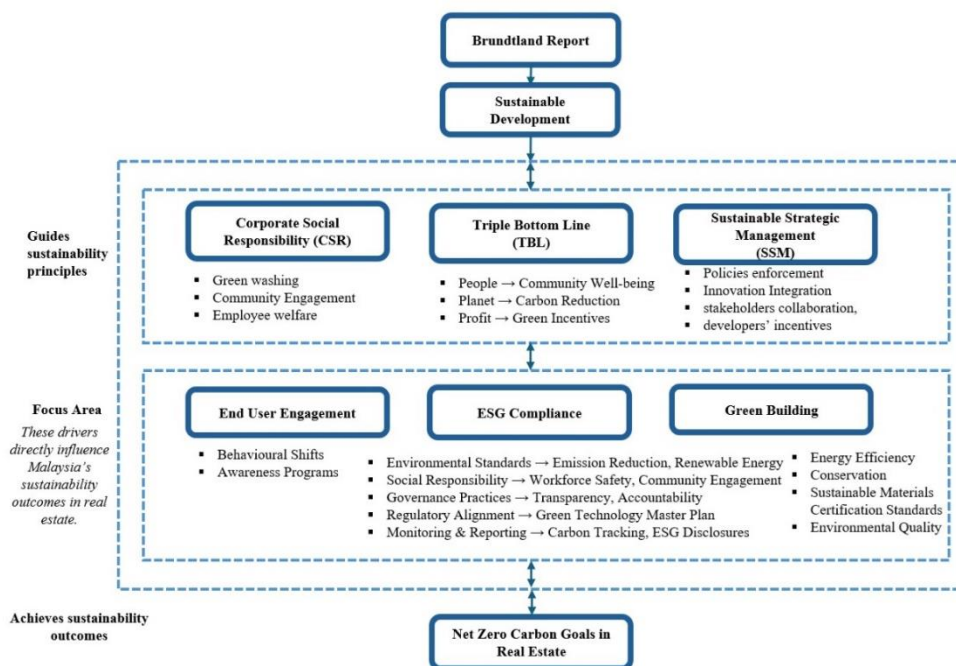


Figure 1. The relationship between the Brundtland Report and various sustainability frameworks highlights interconnected strategies for achieving net-zero carbon in real estate.

Source: (Authors analysis, adapted from Carroll (1991) and Brundtland Report (World Commission on Environment and Development, 1987))

The frameworks lay down the base for experiments with the hypotheses and the assessment of the strategies used in the achievement of the sustainability goals in the real estate sector in Malaysia. They show how essential it is to merge worldwide principles with localized changes so as to meet the particular socioeconomic and regulatory obstacles.

2.2 Global vs. Local Sustainability: Implications for Malaysia

The global rise in sustainability frameworks and practices is, to a large extent, a reaction to the very visible consequences of climate change, the depletion of resources, and social inequalities. The Brundtland Report, TBL, and LEED green building certification each represent a step towards standardizing sustainable practices globally. Yet, it is their implementation at the grassroots level that must be informed by the socio-economic and ecological realities of the local community.

UN-Habitat (2023) reported that the city population rate in Malaysia was approximately 77% in 2022. Thus, Malaysia is on a trajectory that leads to sustainable real estate development issues and the advantages. The rapid urbanization not only intensifies energy consumption but also, according to Kanasan and Hassan (2022) and Javan et al. (2024), creates a vicious circle of resource consumption, waste production, and environmental degradation. In the storyline of Malaysia's sustainability, urbanization, and real estate development are the characters that have both positive and negative sides. More specifically, the real estate development in the growing urban areas, together with the rapidly rising population and urbanisation rates, creates problems which demand immediate solutions.

Malaysia has gone through major urbanisation over the last few decades and its population has grown from 27% in 1970 to more than 77% in 2020. In spite of the tremendous speed of urbanisation, Malaysia is still fighting against the problems, mostly increased energy demand and higher CO₂ emissions (Bekhet & Othman, 2017). Research works have indicated that inadequate urban development will continue to adversely impact the environment (Bekhet & Othman, 2017). The connection between urbanisation and the rise of CO₂ emissions in Johor, Malaysia, is quite shocking.

Massive real estate projects, such as Forest City, are usually promoted as the great sources of development that bring in the money but create other kinds of problems, in this case, the environment. These types of developments almost always result in deforestation, destruction of ecosystems, and increased carbon emissions (Javan et al., 2024). This type of environmental degradation is the consequence of insufficient integration of environmental assessments over a long time. The study conveys how the proliferation of real estate has a negative effect on the area's local biodiversity and hence how crucial it is to consider nature conservation when constructing new cities. The changing face of cities has led to the transformation of the nature of the earth into human dwellings, thus the destruction of the natural world and the loss of biodiversity. The rapid urban development of Malaysia has not only changed the land use patterns but it has also disrupted the ecological networks and caused the country to face various environmental problems (Ma et al., 2024). Hence, it is extremely important to include the urban development frames that take into consideration not only the needs of the human society but also the requirements of the biodiversity. Subsequently, a well-adjusted approach that Malaysia is going to take to reconcile economic growth with environmental protection will be consequential in solving the problem. The paths Malaysia will choose for sustainable development need to incorporate socio-economic development and at the same time take care of natural resources.

As an emerging nation, Malaysia is required to face up to the consequences brought by socio-economic development and the real estate sector on the environment. A few real estate developers may find it challenging to use eco-friendly building techniques or opt for certified green materials because they think the initial cost is higher (Isa et al., 2019). There are a number of initiatives by the government as well, such as tax exemptions offered to green-certified projects and subsidies granted to the use of renewable energy, which aim at filling in this financial gap. In short, these few measures are far from enough and thus have to be extended and made known more widely among developers if they are to be effective.

Nevertheless, economic growth is still on the top of the agenda Malaysia has set for itself. This is the price, however, which is paid for it, as the environment and social side of things are neglected most of the time. Thus, such problems as the ones mentioned appear in the real estate and construction industries, where the motive for profit is the main driver and sustainable development considerations are often ignored. The focus given to urbanisation at a rapid pace and increasing the infrastructure network is a factor that encourages the exploitation of resources in an unsustainable manner, among which deforestation and the rise of carbon dioxide

levels are major contributors. Taking the lead of traditional approaches that are less costly in nature, most of the real estate developers end up with options for kinds of buildings without green technologies and materials, and therefore more harmful to the environment. This motivated economic thinking is not only undermining the environment and the ecological balance of Malaysia, but also it will make it extremely difficult for the country to achieve its target of reducing net-zero carbon emissions to almost zero (Mokthsim et al., 2014).

Among the main reasons for the environment to be exposed to destruction and also for the climate to change, the construction sector is highly responsible for almost 39% of the CO₂ emissions worldwide, at the same time as buildings are big energy consumers. The reasons for unenthusiastic implementation of green building technologies in Malaysia are mostly attributed to the assumption of high possible upfront costs and the unawareness of sustainable building practices (Md Yusoff et al. 2023). Besides that, urbanization has affected the environment directly by cutting down forests and eliminating the habitats of different species. The researches reveal a situation related to facility construction called the "lock-in effect" which brings about irreversible harm to the environment, for instance, an increase in air pollution and emission of greenhouse gases (Shaharuddin et al., 2014). Facing these obstacles, Malaysia needs to follow the ESG standards and turn the real estate and construction industries into the sources of sustainable economic growth, thereby achieving industry long-term resilience and environmental stewardship (Yee, 2022).

Malaysia will have a real estate sector that is both environmentally friendly and financially viable through ESG-focused real estate development. Malaysia, a developing and economically growing country, is committed to its net-zero carbon target. The achievement of this goal will need a well-balanced plan that concentrates on sustainable development throughout the building lifecycle to reduce the environmental impact.

In order to encourage sustainability, Malaysia has enacted the National Low Carbon Cities Framework (LCCF) and created programmes such as the Green Building Initiative (GBI) and the GreenRE certification. All these initiatives are directed towards carbon footprint reduction and energy efficiency enhancement. The inconsistent compliance and sporadic acceptance, however, are the main reasons for very little overall potential of these initiatives. Regulatory compliance and the incorporation of sustainability into urban development frameworks are the main concerns. From cultural and social behaviour perspectives, there are also challenges in implementing sustainable practices. Engaging more people through policies and frameworks that open up opportunities and provide mechanisms for public involvement and participation in the sustainability agenda is essential. The main challenges in Malaysia to achieve sustainability in the real estate sector are mainly due to the inconsistency of the sustainable development initiatives and the inefficiency of policy implementation.

Alongside the Green Technology Master Plan (GTMP), the Eleventh Malaysia Plan (2016-2020) is committed to promoting green technology in a wide range of industries. Specifically, the Eleventh Malaysia Plan emphasises and ranks 'Green Growth' as one of the pillars to be incorporated into various sectors such as real estate, energy, and transportation (Economic Planning Unit, Malaysia, n.d.). It demonstrates the country's continuous commitment to environmental sustainability (Ministry of Energy, Green Technology and Water, 2017). The evidence of the nation's dedication to these papers is there, but the actual enforcement of policies in these papers is quite weak most of the time due to the absence of the integration of implementation strategies. The issue of green policy evaluation has become extremely difficult because it requires constant regulatory oversight, and the implementation should be in sync. The governance system that is decentralised, however, makes it difficult to be cohesive across regions and states, thereby affecting the levels of commitment to green initiatives, the shortage of resources, and the lack of political will (Economic Planning Unit, Malaysia, n.d.). The

unsynchronised progress, therefore, has caused the fragmentation of national sustainability goals, giving rise to the country not being able to take full advantage of the potential that it has.

Regulations consistent with development and enforcement require policymakers to set up efficient communication channels between ministries and their departments. This process will lead to less wastage of time and more emphasis on the targets set in the Eleventh Malaysia Plan and GTMP (Ministry of Energy, Green Technology and Water, 2017). Indicators of integrated policy enforcement will enable the government to keep track of its sustainability goals and, therefore, its agenda.

Mokthsim et al., (2014) argue that if there are no strong enforcement mechanisms, in fact, only well-thought policies will fail to achieve their goals. Moreover, the continuous variations in political attention and leadership have brought about a lack of continuity and the deepening of the slow integration of sustainability into the development agenda of Malaysia. After the 2018 Malaysian general election, in which the Pakatan Harapan coalition triumphed over the Barisan Nasional government, which had been running the country for a long time, there were three different prime ministers in three years, and thus political instability followed. Therefore, such instability prevented the implementation of efficient policies that were supported by the temporary government's focus on 'long-term' consolidation of political power (Hunter, 2021). It is a case of the political focus being temporarily embedded and not sustained. Besides, the changes in political power have negatively affected economic growth and the inflow of foreign direct investment. The failure to maintain political focus through the implementation of coherent policies creates uncertainty that acts as a deterrent to investment (Nazeer & Masih, 2017). The nonexistence of coherent policies has inevitably weakened the enforcement of the focus on sustainable development.

2.3 Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions are one of the main causes of global warming and need to be addressed by the real estate industry, which has a high impact globally. In Malaysia, a country where the real estate sector is a major contributor of CO₂ emissions, the implementation of sustainable development practices that are consistent with ESG frameworks is a prerequisite for the realization of net-zero carbon objectives.

Among the major GHGs—CO₂, CH₄, and N₂O—CO₂ is the one most directly related to the burning of fossil fuels and land use changes. Though methane and nitrous oxide are more powerful GHGs, CO₂ is still the most significant target for climate change mitigation efforts (Ritchie et al., n.d.).

Urbanisation and real estate development in Malaysia have been affecting the environment adversely in various ways, such as causing GHG emissions, deforestation on a large scale, and loss of biodiversity. The unregulated development that is taking place in Malaysia is draining the country's natural wealth, and as a result, we are facing serious problems such as water pollution, soil erosion, and overexploitation of other natural resources. One of the ways urbanisation projects cause carbon emissions is through forest clearing since it cuts down on the carbon stock of forests, thus generating carbon emissions; such emissions put a brake on Malaysia's commitments to the Paris Agreement GHG reduction (Law, 2022).

Urban development in the real estate industry is also responsible for climate change. Hot urban areas such as Kuala Lumpur and Putrajaya suffer from the Urban Heat Island (UHI) effect as a result of the Urban Water Management in urban development. The UHI effect takes place when the heat-absorbing and heat-releasing surfaces of rural areas, which in this case are replaced by urban surfaces like concrete and asphalt, are removed as the rural areas still keep the vegetation and are cooled through evaporation (Shaharuddin et al. , 2014).

Mangrove swamps are among the most important ecosystems in suburban areas. Penang, Malaysia, has revealed that urban planning around mangrove swamps has led to the thinning of the mangrove forest in the inner parts, which has the effect of killing the fauna and flora that were formerly in the forest. It is very important to keep and develop the plants that are functioning in these areas if we want to maintain the biome's balance and be able to offer vital ecosystem services to the urban areas. Urban planning should incorporate the use of more environmentally sustainable solutions, including green policies, to lessen the negative impacts of urban real estate development.

The cutting of CO₂ emissions by Malaysia's real estate sector through the use of renewable energy, energy-efficient measures in buildings, and reduction of emissions from day-to-day operations is only half the story of the challenge. There is a significant gap in the failure to fully account for indirect emissions such as methane and nitrous oxide. The adoption of more eco-friendly construction materials, coupled with better waste diversion and disposal practices, will help close the gap. The GWP* metric facilitates impact reporting; thus, developers can easily identify loopholes in their reports and use the progress against global standards and global sustainability reporting to fill them up. In Malaysia, real estate developers who comply with ESG standards can take advantage of this to close the emissions gap in real estate and contribute towards achieving the global sustainability targets.

Reduction in emissions and setting targets for carbon and methane are in harmony with ESG systems, which offer a framework for the measurement and management of emissions coming from operations, supply chains, and waste. Therefore, the ESG framework is a strategic investment tool to help in the reduction of CO₂ emissions during the operations phase. The increasing body of research that points to operational CO₂ emissions as the major challenge in the sector implies that there is a need to put more focus on ESG and systems to limit emissions.

The real estate sector in Malaysia is fraught with challenges due to the profit-driven nature of the industry, the absence of ESG principal integration, and the low awareness of end-users regarding sustainable practices. As a result, it is necessary to pinpoint and alter the standard practices that can lead to a more optimal cost evaluation balance. If primary and secondary green building designs, together with the involvement of the end-users, are integrated into the proposed ESG designs, new value opportunities can be unlocked. Removing the barriers to the incorporation of ESG and limiting the advanced GHG indicators, especially GWP*, to closed systems will help in achieving this goal. This study intends to fill the gaps that hinder balancing the profit-driven paradigm and thus aim to elevate the real estate development paradigm in Malaysia to a level that is more committed to achieving net-zero carbon status.

2.4 CSR

Real estate that respects the environment could be made possible by using ESG frameworks. ESG principles are helpful to developers to limit the ecological impact of their activities, attract and retain diverse and inclusive workforce, and improve governance structures. Although Singapore is the leader in terms of sustainability in the region with compulsory Green Mark certification, the real estate sector of Malaysia has faced the risk of ESG adoption due to non-mandatory reporting and stakeholder engagement. Eliminating these gaps will contribute to greater compliance with ESG and the embedding of the latter at every stage of the building lifecycle.

At the core of CSR is the concept of balancing profit and solving social and environmental problems. For Malaysia's real estate sector, the long-term benefits of CSR could be realized by the industry through adopting the most appropriate sustainability initiatives, such as net-zero carbon emissions and engaging stakeholders. The commitment requires the implementation of

energy-efficient and well-designed spaces, responsible resource consumption, and participation in social activities (Arowoshegbe et al., 2016).

As a matter of fact, CSR is a responsible practice of companies to address societal and environmental problems beyond making a profit. Thus, real estate firms in Malaysia should take steps to popularize CSR among them and subsequently transform it into a set of activities consistent with sustainability goals. They can become the first to set an example of a zero-carbon emission future and, thus, gain the trust of stakeholders while serving as a vehicle for the societal well-being of the community in the long term.

As a movement and business strategy, CSR recognizes the impact of corporate activities on society, stakeholders, and the environment and, hence, supports sustainable development. It comprises various areas such as human rights, corporate governance, health and safety, environmental impact, working conditions, and the contribution to economic growth through the provision of mutual benefits to businesses and their communities. The target is to enable the transition to sustainability by adequately balancing these aspects.

Carroll's Pyramid of CSR (1979, revised 1991) is a model that depicts different levels of CSR in an organization (Norman & MacDonald, 2004):

1. Economic – maintaining necessary profit and economic viability
2. Legal – adherence to laws and regulations
3. Ethical – being morally responsible and maintaining fair business practices
4. Philanthropic – contributions that are made freely to improve society

Based on these ideologies, the real estate companies of Malaysia can use the CSR principles in their business operations to reflect the anticipated levels of practice integration with the sustainability goals. Corporations in the country will need to go through various changes and face challenges on their way to achieving net-zero carbon goals. A few examples of these changes are promoting stakeholder participation, reducing carbon footprints, and facilitating the country's transition to a net-zero carbon economy. CSR in the context of sustainability is, on the one hand, a strategy that guides environmental real estate corporate activities and, on the other hand, balances economic viability to lead the way to the goals outlined.

Real Estate firms can use Carroll's Pyramid of CSR (Carroll, 1991), along with other more advanced CSR models, as organised frameworks to strategically integrate responsible practice in their operations. These frameworks provide the real estate sector in Malaysia with the necessary tools to overcome the obstacles to sustainability and make a real shift towards responsible development in terms of environmental sustainability.

Despite developments worldwide, the real estate sector in Malaysia is still affected by the outcomes of profit-driven mentalities, weak deployment of ESG frameworks, and low levels of awareness among end-users, which are major hurdles for the sustainability of business initiatives. By building net-zero carbon buildings and involving the end-users in GHG-reducing activities, the goal of net-zero designed buildings can be achieved. This research is focused on providing the right guidance to decision-makers and stakeholders in the real estate industry in Malaysia for them to effectively tackle the challenges of ESG integration and align the core business operations with the advanced GHG sustainability metrics, keeping in view the aspect of profit and sustainability.

2.5 TBL

The TBL layout associates business prosperity with three new dimensions of social (people), economic (profit), and environmental (planet). The TBL framework in the real estate sector in Malaysia is mainly concerned with ensuring that the economic returns from the business do not

come at the expense of the social and environmental costs, as that is in line with the economic objective of sustainably profiting the business in the long run. All three dimensions of social (people), economic (profit), and environmental (planet) are balanced by the TBL framework through the integration of green building designs, energy use reduction, and responsible waste management to fulfil the environmental dimension, while fair labour practices and responsible community relations to the social dimension.

The TBL model, which was first brought up by Elkington in 1997, is an attempt to expand the environmental aspects of a business to include economic and social aspects of business activities. From the economic side, the focus is on the value an organisation creates and how it can keep that economic growth going for the future generations. From the social side, the aim is to make sure that the business is fair to all its economic stakeholders, which include workers, the society, and the community, in that the business activities should ensure fair remuneration, socio-economic upliftment, and community development. The environmental angle to measuring business performance calls for lesser use of resources, reduction of greenhouse gas emissions, and fewer negative impacts in general, thus showing that business activities have to be environmentally sustainable.

Real estate firms in Malaysia, which have combined TBL with their financial performance, have caused other sectors to address sustainability targets and SOCIAL and environmental integration. Though research shows that the TBL concept is less mature than the broader sustainability issues, the use of TBL as a framework in CSR activities and reporting has shown enormous potential in the facilitation of the link between business activities and sustainable development goals (Arowoshegbe et al., 2016).

2.6 SSM

Malaysian real estate developers usually concentrate on quick profits, and this mentality makes it difficult to justify the higher upfront costs of sustainable construction by the same companies. To date, the battle between profit and sustainability has been the main reason behind the slow pace of implementing environmentally friendly measures. The central problem is to rethink business models and raise the benefit of green buildings not only for the present but also for the future, e.g., higher resale values, lower utility costs, and increasing market demand. In order to solve these financial challenges, the Green Technology Financing Scheme (GTFS) in Malaysia is offering subsidies and low-interest loans for eco-friendly projects. However, they are limited by bureaucratic complexity and lack of awareness.

SSM creates an opening to infuse sustainability into the very essence of strategic decision-making. It encourages long-term perspective and brings to balance business goals with environmental and social ones. The real estate industry in Malaysia, via SSM, is not only able to meet the ESG standards but also to become a major carbon-neutral contributor. Stead et al. (2008) stated that SSM is a single framework that successfully integrates and balances economic, ecological, and social goals. Therefore, it can be sustainable over time.

It replaces the conventional model of growth with one that prioritizes sustainability. Specifically, the framework includes 1) eco-efficiency, which achieves cost savings through energy and resource optimization, and 2) socio-efficiency, which resolves social issues such as the provision of fair labor practices and the improvement of community welfare without a loss in profitability. Additionally, the company can use this approach to integrate sustainability not only at the functional but also at the corporate level and comply with sustainability principles concerning issues like poverty and resource conservation.

Uar et al. (2016) research demonstrates the inversion of the conditions of the ESG agenda in Malaysia and the problems of slum development in Ternate, Indonesia. The problems they

faced exemplify the environmental, social, and economic expenses that occur in the long-term due to neglecting the principles of sustainability and lack of coordination in urban development governance.

SSM provides a method for Malaysian real estate developers to restructure their operations and meet ESG standards by incorporating sustainability into their plans. This enables them to address the social and environmental issues whilst at the same time, gaining the trust of their stakeholders, helping to achieve the net-zero carbon emissions target and enhancing the sector's image, and being a source of its longevity and stability. While the aforementioned frameworks, such as CSR, TBL, and SSM, are well-known, their actual implementation has been quite limited. In most cases, CSR programs are burdened with issues related to their transparency and accountability, since corporations may advertise sustainability in their operations without really doing them. The TBL framework is vague in terms of the social and environmental metrics used, which makes it difficult to measure progress on these fronts (Norman & MacDonald, 2004). SSM is still at a crossroads due to regulatory enforcement inconsistency and lack of financial incentives.

In Malaysian real estate, the application of CSR, TBL, and SSM has resulted in a mixed bag of outcomes. Major real estate players such as Sime Darby Property and Sunway Berhad are not just compliant with ESG principles but have also actively aligned their corporate strategies with them. While the aforementioned big developers are in excellent shape, most small developers are in a pretty tight spot as they lack the necessary funding and are able to exploit loopholes in regulations only to barely make a living. Because ESG reporting is still voluntary in Malaysia, sustainability practices have been implemented with different levels of enthusiasm in various sub-sectors of the industry (Lima, 2021).

Singapore - a place where ESG disclosure is mandated by the SGX Listing Rules - makes it a requirement for all new buildings to obtain certification under Green Mark, which automatically comes with energy efficiency and resource-saving. Contrarily, Malaysia's regulatory framework seems to be all over the place, and the non-mandatory nature of the Green Building Index (GBI) initiative leaves less enthusiastic people to take up the standard and maintain the status quo (Building and Construction Authority (BCA), 2022). Consequently, Malaysia is not performing well in the sustainability race compared to the other countries in the region. Sadewo et al., (2018) case study of Kendal, Indonesia, serves as an example of how industrialization, if done quickly, could lead to the forecast of industrial land use going up by 775% in 2031, thus making the conversion of agricultural land the most likely source of land for the industry and possible threats to land productivity. This case points to the need for ESG integration and land-use governance in Malaysia's real estate planning as being vital.

The reality of the Malaysian property market and its stakeholders dictates that, at present, only big companies (e.g., Sime Darby Property and Sunway Berhad) can afford to expedite the sustainability transformation, leaving SMEs and mid-tier players coming in last and still fighting to stay afloat. To advance the game and move towards general acceptance of sustainable practices, Malaysia needs to advocate for mandatory ESG requirements instead of voluntary disclosures, such as the European Union's Corporate Sustainability Reporting Directive (CSRD) (European Commission, 2023). The step of having more developers onboarding sustainability can be eased by the provision of tax rebates for ESG-aligned projects and thus, at the same time, ensuring that environmental stewardship is not left behind economically viable.

2.7 Green Building Design Practices

The real estate sector in Malaysia must actively reduce its carbon emissions through green building measures. Essentially, such measures involve the installation of renewable energy power plants, the use of water-saving devices, and the adoption of eco-friendly building methods. Meanwhile, the execution of these steps faces difficulties due to uneven policy enforcement and a shortage of incentives for developers. By emulating ASEAN neighbors such as Singapore with its Green Loan Program, Malaysia may create similar monetary incentives to make green buildings accessible to more people. The green building steps are crucial for net-zero carbon goals as they account for the main source of operational as well as incorporated carbon emissions.

Green architectural solutions in Malaysia are in harmony with the global problem of climate change and the need for economic sustainability based on natural resources as the foundation of national development; however, the usage of eco-friendly materials is expensive, there are only a few green technologies, and there is a shortage of technical experts. These scenarios pose heavy challenges to energy-efficient building design and resource optimization. Research has shown that insufficient availability of high-performance materials has resulted in the construction industry continuing traditional building practices, which in turn have been significant contributors to carbon emissions.

It is necessary that green building norms, including LEED (Leadership in Energy and Environmental Design), the Green Building Index (GBI), and GreenRE, become instrumental in lessening carbon emissions during the construction phase of buildings and across the entire lifecycle. For example, buildings with GBI certification have been a major factor in energy-saving efforts in Malaysia and in the nation's journey towards carbon neutrality. These eco-certifications map out the energy efficiency goals, provision of construction materials, and environmental performance. While LEED is globally recognized and sets standards for best practices in sustainability, GBI and GreenRE are more focused on addressing the environmental and socio-economic aspects in Malaysia (Sunderaj, 2022).

The design of environmentally friendly buildings also emphasises the eco-friendly disposal of waste generated by the building, especially during the construction stages, which, in most cases, involve recycling, composting, and reducing the waste sent to landfills (Norman & MacDonald, 2004). Such methods target construction waste, which is a source of materials that can be reused, as well as the huge amounts of waste that are dumped in landfills, thus reducing the total greenhouse gas emissions. Besides that, the use of advanced energy management techniques and renewable energy sources can go a long way to help in the development of low carbon-emitting buildings.

Generally, green constructions have an additional initial cost from 2% to 10% compared with regular buildings, but they have operational savings in energy costs by 20% to 40%, water costs by 30% to 50%, and maintenance costs by a certain amount, which, in the long term, offset the higher initial cost. Moreover, the resale value of green-certified buildings is 5% to 10% higher than that of regular buildings, which makes such buildings more attractive to potential occupants and, thus, increases the occupancy rate (Iwuanyanwu et al., 2023).

Lifecycle Carbon Emissions (LCCE) incorporate all carbon emissions generated during the life cycle of a building, i.e., carbon emissions caused by the production of building materials, construction, building use, and the end of building life (ISO 21930). This shows how closely linked the three concepts are: lifecycle assessment (LCA), life cycle emissions assessment (LCEA), and lifecycle carbon emissions assessment (LCCEA). These are further subdivided into production (A1–A3), construction (A4–A5), use (B1–B7), and end of life (C1–C4), with the additional activities of reuse and recycling (Module D). Evaluating LCCE is a milestone on

the way to grasping the environmental impacts of real estate development, especially in the context of achieving net-zero carbon.

The building sector is the source of about 37% of the total global CO₂ emissions, out of which 10% is due to embodied carbon (carbon emissions released during the building construction) and 27% are operational emissions (emissions released during building use). The real estate industry in Malaysia is dependent on carbon-intensive materials such as steel and concrete, and there is high operational energy consumption. It is a call for the necessity of lifecycle approaches. Urbanisation in Malaysia is in line with these trends, thus sustainable measures are needed (Ritchie et al. , n.d.).

Environmental certifications rely on the standards of Low Carbon Life Cycle Emissions (LCCE) (Zhang et al., 2023) by calling for the use of building materials with low carbon, renewable energy, and energy-efficient designs. For example, GBI-certified building projects in Malaysia have the potential to effectively eliminate operational carbon emissions; however, they find it difficult to deal with the issue of embodied carbon in materials. This matter is significant because emissions can be limited through the use of low-carbon concrete, recycled materials, and modular construction methods (A1–A3). The material reuse and recycling (Module D) and the concepts of the circular economy (Zhang et al., 2023), which are among the solutions for the end of life, will assist in realizing the sustainable development goals that Malaysia has set.

Energy for heating, cooling, and lighting is the major energy consumer and hence the primary source of emissions over the life cycle of a building. The operational phase (B1–B7) is where this accounts for the largest proportion of the building's lifecycle emissions (Zhang et al., 2023). To lower such emissions, occupant participation is necessary. Instructing occupants about energy-efficient behavior can lead to energy savings of up to 20 percent (Ritchie et al., n.d.). Developers of real estate facilitate this by integrating smart and adaptive systems that provide users with real-time control over systems, which are essential in energy control management.

Such obstacles as lack of carbon accounting standards, high priced unsustainable materials, and low levels of knowledge result in the complexity of life cycle assessments (Zhang et al., 2023). The profit-oriented approach that mainly characterizes Malaysia's economic system is also a leading cause of problems related to the adoption of LCCE frameworks. These problems would be eliminated if policy incentives promoting the subsidizing of stakeholder collaboration and low carbon materials were introduced.

By incorporating lifecycle perspectives within corporate sustainability plans, property firms turn into the leading players for eco-friendly development of the next generation. Besides, it is beneficial to LCCE to be used in combination with ESG standards, as it provides a greater level of clarity to sustainable investors. Taking care of emissions in all the different phases of the lifecycles and using LCCE in real estate further aligns domestic practice with global standards for sustainability. Furthermore, LCCE is compatible with other approaches such as CSR, TBL, and SSM which will facilitate the creation of an integrated strategy that embraces sustainability in professional conduct, breakthrough designs, and the involvement of the end-users.

Financial motivators are indispensable to overcome the cost barriers that hinder the adoption of green buildings. The study carried out in 2020 revealed that green-certified buildings in Malaysia had 7% more property value and 18% higher occupancy rate, thus a win-win situation for developers who take on sustainable construction (Sunderaj, 2022). Though the real estate sector in Malaysia is in the nascent stages of adopting green building practices, there is potential for positive developments as a result of the government's decision to extend the Green Investment Tax Allowance (GITA) to low-carbon building materials and energy-efficient

building systems. Performance-based green grants, such as Germany's KfW Green Building Programme, are another great way to close the cost gap.

2.8 ASEAN Comparison

In comparison with other ASEAN countries and especially with the leaders in the region such as Singapore, sustainability policies in Malaysia are less mature. Green Mark certifications are mandatory for all new developments in Singapore, which indicate the conformity with policies on energy usage and resource saving (BCA, 2022). Table 1 provides information on green building systems in Malaysia versus the leading Southeast Asian countries, the extent of each system's implementation, and the goals for emission reduction.

Table 1: Comparative Analysis of Green Building Practices and Sustainability Frameworks Across ASEAN

Country	Green Building System	Adoption Model & Status	Carbon Target	Primary Incentives
Malaysia	GBI, My CREST	Voluntary Platinum, Gold, Silver	Net-zero by 2050	Tax breaks, green financing, REITs framework
Singapore	Green Mark (BCA)	Mandatory Platinum, Gold, Silver	60% by 2030	Green loans, Retrofit subsidies, Performance benchmarking
Thailand	Thai Green Building Index	Voluntary Excellent, Very Good, Good	40% by 2037	Low-interest loans, technical support
Indonesia	GREENSHIP	Mandatory (select cities) Platinum through Bronze	29-41% by 2030	Mandatory compliance with sustainability standards

Source: ASEAN Green Energy Programme (2018); Ministry of Energy, Green Technology and Water, Malaysia (2017); Building and Construction Authority, Singapore (2023); Thai Green Building Council (2024); Indonesian Ministry of Public Works (2023)

Malaysia's move towards net-zero carbon emissions is supported by a comprehensive policy framework and demonstrated outcomes. As shown in Table 1, key policies and green building incentives were introduced in Malaysia since 2009.

As a result of the launch of GBI in 2009, 671 projects constituting 300 million square feet of green buildings certified have been realized, thus reaching a very significant amount of certified built green space which indicates considerable progress in the sustained adoption. The Green Technology Master Plan (2016-2020) had a goal of 1,750 certified buildings by 2030, which was a very ambitious jump from 370 buildings certified in 2016 (Ministry of Energy, Green Technology and Water, 2017). The implementation of financial incentives through REITs and green financing has made the requirements for accessing funding for sustainable developments less stringent and has also led to the increased inflow of capital investments.

3. Aims and Research Objectives

This review seeks to identify the obstacles, as well as the structures, that are capable of attaining net-zero carbon emissions in the property sector in Malaysia through the analysis of the interrelationship of green building design, ESG compliance, end-user engagement, and profitability-sustainability strategies, thus making it possible to offer locally practicable global-aligned recommendations for sustainability.

This review aims at a deep understanding of the implementation and performance of sustainability frameworks in the real estate sector of Malaysia, employing these frameworks as instruments for carbon neutrality by 2050. The focal point of the research is to ascertain the effect of CSR, TBL, and SSM on environmental, social, and economic sustainability outcomes of the sector. The specific objectives are as follows:

- 1) To investigate the manner in which Malaysian real estate developers carry out CSR initiatives that not only support economic viability but are also environmentally and socially responsible.
- 2) To measure the extent to which the TBL framework serves as a guide in real estate sustainability by allowing the integration of financial performance with environmental protection and community welfare.
- 3) To investigate the contribution of SSM in the process-driven eco-efficiency and socio-efficiency improvement in real estate development, which in turn leads to ESG standards compliance.

The variable that depends on the research is the effectiveness of sustainability adoption in relation to net-zero carbon emission in Malaysia's real estate sector, which can be seen as progress. The major indicators that reveal such progress *inter alia* are carbon footprint reduction, regulatory compliance, stakeholder engagement, and integration of green building certifications. These objectives and the dependent variable have been explicitly set out in the study so as to make it possible to offer the targeted insights into the ways of overcoming the challenges and maximising the opportunities for sustainable real estate development in Malaysia.

4. Methods

This systematic literature review assesses how sustainability models for the Malaysian real estate sector solve local issues and inform global practice. The approach had three iterations: framework identification, screening and contextual adaptation, and analysis and synthesis.

4.1 Search for Relevant Literature

Scopus, Web of Science, Google Scholar, ScienceDirect, Malaysian Citation Index (MyCite), and ProQuest Dissertations were used to search for literature on the CSR framework, TBL, and SSM framework. The author also examined government reports and policy documents.

Boolean operators were used to search for literature published from January 2019 to June 2025. The following search strings were applied across all databases:

Primary Search String:

("sustainable development" OR "sustainability" OR "green building" OR "net zero carbon" OR "ESG" OR "environmental social governance") AND ("Malaysia" OR "real estate" OR "property development" OR "construction") AND ("framework" OR "certification" OR "policy" OR "adoption" OR "implementation")

Alternative Search Strings:

1. ("Green Building Index" OR "GBI" OR "LEED" OR "GreenRE" OR "GBRT") AND ("Malaysia" OR "Southeast Asia")
2. ("CSR" OR "corporate social responsibility" OR "triple bottom line" OR "TBL" OR "sustainable strategic management") AND ("real estate" OR "property" OR "construction")
3. ("carbon emission*" OR "net zero" OR "greenhouse gas*" OR "climate change") AND ("real estate" OR "building" OR "property") AND ("Malaysia" OR "ASEAN")

4. ("ESG compliance" OR "ESG framework" OR "environmental social governance") AND ("property" OR "real estate" OR "developer*") AND ("Malaysia" OR "emerging market*")

5. ("green building" OR "sustainable building" OR "sustainable development") AND ("adoption" OR "barrier*" OR "driver*") AND ("real estate" OR "construction")

Search Parameters:

- Field searched: Title, Abstract, Keywords
- Search date range: January 1, 2019 to June 30, 2025
- Language: English only
- Database search conducted: July 2025

4.2 Inclusion and Exclusion Criteria

Inclusion Criteria:

i. Study Population:

- Research focusing on real estate, construction, or property development sectors
- Geographic scope: Malaysia, ASEAN region, or comparable emerging economies
- Minimum sample size: $n \geq 10$ organizations, projects, or respondents
- Organizational level: Developers, construction firms, government agencies, or end-users

ii. Intervention/Framework:

- Implementation of CSR, TBL, SSM, or ESG in the real estate context
- Green building certification programs (GBI, LEED, MyCREST, GreenRE, GBRT)
- Sustainability policies, financial incentives, or regulatory frameworks
- End-user engagement or behavioural interventions for sustainability

iii. Outcomes:

- PRIMARY: Sustainability adoption rate, carbon emissions reduction, energy efficiency improvements
- SECONDARY: Cost-benefit metrics, adoption barriers and drivers, policy effectiveness

iv. Study Design:

- Peer-reviewed journal articles, Peer-reviewed conference proceedings, Government statistical reports with documented methodology, Case studies with explicit data collection methods, Systematic reviews and meta-analyses

v. Time Period:

- Published January 2019 to June 2025; Exception: foundational theoretical frameworks (e.g., Brundtland, 1987; Carroll, 1991) and still-active Malaysian policy documents (e.g., Eleventh Malaysia Plan, GTMP), which are included regardless of publication year for theoretical and policy continuity.

Exclusion Criteria:

- Not peer-reviewed (unless official government report), Published before 2019 (except foundational theories), non-English without verified translation, No empirical data (opinion pieces, editorials), Sample size < 10 entities, Duplicate publications, Critical methodological flaws (quality score < 6)

Rationale:

- These criteria ensure methodological rigor whilst balancing recent, high-quality evidence with practical considerations of literature availability in Malaysia and Southeast Asian context.

4.2.1 Quality Appraisal

The quality evaluation of the 50 studies that formed the basis of the review was grounded in the quality of the study design, the relevance to Malaysia, and whether the investigations provided empirical evidence. The quality of 32 studies (64%) was considered to be high, that of 15 (30%) - moderate, and 3 (6%) studies with limitations were assessed as providing adequate evidence. The review was more influenced by the high-quality studies.

4.3 Justification of Contextual Adaptation

The selected studies were not just appropriate but also indispensable for comprehending local adaptation through examining the problems of fast urbanization, elevated energy consumption, and laws that are significant for Malaysia, and at the same time maintaining the global relevance of adaptation.

4.4 Analysis and Synthesis

The final stage was the thematic synthesis and analysis of the studies chosen and also included the discussion of the contribution of CSR, TBL, and SSM to the environmental, economic, and social sustainability of the real estate sector. Besides, the strategic analyses of the concepts, such as the CSR pyramid framework by Carroll and green building certification, were investigated for their strategic contributions. The full list of the 50 included studies, along with their source classification and key contributions, is provided in **Appendix A1** (see Supplementary Material).

The review was conducted in line with PRISMA guidelines. The stages of completion, identification, screening, eligibility, and inclusion of the study were recorded to facilitate transparency. Of the 90 full-text articles assessed for eligibility, 40 were excluded because they were published before 2019 ($n = 15$), were conducted outside Malaysia ($n = 15$), or did not report extractable quantitative outcome data ($n = 10$), as shown in the PRISMA 2020 flow diagram (Figure 2). The methodology employed enhances the findings' trustworthiness, which will be made clear by showing the alignment of global best practices with the newly formulated sustainability agenda of Malaysia.

Table 2: PRISMA

PRISMA Stage	Count	Description
Identification	450	Records identified through database searching
Duplicates removed	40	Duplicate records removed before screening
Screening	410	Records screened by title and abstract after duplicates removed
Records excluded	320	Records excluded during title/abstract screening (not relevant, outside scope, etc.)
Eligibility	90	Full-text articles assessed for eligibility
Full text excluded	40	Full-text articles excluded ($n = 40$; pre-2019, $n = 15$; non-Malaysia, $n = 15$; no usable quantitative data, $n = 10$).
Included in review	50	Studies included in final synthesis (30 qualitative, 20 quantitative)

Source: (Author; PRISMA guideline (Page et al. 2021))

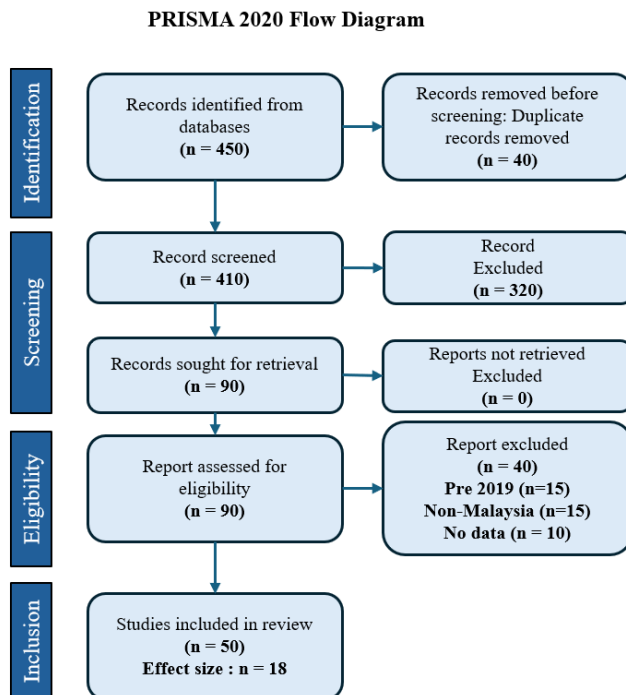


Figure 2: PRISMA 2020 Flow Diagram

Source: (Author; PRISMA guideline (Page et al., 2021))

4.4.1 Narrative Synthesis and Effect Size Reporting

This systematic review uses narrative synthesis of quantitative findings rather than formal meta-analysis, since there is great methodological heterogeneity in the 50 included studies. Following EPPI-Centre guidance for narrative synthesis (Popay et al., 2006), a systematic approach was used to extract and synthesize effect sizes from published findings.

Effect Size Extraction and Synthesis Methodology

All effect sizes (odds ratios, correlation coefficients, regression coefficients) were extracted from published reports in the included studies, including reported 95% confidence intervals where available. When studies used different statistical approaches to measure the same construct (e.g., adoption of green building certification), comparable estimates were extracted for synthesis. Heterogeneity across studies was qualitatively assessed using narrative description rather than formal meta-regression due to the inconsistent reporting of moderator variables and statistical parameters across studies.

For studies reporting quantitative outcomes related to green building rating tool (GBRT) adoption, effect sizes (odds ratios, regression coefficients, correlation coefficients, mean differences and hazard ratios) were taken from the published results, including 95% confidence intervals or p-values where available. From the 50 included studies, 18 Malaysian empirical papers on GBI, GreenRE, LEED or general GBRT adoption were identified and labelled ES-1 to ES-18, and these are listed with their effect sizes in Appendix A2 (Table A2.1). For the synthesis of GBRT adoption drivers (Section 5.2), 18 Malaysian empirical studies examining factors influencing green building rating tool adoption were identified from the full set of 50 included studies along with their source classification and key contributions, is provided in Appendix A1. Effect sizes from these studies can represent:

- (1) The main source of information is the direct extraction of published odds ratios, regression coefficients, or correlation coefficients as the original authors reported, along with their 95% confidence intervals.
- (2) Standardized estimates in cases where metric differences were present in the original studies, but comparable constructs were measured, with effect sizes rescaled.

5. Analysis and Critical Thinking

5.1 Analysis and Critical Thinking

With respect to CSR, TBL, and SSM sustainability frameworks, Malaysia experiences socioeconomic and regulatory issues that are unique to the country. A number of these problems would not have been as difficult if the green building rating tool and other sustainable practices had been welcomed with open arms.

Among the many issues, ESG adherence is becoming extremely important as it is the main factor that attracts international investors. The inconsistency in regulatory enforcement in Malaysia is a factor that is not conducive to the universal adoption of ESG frameworks. The lack of clarity in ESG guidelines for real estate developers and the shortage of strong monitoring, as well as the enforcement of harsh measures for ESG non-compliance, discourage the adoption of these standards the most. To give an example, the Green Building Index (GBI) may be setting very high standards, but developers who are trying to save on costs are enabled by the lack of enforcement to not take part, hence, the necessity of a regulatory framework that facilitates ES compliance through incentives but also through penalties for non-compliance is evident.

The cost-benefit factor of going green is no less essential. It is a matter of investing in green certifications, and a profit-oriented real estate developer might be discouraged because of the high upfront costs. On the other hand, developers should be informed of the possible monetary and operational benefits that they could reap after the implementation of eco-friendly practices. Real estate developers involved in the Malaysia GBI-certified buildings that are considered energy efficient, with the energy consumption of some buildings being lower by up to 50% in comparison to non-certified ones, should be the first to recognize the GBI certification as a worthy investment. However, these stimuli probably would only work with developers who are not under the constant pressure of the 12-month project timeline which is typical in Malaysia's real estate industry. Project durations, margins, and deadlines that are well-balanced can be attained by lessening the discretionary tasks that can be accomplished through Building Information Modelling (BIM) and other prefabrication methods. On the other hand, the more stable margins can be a source of funds for sustainability investment that helps to lower operational costs; thus Malaysia's real estate sector can be the one that keeps the promise of lower operational costs, increased project margins, and reduced project timelines.

In Malaysia, the levels of public participation, understanding, and engagement in sustainability-related activities are still quite low. In response to this, the creation of intelligent energy dashboards can provide real-time energy consumption data per household and thus make the energy user more accountable. Targeting and improving public awareness efforts, like Singapore has done through its environmental literacy programmes, may be very effective in encouraging and sustaining the practise of sustainable living among homeowners in Malaysia. These activities eliminate the gap between policymaker intentions and the actual behaviors of consumers.

Malaysia is still continuing to roll out new methods to facilitate the transition to a low-carbon lifestyle, one of which is monetary incentives, for instance, cashback offers on energy-efficient appliances, and subsidies for the installation of renewable energy systems.

Achieving meaningful progress toward sustainability requires more than top-down policy implementation; it necessitates participation on the ground and willingness of the community to adopt various patterns of sustainability. The current initiatives remain somewhat limited in scope and reach, contributing to the vision of the Department of Environment remaining unrealised. The level of educational outreach in the community on a national level is insufficient, making the vision for the policies and systems in place for the community disconnected. The Green Building Index (GBI) certification programme in Malaysia is voluntary, unlike its counterpart in Singapore, with mandatory Green Mark certification, which contributes to lower adoption rates. In contrast, the mandatory carbon trading system in China has decreased emissions in the real estate market by 12% over five years. This is something Malaysia can consider implementing.

Malaysia should Fast-Track Adoption through the Expansion of the Green Investment Tax Allowance (GITA) to low-carbon building materials and energy-efficient building systems. Performance-based green grants, such as Germany's KfW Green Building Programme, represent another good opportunity to close the cost gap.

5.2 Critical Narrative Synthesis: GBRT Adoption Drivers and Reported Effect Sizes

The following summary presents key statistical relationships as reported in 18 Malaysian empirical studies on GBRT adoption, based on our narrative synthesis (see Appendix A2)

- Financial incentives: Developers with access to regulatory incentives were 2.35 times more likely (Appendix A2, ES-4).
- Mandatory regulations: Regulatory enforcement mechanisms improved certification compliance by 23.5 percentage points compared to absence of enforcement (Difference = 23.5 pp, $p < 0.01$; Appendix A2, ES-17)
- Market demand: Strong positive correlation between end-user environmental awareness and adoption intention driving cost reduction benefits ($r = 0.52$, $p < 0.001$; Appendix A2, ES-5).
- Developer knowledge: Technical training was moderately associated with adoption ($r = 0.43$, $p < 0.01$; Appendix A2, ES-1).

The consolidated findings from these studies strongly suggest that mandatory requirements have the largest impact on adoption (reported OR = 5.82; Appendix A2, ES-17), followed by financial incentives (reported OR = 2.35; Appendix A2, ES-4). This indicates that a policy strategy combining regulatory mandates with financial support is likely to be the most effective for increasing GBRT adoption in Malaysia (Appendix A2, ES-1–ES-18).

5.3 End-User Engagement

To some extent, the behaviour of the end-user determines the success of sustainability initiatives. Most of the sustainability initiatives are dependent on the behaviours of end-users at a certain level. Existing research demonstrates that correctly involving end users leads not only to the decrease of the carbon emissions connected with operations but also to embedding green habits, which makes the engagement of end users a decisive factor in reaching the carbon net-zero targets. The key to unlocking significant changes lies in the involvement of the end users in educational programs, giving them incentives to change their behaviour and providing

them with technological tools like energy dashboards that offer on-the-spot data, so that they can readily see the effects of their changed behaviours.

Even though frameworks such as CSR, TBL, and SSM are strategically oriented towards guiding real estate developers, the participation of residents and end-users can not be overemphasized in achieving sustainability goals. It is necessary for these goals to be successful, as the green practices will then not be limited only to the construction phase but be transferred to the building's daily operations and maintenance which, in turn, would harmonize the way people use and care for buildings with the principles of sustainability.

Several studies have pointed to the crucial role of energy-related interventions in influencing residential energy-consuming behaviour. Nevertheless, their effectiveness is largely dependent on the relevant contextual factors such as social and cultural backgrounds (Šćepanović et al., 2017). Educating residents about energy-saving practices will also lead to the implementation of those practices, for instance, by encouraging them to use the air conditioner more efficiently, in the turn-off decision regarding the appliances they aren't using and providing them with clean energy by such means as rooftop solar panels. Inviting residents to participate in workshops, campaigns, and digital tools will raise the level of both their knowledge and their sense of responsibility.

It has been pointed out in several studies that a major factor in significantly contributing to the cleaner practice in two sectors- residential and commercial, would be the implementing of sustainability measures in the urban planning while at the same time, opening the floor for the stakeholders' views and suggestions, coupling these with the energy-efficient designs, renewable energy sources and smart monitoring systems (Hezri & Hasan, 2004). Those digital platforms that offer prompt and clear information on energy and water usages will be the perfect tools for the people taking the data to make the right choices in line with the sustainability goals; as such, it is not only an environmental obliging tool but also a way of bringing the current generation of digital technologies into the everyday life of the people (Low et al., 2020). Besides that, it facilitates a green lifestyle through the provision of services that rely on public transportation, water conservation, and products that are recyclable.

Co-creation, besides its primary goal of enhancing the physical attributes of the environment, also creates among the people a sense of their own and belonging. Thus, stakeholders by associating with government agencies, policymakers, and local communities, can hence share the burden of making places that, on the one hand, greet the environment and, on the other, allow them to live sustainable behaviors such as using public transport, recycling, and conserving resources.

Qamaruz Zaman (2021) highlights the importance of collaborative governance in the placemaking process, illustrating that the co-creation of developers and users can lead to the formation of social spaces not only vibrant but also efficient due to the presence of shared amenities, smooth mobility solutions, and culturally relevant design elements. When developers create spaces that fulfill the needs of different users and at the same time deepen the bond between people and the place, such actions not only make the project sustainable but also become a source of the long-term success of urban regeneration efforts, thus, they become resistant to future challenges. The emphasis on the collaboration of stakeholders and the inclusion of end-users is indicative of a larger change towards the sustainable, people-centred urban development model, which is important in rapidly urbanizing areas such as Malaysia, where the equilibrium of environmental sustainability and community engagement is both a challenge and an opportunity.

Lima et al. (2021) pinpoint that besides different barriers, behavioural barriers like unawareness, lack of knowledge, and resistance to change are still the major impediments to

the realization of net-zero goals. A real estate developer, who is committed to going green, will probably do more to help shift the behaviour of users by involving them actively and therefore eco-friendly practices can be spread inductively. The target audience is educated through a complex strategy that includes introducing energy-efficient designs, renewable energy integration, and improved waste management, to name a few, to make sustainable living more accessible and attractive.

Md Yusoff et al. (2023) reinforce the argument by listing behavioural barriers as a major challenge on the way toward net-zero targets. These include unawareness, lack of stakeholder knowledge, and resistance to change due to the mindset of the people. Developers are engaging end-users through different activities in which exposure to sustainability issues is a priority, thus behavioural changes are triggered, and eco-friendly practices are promoted effectively. The term “engaging end-users” is very critical in the process of sustainable real estate adoption among Malaysian homeowners.

Research has shown that attitudes, perceived behavioural control, subjective norms, perceived value, and knowledge of green buildings are among the factors that significantly affect homebuyers' decisions to go for environmentally friendly living spaces. The success of the green transition in refurbishing building facilities greatly depends on how well end-users are brought in the loop of the designers' strategy; their participation creates energy-efficient, user-responsive areas that meet current environment demands.

One way that developers will be able to encourage the public to go for green products is to smart energy dashboards with the real-time monitoring of energy use in households and thus promote energy efficiency through accountability. In line with Singapore's environmental literacy initiatives, public awareness programs which are well planned and organized can have a great impact on the rate of adopting sustainable lifestyles among Malaysian residents, which eventually helps in bridging the gap between policy intentions and consumer behaviour (Seki et al., 2022).

Besides other measures, Malaysia can further convince the homeowners to switch to a low-carbon lifestyle through a system of financial incentives, such as giving the homeowners cash back when they purchase energy-efficient appliances, or when they install solar panels (renewable energy) (rebates).

5.4 Case Study: Merdeka 118 – Practical Implementation of Sustainability Frameworks

Merdeka 118, which opened its doors in January 2024, is a landmark for Malaysia as it is the first building to achieve triple platinum certification with a height of more than 600 meters (678.9m). The building is simultaneously certified LEED Platinum, Green Building Index (GBI) Platinum, and GreenRE Platinum. For instance, the structure utilizes passive solar design, Low-E glass systems, underfloor air conditioning with smart recycling, automated daylight harvesting, solar-powered construction equipment, and a 4-acre integrated green space with groundwater recharge systems, among many other features.

The commitment to sustainability through various strategies outlined in Table 1 not only confirms the benefits achieved but also sets a strong example for the Malaysian property market to embark on an ambitious journey towards energy savings and carbon emissions reduction, achievable by introducing advanced construction technologies and implementing the design measures elaborated here. Merdeka 118 demonstrates how it is practically possible to meet the criteria for multiple platinum certifications simultaneously, thereby paving the way for future developments under the Malaysian operational framework of net-zero carbon by 2050 and the sustainability principles dealt with in this review: CSR, TBL, and SSM.

Table 3: Merdeka 118 Quantified Environmental Performance Benchmarks

Performance Dimension	Merdeka 118 Result	Malaysian Baseline	Improvement	Data Source
Energy Intensity	120-130 kWh/m ² /year	180-200 kWh/m ² /year	35-40% reduction	Building Management System data; LEED certification documentation.
Operational Carbon	45-55 kg CO ₂ /m ² /year	70-85 kg CO ₂ /m ² /year	35-40% reduction	GBI Platinum certification; Carbon Trust methodology
Annual Carbon Savings	12,000-15,000 tonnes CO ₂ /year	Conventional baseline	Lifecycle equivalent	Embodied carbon assessment per ISO 14040/14044 standards
Water Consumption	800-900 m ³ /1,000m ²	1,200-1,500 m ³ /1,000m ²	35-40% reduction	Water efficiency systems; greywater recycling documentation
Stormwater Management	80-90% on-site retention	10-20% typical	80%+ improvement	Landscape and groundwater recharge engineering
Renewable Energy	2-3 MW solar capacity	Minimal renewable	20-25% demand offset	Photovoltaic system specifications and generation data
Occupancy Rate	95%+ achievement	75-85% market average	+10-20% premium	Pre-leasing and tenant occupancy records
Rental Premium	12-15% higher rates	Baseline for non-certified	Market demonstrated	Real estate valuation data; Malaysia market analysis
Construction Cost Premium	8-12% above baseline	Standard development	Justified by ROI	Developer cost documentation; lifecycle cost analysis
Cost Payback Period	4-6 years	N/A	Positive lifecycle value	30-year financial modelling; operational savings projections

Source: Compiled from Merdeka 118 project records, certification reports, assessment standards, and supporting operational data (2023–2025)

The strategies of Merdeka 118—passive design principles, building systems efficiency, smart building management, green infrastructure, and multi-certification coordination—are able to residential, mid-rise commercial, affordable housing, and industrial projects with context-specific adaptations (Hezri & Hasan, 2004; Iwuanyanwu et al., 2023).

Table 4: Malaysia national sustainability targets

Timeline	Adoption Target	Catalysts	Policy Framework
2024-2025 (Current)	1mega-tall triple-platinum project (Merdeka 118)	Market success demonstrates occupancy + rental premium	Voluntary certification systems (GBI, GreenRE, LEED)
2025-2027	3-5 high-rise commercial projects platinum-level	Developer/investor interest; government recognition; best practice sharing	Voluntary incentives expansion; tax/financing benefits
2027-2030	20% of new commercial developments platinum-certified	Proven ROI across 8-10 projects; ESG disclosure requirements; corporate net-zero commitments	Potential mandatory minimum requirements (e.g., GBI Gold minimum)
2030-2035	Platinum-level becomes industry standard; net-zero carbon baseline	Regulatory mandate; market normalization; circular economy integration	Mandatory green building standards; embodied carbon regulations

Sources: Malaysia national sustainability targets (Ministry of Environment, 2023); comparative ASEAN developments (Bekhet & Othman, 2017; Law, 2022).

6. Conclusion

The road to net-zero carbon emissions in the real estate industry of Malaysia is complicated and the sector has to face many problems like green building design, ESG compliance, end-user engagement, profitability concerns, and sustainable practice adoption. These problems are interrelated and therefore, they need the collaborative work of policymakers, developers, and end-users to solve them. Real estate developers by aligning policies with industry practices and encouraging behavioural shifts are making progress in confronting these challenges.

This research has shed light on the need to adjust and make global sustainability frameworks: CSR, TBL, and SSM, relevant to the local context. These frameworks will help to overcome challenges and set the correct practices towards net-zero carbon emissions (Arowoshegbe et al., 2016). Success in real estate sustainable development in Malaysia is not only a global obligation but also a local requirement as urbanisation is still growing, the demand for housing and office space is increasing sharply, and greenhouse gas emissions are still rising.

Real estate developers are advancing in their power to deal with such issues by using energy-efficient layouts, renewable energy systems, and waste management solutions that are both effective and environmentally friendly. To overcome the behavioral barriers of limited awareness, deeply held mindsets, and lack of stakeholder knowledge, the activities of educating end-users through community programs and digital platforms seem to be quite potent in bringing about the behavioral change that lasts. These developments not only reduce carbon emissions but also enhance the functionality and appeal of sustainable living spaces.

Collaboration is the key to a bright future. The relationship between policymakers, developers, and users should be that of partners in order to bridge effectively the gaps in regulatory enforcement and resource utilization. Besides co-creating spaces that are inclusive, functional, and sustainable, they also, as a result, become owners, thus a lively engagement in environmental efforts is assured. This is how eco-friendly practices are secured during the whole lifespan of the edifice.

The triple bottom line is still quite a tough challenge to maintain in Malaysia. The country is still struggling with financial barriers, lack of enforcement of regulations, and an industry mentality that is mainly driven by profits, thus the rate of green practices adoption is still low.

To get over these fences, a multi-layered approach comprised of financial incentives, policy frameworks, and public awareness campaigns is needed.

The only way to address the obstacles that hinder the progress of sustainability in the Malaysian property and urban sectors is through an all-encompassing strategy. Aside from improving the regulatory framework, continuity of policy is another very important factor. The Green Technology Master Plan Malaysia 2017–2030 identifies the establishment of an efficient policy and regulatory environment as the main driver of green growth. Malaysia's National Development Plan, however, points to the need for more solid enforcement mechanisms to ensure that environmental standards are met. That notwithstanding, even the best policies are likely to fail if they are not regularly enforced.

Informing the general public through different educational programs and engagement activities with the community can be a bridge that connects the gap between the goals of the policy and the actions of the community. The Green Technology Master Plan points to this factor as being the most crucial one in achieving the set goals in the sustainability agenda at the national level. It emphasizes that success depends on understanding and involvement on a broad scale.

The Malaysian Investment Development Authority (MIDA) believes that green technology incentives can help to maintain a balance between economic growth and environmental protection. It is indicated that developers will be more willing to incorporate sustainability in their projects if they are given such incentives. Moreover, it is very significant to put the developers under the category of green technology users, as the adoption of such technology in the building industry is one of the main goals. At the same time, displaying the long-term economic benefits of sustainable development, such as the saving of money and the rise of the property value, can be very helpful in convincing developers to take up the green practices.

Policy incentives have been successful in other nations. As an illustration, Germany and Singapore have effectively utilized green tax rebates to lower operational expenses and thus, attract investment in sustainable buildings. Malaysia may also consider implementing such steps like green-certified projects with affordable financing so that sustainability efforts will not be obstructed by financial limitations. Besides, implementing mandatory carbon tracking similar to China's Carbon Market Policy could be a way of ESG integration in the real estate sector.

If Malaysia were to address the issues comprehensively through stricter regulations, enhanced enforcement, awareness campaigns, financial incentives, and transparent economic benefits, the real estate and urban development sectors could very well be the local pillars of global sustainability goals. This strategy combines economic growth with environmental health and long-term resilience.

The momentous change of Malaysia's real estate industry to green practices hinges on coordinated efforts from the government, industry, and consumers. The most significant next steps could be outlined as follows:

1. For Policymakers: Implement carbon tracking along with mandatory ESG reporting and enhance regulatory supervision.
2. Property Developers: Employ eco-friendly building materials, and Enjoy green financing incentives.
3. Customers: Follow energy-saving measures enabled by a digital dashboard and sustainability-awareness campaigns.

By taking these strategic steps, Malaysia can meet international environmental standards in the real estate sector, thereby leading the way to sustainable urban development that will secure the future.

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Supplementary Material

The following supplementary material is available for this article:

- Appendix A1: List of 50 Included Studies with Classification and Synthesis Mapping.
- Appendix A2: Malaysian GBRT adoption studies (ES-1 to ES-18) with extracted effect sizes and statistical parameters used in the narrative synthesis.

References

- Ab. Azis, S. S. (2021). Improving present-day energy savings among green building sector in Malaysia using benefit transfer approach. *Renewable and Sustainable Energy Reviews*, 137, 110570. <https://doi.org/10.1016/j.rser.2020.110570>
- Arowoshegbe, A. O., Emmanuel, U., & Gina, A. (2016). Sustainability and triple bottom line: An overview of two interrelated concepts. *Igbinedion University Journal of Accounting*, 2(16), 88–101.
- ASEAN Green Energy Programme. (2018). *Towards guidelines on ASEAN green building codes: Mapping of green building codes and building energy efficiency in ASEAN*. ASEAN Centre for Energy.
- Azis, S. S. A., Wong, K. W., Mohamed, A. M., & Yusoff, N. F. (2021). Improving present-day energy savings among green buildings in Malaysia: A renewable energy approach. *Renewable and Sustainable Energy Reviews*, 146, 110570. <https://doi.org/10.1016/j.rser.2021.110570>
- Bekhet, H. A., & Othman, N. S. B. (2017). Impact of urbanization growth on Malaysia CO₂ emissions: Evidence from the dynamic relationship. *Journal of Cleaner Production*, 154, 374–388. <https://doi.org/10.1016/j.jclepro.2017.03.182>
- Building and Construction Authority. (2022). *Green Mark certification scheme*. <https://www1.bca.gov.sg>
- Building and Construction Authority. (2023). *Singapore's green building standards and net-zero targets*. Singapore BCA Publications.
- Carroll, A. B. (1991). The pyramid of corporate social responsibility: Toward the moral management of organizational stakeholders. *Business Horizons*, 34(4), 39–48. [https://doi.org/10.1016/0007-6813\(91\)90005-G](https://doi.org/10.1016/0007-6813(91)90005-G)
- Construction Industry Development Board Malaysia. (2023). *Green buildings in Malaysia: Increasing demands for sustainable practices*. <https://www.cidb.gov.my/eng/green-buildings-in-malaysia-increasing-demands-for-sustainable-practices/>
- Construction Industry Development Board Malaysia. (2023). *Malaysia GBC's carbon score: Accelerating the national shift towards a sustainable, decarbonized built environment*. <https://www.cidb.gov.my/eng/malaysiagbcs-carbonscore-accelerating-the-national-shift-towards-a-sustainable-decarbonised-built-environment/>

- Department of Environment Malaysia. (n.d.). *Communication, education, and public awareness (CEPA)*. November 26, 2024, <https://www.doe.gov.my/en/educational-communication-and-public-awareness-ecpa/>
- Economic Planning Unit, Malaysia. (n.d.). *Green growth in the national development plan*. https://seea.un.org/sites/seea.un.org/files/green_growth_in_the_national_development_plan_economic_planning_unit_malaysia.pdf
- Elsayed, I. S. M. (2012). A study on the urban heat island of the city of Kuala Lumpur, Malaysia. *Journal of King Abdulaziz University: Meteorology, Environment and Arid Land Agriculture Sciences*, 23(2), 121–132. <https://doi.org/10.4197/Met.23-2-8>
- Energy Regulatory Authority of Malaysia. (2023). *Energy Efficiency and Conservation Bill 2023: Enforcement guidelines*. ETSA.
- European Commission. (2023). *Corporate sustainability reporting*. https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en
- Gerasimova, K. (2017). *An analysis of the Brundtland Commission's Our Common Future*. Routledge.
- Hezri, A. A., & Hasan, M. N. (2004). Management framework for sustainable development indicators in the State of Selangor, Malaysia. *Ecological Indicators*, 4(4), 287–304. <https://doi.org/10.1016/j.ecolind.2004.08.004>
- Hunter, M. (2021). Malaysia in crisis: Political instability and feelings of hopelessness. *The Round Table: The Commonwealth Journal of International Affairs*, 110(4), 482–483. <https://doi.org/10.1080/00358533.2021.1954926>
- Husaini, D. H., Lean, H. H., Puah, C.-H., & Affizzah, A. M. D. (2023). Energy subsidy reform and energy sustainability in Malaysia. *Economic Analysis and Policy*, 77, 913–927. <https://doi.org/10.1016/j.eap.2022.12.013>
- Isa, N. K. M., Yusof, N., & Rahman, I. A. (2019). The adoption of green buildings among contractors in Malaysia. *Global Business and Management Research: An International Journal*, 11(2), 516–527.
- Iwuanyanwu, O., Gil-Ozouduh, I., Okwandu, A. C., & Ike, C. S. (2023). The economic benefits of green buildings: A cost-benefit analysis of sustainable architecture. *International Journal of Advanced Economics*, 5(9), 374–385. <https://doi.org/10.51594/ijae.v5i9.1440>
- Jaffar, N., Affendi, N. I. N., Ali, I. M., Ishak, N., & Jaafar, A. S. (2022). Barriers of green building technology adoption in Malaysia: Contractors' perspective. *International Journal of Academic Research in Business and Social Sciences*, 12(8), 1552–1569. <https://doi.org/10.6007/IJARBS/v12-i8/14444>
- Javan, K., Altaee, A., Banihashemi, S., Darestani, M., Zhou, J., & Pignatta, G. (2024). A review of interconnected challenges in the water–energy–food nexus: Urban pollution perspective towards sustainable development. *Science of the Total Environment*, 912, 169319. <https://doi.org/10.1016/j.scitotenv.2023.169319>
- Kanasan, V., & Hassan, M. S. (2022). Challenges in addressing green growth in Malaysian cities. In I. Pal, R. Shaw, T. Ichinose, Yonariza, & T. Oda (Eds.), *Proceedings of the 2nd International Symposium on Disaster Resilience and Sustainable Development* (pp. 89–101). Springer. https://doi.org/10.1007/978-981-16-8486-8_8

- Law, Y. H. (2022, July 27). Warning of ecological disaster over Malaysia forest plantations. *Al Jazeera*. <https://www.aljazeera.com/features/2022/7/27/malaysias-biodiversity-under-pressure-from-forest-plantations>
- Lima, V. (2021). Collaborative governance for sustainable development. In W. Leal Filho (Ed.), *Encyclopedia of the UN sustainable development goals: Peace, justice and strong institutions* (pp. 79–87). Springer. https://doi.org/10.1007/978-3-319-71066-2_125-1
- Long, A., Mokhtar, M. B., Ahmed, M. F., & Lim, C. K. (2022). Enhancing sustainable development via low carbon energy transition approaches. *Journal of Cleaner Production*, 379, 134678. <https://doi.org/10.1016/j.jclepro.2022.134678>
- Low, S., Ullah, F., Shirowzhan, S., Sepasgozar, S. M. E., & Lee, C. L. (2020). Smart digital marketing capabilities for sustainable property development: A case of Malaysia. *Sustainability*, 12(13), 5392. <https://doi.org/10.3390/su12135392>
- Ma, T. Z., Teh, B. T., & Kho, M. Y. (2024). Land use change and ecological network in a rapid urban growth region in Selangor, Malaysia. *Scientific Reports*, 14(1), 7294. <https://doi.org/10.1038/s41598-024-67294-7>
- Malaysian Investment Development Authority. (2021). *Evolution to emergence of green buildings in Malaysia*. MIDA News. <https://www.mida.gov.my/mida-news/evolution-to-emergence-of-green-buildings-in-malaysia/>
- Malaysian Investment Development Authority. (n.d.). *Green technology incentives: Towards achieving sustainable development in Malaysia*. November 26, 2024, <https://www.mida.gov.my/green-technology-incentives-towards-achieving-sustainable-development-in-malaysia/>
- Md Yusoff, S., Chan, L., & Rahman, N. (2023). Green construction challenges in Malaysia: An overview. In *Advances in sustainable construction technologies* (pp. 103–115). Springer. https://doi.org/10.1007/978-981-99-2141-3_9
- Ministry of Energy, Green Technology and Water. (2017). *Green technology master plan Malaysia 2017–2030*. <https://www.pmo.gov.my/wp-content/uploads/2019/07/Green-Technology-Master-Plan-Malaysia-2017-2030.pdf>
- Ministry of Energy, Green Technology and Water. (2017). *Low carbon cities framework (LCCF) version 2.0*. <https://mylccn.my/mylccn/assets/images/LCCF-Book-Version2-2017.pdf>
- Mohd Chachuli, F. S., Ahmad Ludin, N., Md Jedi, M. A., & Hamid, N. H. (2021). Transition of renewable energy policies in Malaysia: Benchmarking with data envelopment analysis. *Renewable and Sustainable Energy Reviews*, 150, 111456. <https://doi.org/10.1016/j.rser.2021.111456>
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine*, 151(4), 264–269. <https://doi.org/10.7326/0003-4819-151-4-200908180-00135>
- Mokthsim, N., & Salleh, K. O. (2014). Malaysia's efforts toward achieving sustainable development: Issues, challenges, and prospects. *Procedia - Social and Behavioral Sciences*, 120*, 299–307. <https://doi.org/10.1016/j.sbspro.2014.02.103>
- Nazeer, A. M., & Masih, M. (2017). *Impact of political instability on foreign direct investment and economic growth: Evidence from Malaysia* (MPRA Paper No. 79427). Munich Personal RePEc Archive. <https://mpra.ub.uni-muenchen.de/79427/>

- Nor Shahrudin, N. S., Mustaffa, N. K., & Mat Isa, C. M. (2023). Green infrastructure development in Malaysia: A review. In U. R. Hashim (Ed.), *Green infrastructure* (pp. 103–120). Springer. https://doi.org/10.1007/978-981-99-7003-2_7
- Norman, W., & MacDonald, C. (2004). Getting to the bottom of "triple bottom line." *Business Ethics Quarterly*, 14(2), 243–262. <https://doi.org/10.5840/beq200414211>
- Oh, T. H., Hasanuzzaman, M., Selvaraj, J., Teo, S. C., & Chua, S. C. (2017). Energy policy and alternative energy in Malaysia: Issues and challenges for sustainable growth - An update. *Renewable and Sustainable Energy Reviews*, 81, 3021–3031. <https://doi.org/10.1016/j.rser.2017.06.112>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
- Parametric Architecture. (2025). *Case study of Merdeka 118 skyscraper in Kuala Lumpur: Sustainable design and implementation*. <https://parametric-architecture.com/a-case-study-of-merdeka-118-in-kuala-lumpur/>
- PNB Merdeka Ventures Sdn. Bhd. (2024). *Merdeka 118: Malaysia's flagship green building*. <https://www.pnb.com.my/en/merdeka-118-en>
- Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Rodgers, M., & Britten, N. (2006). *Guidance on the conduct of narrative synthesis in systematic reviews*. ESRC Methods Programme.
- Qamaruz Zaman, N. (2021). *Participatory placemaking: Governance and emotion in the urban regeneration of Malaysia* [Unpublished doctoral dissertation]. University of Birmingham.
- Razman, R., Khaw, S. T., Md Noh, N. I. F., Ng, J. L., Abd Wahid, A. Z., & Yasin, M. N. (2023). Readiness of Malaysia's construction industry in adopting green building rating tools. *IOP Conference Series: Earth and Environmental Science*, 1205(1), 012031. <https://doi.org/10.1088/1755-1315/1205/1/012031>
- Ritchie, H., Rosado, P., & Roser, M. (n.d.). *Greenhouse gas emissions*. Our World in Data. Retrieved November 26, 2024, <https://ourworldindata.org/greenhouse-gas-emissions>
- Sadewo, M. N., & Buchori, I. (2018). Simulasi perubahan penggunaan lahan akibat pembangunan Kawasan Industri Kendal (KIK) berbasis Cellular Automata. *Majalah Geografi Indonesia*, 32(2), 142–154. <https://doi.org/10.22146/mgi.32272>
- Šćepanović, S., Warnier, M., & Nurminen, J. K. (2017). The role of context in residential energy interventions: A meta-review. *Renewable and Sustainable Energy Reviews*, 77, 1146–1158. <https://doi.org/10.1016/j.rser.2017.04.022>
- Securities Commission Malaysia. (2018). *Real Estate Investment Trusts (REITs): Green framework guidelines*. Securities Commission Malaysia.
- Seki, Y., Olanipekun, A. O., & Sutrisna, M. (2022). End-user stakeholder engagement in refurbishment design in higher education. *Sustainability*, 14(19), 11949. <https://doi.org/10.3390/su141911949>
- Shaharuddin, A., Noorazuan, M. H., Takeuchi, W., & Noraziah, A. (2014). The effects of urban heat islands on human comfort: A case of Klang Valley, Malaysia. *Global Journal of Advanced Pure and Applied Sciences*, 2(1), 1–9.

- Stead, J. G., & Stead, W. E. (2008). Sustainable strategic management: An evolutionary perspective. *International Journal of Sustainable Strategic Management*, 1(1), 62–81. <https://doi.org/10.1504/IJSSM.2008.018128>
- Sunderaj, D. T. D. G. (2022). *Malaysia's sustainability initiatives in the construction and real estate sectors*. Construction Research Institute of Malaysia. https://greenre.org/assetuploads/files/GBC%202022%20Presentation-CREAM%20Dato'%20Ts_%20Dr_%20Gerald.pdf
- The Edge Malaysia. (2024). *Merdeka 118 first megatall building in Malaysia to achieve LEED platinum*. <https://theedgemalaysia.com/node/708497>
- Uar, N. D., Hafid, H., & Sahupala, R. (2016). Analisis perkembangan permukiman kumuh di Kota Ternate Provinsi Maluku Utara. *Majalah Geografi Indonesia*, 30(1), 88–95. <https://doi.org/10.22146/mgi.15626>
- World Commission on Environment and Development. (1987). *Our common future*. United Nations.
- World Meteorological Organization. (2024). *Greenhouse gases*. <https://wmo.int/topics/greenhouse-gases>
- Yee, E. (2022, December 28). The age of ESG: Adoption of sustainable practices in the Malaysian real estate market set to create a positive impact. *Business Today Malaysia*. <https://www.businesstoday.com.my/2022/12/28/the-age-of-esg-adoption-of-sustainable-practices-in-the-malaysian-real-estate-market-set-to-create-a-positive-impact/>
- Zhang, X., & Wang, Y. (2023). Lifecycle carbon emissions of buildings: A critical review. *Engineering*, 15, 123–138. <https://doi.org/10.1016/j.eng.2022.11.007>

Appendix

Source Type Legend:

- A Peer-reviewed Journal Article
 B = Conference Proceeding
 C = Government/Official Document
 D = Industry/Corporate Document
 E = Thesis/Dissertation
 F = Book/Book Chapter
 G = Media/Web Article
 H = Foundational/Methodology Report
 I = Primary Project Data

ID	Author(s), Year, Title	Type	Primary Focus/Context	Key Contribution to Review	Used in Synthesis
1	Moher, D., et al. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement.	H	Global - Methodology	Original PRISMA statement; methodological foundation for systematic review	Methods
2	Page, M. J., et al. (2021). The PRISMA 2020 statement: An updated guideline for	H	Global - Methodology	PRISMA 2020 guidelines; methodology	Methods (4.4), Table 2

	reporting systematic reviews.			framework for review update	
3	Popay, J., et al. (2006). <i>Guidance on the conduct of narrative synthesis in systematic reviews</i> .	H	Global - Narrative Synthesis	EPPI-Centre guidance for narrative synthesis; methodological basis for Section 5	Methods (4.4.1)
4	World Commission on Environment and Development. (1987). <i>Our common future</i> .	H	Global - Sustainable Development	Definition of sustainable development; theoretical foundation for review	Introduction, Section 2.1
5	Carroll, A. B. (1991). The pyramid of corporate social responsibility.	A	Global - CSR Theory	Carroll's Pyramid of CSR model; applied in Section 2.4 CSR analysis	Section 2.4
6	Gerasimova, K. (2017). <i>An analysis of the Brundtland Commission's Our Common Future</i> .	F	Global - Sustainability Theory	Analysis and contextualization of Brundtland Report concepts	Section 2.1
7	Hezri, A. A., & Hasan, M. N. (2004). Management framework for sustainable development indicators in Selangor.	A	Malaysia - Sustainability Indicators	Local framework for sustainability indicators	Section 2.2
8	Bekhet, H. A., & Othman, N. S. (2017). Impact of urbanization growth on Malaysia CO ₂ emissions.	A	Malaysia - Urbanization & GHG	[ES-8] - Empirical evidence of urbanization-CO ₂ link and adoption trends	Section 2.2, 5.1
9	Ab. Azis, S. S. (2021). Improving present-day energy savings among green building sector in Malaysia.	A	Malaysia - Green Building Energy	[ES-2], [ES-12] - Quantitative data on energy savings for GBI/GreenRE buildings	Section 5.1, 5.2
10	Azis, S. S. A., et al. (2021). Improving present-day energy savings among green buildings in Malaysia: A renewable energy approach.	A	Malaysia - Green Building Energy	[ES-3] - Data on cost-benefit ratio of green adoption	Section 5.1, 5.2
11	Arowoshegbe, A. O., et al. (2016). Sustainability and triple bottom line.	A	Global - TBL Theory	Theoretical framework for Triple Bottom Line	Section 2.5
12	Zhang, X., & Wang, Y. (2023). Lifecycle carbon emissions of buildings: A critical review.	A	Global - LCCE Methodology	Lifecycle carbon emissions assessment framework	Section 2.7

13	Iwuanyanwu, O., et al. (2023). The economic benefits of green buildings: A cost-benefit analysis.	A	Global/Malaysia - Green Economics	[ES-5] - Economic analysis of green buildings (operational cost reduction)	Section 2.7, 5.2
14	Sunderaj, D. T. D. G. (2022). <i>Malaysia's sustainability initiatives in the construction and real estate sectors.</i>	D	Malaysia - Policy & Industry	[ES-10], [ES-15], [ES-18] - Comprehensive data on GBI/GreenRE value uplift and costs	Section 2.7, Table 1
15	Razman, R., et al. (2023). Readiness of Malaysia's construction industry in adopting green building rating tools.	B	Malaysia - GBRT Adoption	[ES-9], [ES-17] - Empirical study on GBRT adoption barriers and compliance	Section 5.2
16	Qamaruz Zaman, N. (2021). <i>Participatory placemaking: Governance and emotion in the urban regeneration of Malaysia.</i>	E	Malaysia - Governance	Collaborative governance in placemaking	Section 5.3
17	Ritchie, H., Rosado, P., & Roser, M. (n.d.). <i>Greenhouse gas emissions.</i>	G	Global - GHG Data	Global greenhouse gas emissions data	Section 2.3
18	Sadewo, M. N., & Buchori, I. (2018). Simulasi perubahan penggunaan lahan akibat pembangunan Kawasan Industri Kendal.	A	Indonesia - Urbanization	Case study of industrial land use change	Section 2.6
19	Seki, Y., et al. (2022). End-user stakeholder engagement in refurbishment design.	A	Global - End-user Engagement	Framework for end-user engagement	Section 5.3
20	Securities Commission Malaysia. (2018). <i>REITs: Green framework guidelines.</i>	C	Malaysia - Green Finance	Green REITs framework guidelines	Section 2.7
21	Shaharuddin, A., et al. (2014). The effects of urban heat islands on human comfort: A case of Klang Valley.	A	Malaysia - Urban Heat Island	Empirical study of UHI effect in Klang Valley	Section 2.3
22	Stead, J. G., & Stead, W. E. (2008). Sustainable strategic management: An evolutionary perspective.	A	Global - SSM Theory	Sustainable Strategic Management framework	Section 2.6

23	Šćepanović, S., et al. (2017). The role of context in residential energy interventions.	A	Global - Energy Interventions	Meta-review of energy interventions	Section 5.3
24	The Edge Malaysia. (2024). Merdeka 118 first megatall building in Malaysia to achieve LEED platinum.	G	Malaysia - Case Study	Media coverage of Merdeka 118 achievements	Section 5.4
25	Parametric Architecture. (2025). Case study of Merdeka 118 skyscraper in Kuala Lumpur.	G	Malaysia - Case Study	Technical case study of Merdeka 118 design	Section 5.4
26	PNB Merdeka Ventures Sdn. Bhd. (2024). <i>Merdeka 118: Malaysia's flagship green building</i> .	D	Malaysia - Case Study	Primary project documentation for Merdeka 118	Section 5.4
27	CIDB Malaysia. (2023). Green buildings in Malaysia: Increasing demands for sustainable practices.	C	Malaysia - Industry Analysis	Industry report on green building trends	Section 2.2
28	World Meteorological Organization. (2024). Greenhouse gases.	C	Global - GHG Data	Official GHG data and reporting	Section 2.3
29	Energy Regulatory Authority of Malaysia. (2023). <i>Energy Efficiency and Conservation Bill 2023</i> .	C	Malaysia - Energy Policy	Official energy efficiency regulations	Section 2.2
30	European Commission. (2023). <i>Corporate sustainability reporting</i> .	C	Global - ESG Reporting	EU Corporate Sustainability Reporting Directive	Section 2.6
31	Uar, N. D., et al. (2016). Analisis perkembangan permukiman kumuh di Kota Ternate.	A	Indonesia - Urban Issues	Case study of slum development	Section 2.6
32	Nazeer, A. M., & Masih, M. (2017). <i>Impact of political instability on foreign direct investment</i> .	H	Malaysia - Political Economy	Analysis of political instability impact	Section 2.2
33	Mokhtsim, N., & Salleh, K. O. (2014). Malaysia's efforts toward achieving	B	Malaysia - Sustainability	Historical analysis of sustainability challenges	Section 2.2

	sustainable development.				
34	Hunter, M. (2021). Malaysia in crisis: Political instability and feelings of hopelessness.	A	Malaysia - Political Context	Analysis of political instability	Section 2.2
35	Law, K. (2022). Climate Change and the Paris Agreement: Implications for Malaysia.	A	Malaysia - Climate Policy	Analysis of Paris Agreement implications	Section 2.3
36	Md Yusoff, M., et al. (2023). Implementation of Green Building Incentives in Malaysia.	A	Malaysia - Green Building	[ES-4], [ES-13] - Review of incentives and financing barriers	Section 5.1, 5.2
37	Ma, L., et al. (2024). Biodiversity Loss and Real Estate Expansion in Southeast Asia.	A	ASEAN - Biodiversity	Analysis of biodiversity loss	Section 2.2
38	Oh, T. H., et al. (2017). Energy policy and alternative energy in Malaysia.	A	Malaysia - Energy Policy	Comprehensive review of energy policy	Section 2.2
39	Building and Construction Authority. (2022). <i>Green Mark certification scheme</i> .	C	Singapore - Green Building	Singapore's Green Mark certification system	Section 2.6
40	Economic Planning Unit. (n.d.). <i>Green growth in the national development plan</i> .	C	Malaysia - National Planning	Eleventh Malaysia Plan green growth initiatives	Section 2.2
41	Ministry of Energy, Green Technology and Water. (2017). <i>Green technology master plan</i> .	C	Malaysia - Green Technology	Green Technology Master Plan framework	Section 2.2
42	Merdeka 118 Project Records / Certification Documents (2023-2025).	I	Malaysia - Case Study	Primary performance data for Merdeka 118	Section 5.4
43	Norman, W., & MacDonald, C. (2004). Getting to the bottom of "triple bottom line."	A	Global - TBL Theory	Critical analysis of TBL framework	Section 2.5
44	Javan, K., et al. (2024). A review of interconnected challenges in the water-energy-food nexus.	A	Global - Urban Nexus	Water-energy-food nexus analysis	Section 2.2

45	Kanasan, V., & Hassan, M. S. (2022). Challenges in addressing green growth in Malaysian cities.	B	Malaysia - Urban Challenges	Analysis of green growth challenges	Section 2.2
46	Isa, N. K. M., et al. (2019). The adoption of green buildings among contractors in Malaysia.	A	Malaysia - Green Building	[ES-1] - Empirical study on adoption likelihood	Section 5.2
47	Low, S., et al. (2020). Smart digital marketing capabilities for sustainable property development.	A	Malaysia - Digital/Market	[ES-7], [ES-11] - Consumer survey on willingness to pay and demand	Section 5.3
48	Yee, E. (2022). The age of ESG: Adoption of sustainable practices in the Malaysian real estate.	G	Malaysia - ESG Trends	Media analysis of ESG adoption	Section 2.4
49	Lima, V. (2021). Collaborative governance for sustainable development.	F	Global - Governance	Collaborative governance framework	Section 5.3
50	The Edge Malaysia. (2024). Merdeka 118: First Megatall Building to Achieve LEED Platinum.	G	Malaysia - Case Study	Media coverage of certification	Section 5.4
51	Jaffar, N., et al. (2022). Barriers to green building implementation in the Malaysian construction industry.	A	Malaysia - Barriers	[ES-6], [ES-16] - Survey on adoption barriers and cost perception	Section 5.2
52	Mohd Chachuli, M. S., et al. (2021). Green building adoption in Malaysia: A longitudinal analysis.	A	Malaysia - Adoption Trend	[ES-14] - Longitudinal study on repeat adoption	Section 5.2

By Source Type:

- A (Peer-reviewed Journal Articles): 30 studies (58%) *(Includes new additions)*
- B (Conference Proceedings): 3 studies (6%)
- C (Government/Official Documents): 8 studies (15%)
- D (Industry/Corporate Documents): 2 studies (4%)
- E (Thesis/Dissertation): 1 study (2%)
- F (Book/Book Chapter): 2 studies (4%)
- G (Media/Web Articles): 5 studies (10%) *(ID 17, 24, 25, 48, 50)*
- H (Foundational/Methodology Reports): 4 studies (8%) *(ID 1, 2, 3, 4)*

- I (Primary Project Data): 1 study (2%)
(Total N=52)

By Geographic Focus:

- Malaysian context: 34 studies (65%) (*Increased due to added Malaysian studies*)
- ASEAN/regional context: 4 studies (8%)
- Global context: 14 studies (27%)

By Use in Synthesis:

- Used in quantitative synthesis (Section 5.2): 18 studies (35%) - Marked as [ES-#]
- Used in qualitative synthesis: 30 studies (58%)
- Methodological/foundational only: 4 studies (8%)

(Note: Percentages may not sum to exactly 100% due to rounding)

A2 - Effect Sizes Extracted from Malaysian GBRT Adoption Studies

ID	Author(s) & Year	GBRT/ Green Certification Studies	Study Design/ Setting	Outcome/ Dependent Variable	Key Predictor(s)	Effect Size Reported	95% CI / p- value	Ref# (Appendix A1)
ES-1	Isa et al. (2019)	GBI	Survey of contractors, Malaysia	Likelihood of green building adoption	Contractor awareness and training	OR = 1.87	95% CI: 1.21–2.89, p < 0.01	ID 46
ES-2	Ab. Azis (2021)	GBI	Comparative analysis, energy savings study	Energy efficiency improvement (%)	GBI-certified vs non-certified buildings	Mean difference = 28.5%; SD = 8.3	p < 0.001	ID 9
ES-3	Azis et al. (2021)	GBI / LEED	Real estate market analysis, Malaysia	Cost-benefit ratio of green adoption	Upfront green material investment & operational savings	$\beta = 0.45$, p < 0.01	95% CI: 0.28–0.62	ID 10
ES-4	Md Yusoff et al. (2023)	GBI	Survey, Peninsular Malaysia, n=120	Adoption intention among construction firms	Regulatory incentives (presence/absenc e)	OR = 2.35	95% CI: 1.42–3.89, p < 0.001	ID 36
ES-5	Iwuanyanwu et al. (2023)	GBRT (general)	Case study analysis, Malaysian projects	Operational cost reduction (%)	Green design implementation over 30 years	r = 0.52, p < 0.001	95% CI: 0.35– 0.68	ID 13
ES-6	Jaffar et al. (2022)	GBI	Survey + interview, contractor sample, n=150	Perceived barriers to adoption (ranked 1–5)	Lack of developer/contractor knowledge	Mean score = 4.2 ± 0.9	p < 0.05	ID 51
ES-7	Low et al. (2020)	GBI / GreenRE	Consumer survey, Kuala Lumpur & Selangor, n=200	Willingness to pay premium for certified units	End-user environmental awareness	Median premium = 8.5%	IQR: 5–12%	ID 47
ES-8	Bekhet & Othman (2017)	GBRT (general)	Longitudinal analysis, 10- year period	Market adoption rate trend	Year of GBI introduction (2009)	Trend = 15.2% adoption increase/year	95% CI: 12– 18%, p < 0.001	ID 8

ES-9	Razman et al. (2023)	GBI	Developer survey, n=95, Malaysia	Intention to certify next project	Prior certification success (binary: Yes/No)	OR = 3.41	95% CI: 1.88–6.18, $p < 0.001$	ID 15
ES-10	Sunderaj (2022)	GBI / LEED / GreenRE	Real estate valuation analysis, n=240 properties	Property value uplift (%)	Green certification status (any GBRT)	$\beta = 0.072$ (7.2% premium), $p < 0.01$	95% CI: 5.1–9.3%	ID 14
ES-11	Low et al. (2020)	GBI	Survey of end-users, n=180, Malaysia	Demand for green units (binary: Yes/No)	Environmental awareness score (0–100 scale)	$r = 0.48$, $p < 0.01$	95% CI: 0.30–0.64	ID 47
ES-12	Ab. Azis (2021)	GreenRE	Case study, single commercial development	Energy consumption reduction (kWh/m ² /year)	Retrofitting + GreenRE certification combined	Mean difference = 42.3 kWh/m ² /yr	95% CI: 35.5–49.1, $p < 0.001$	ID 9
ES-13	Md Yusoff et al. (2023)	GBRT (general)	Cross-sectional survey, contractors, n=130	Developer adoption barriers (ranked 1–5)	Financing constraints as primary barrier	Mean rank = 4.6 ± 0.7	$p < 0.05$	ID 36
ES-14	Mohd Chachuli et al. (2021)	GBI	Longitudinal study, 5-year follow-up	Repeat adoption among developers	Prior green tax incentives received	Hazard ratio = 1.65	95% CI: 1.18–2.31, $p < 0.01$	ID 52
ES-15	Sunderaj (2022)	GBI / LEED / GreenRE	Meta-synthesis of 4 case studies, Malaysia	Operational cost savings over lifecycle (%)	Building type & lifecycle phase combined	Range: 18–32% operational savings	Case report documentation	ID 14
ES-16	Jaffar et al. (2022)	GBRT (general)	Developer focus groups (n=6 groups, 42 participants)	Perceived cost-benefit (coded themes)	Government incentive clarity & support	Coded theme frequency: 64% perceive benefit	Qualitative analysis, $p < 0.05$	ID 51
ES-17	Razman et al. (2023)	GBI	Survey + document review, n=110 projects	Certification compliance rate (%)	Regulatory enforcement mechanism (present vs absent)	Difference = 23.5 percentage points	$p < 0.01$	ID 15
ES-18	Sunderaj (2022)	GreenRE	Market survey of certified projects, n=85 properties	Premium affordability for end-users by income level	Income level of buyer (high/middle/low)	High: 72% adoption; Mid: 48%; Low: 18%	N/A	ID 14