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LOW-CARBON ADOPTION IN JOHOR HOUSING DEVELOPMENT

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Abstract

Construction activities have been identified as one of the sectors that contribute to high gas emissions, which inspires low-carbon housing development. This paper discusses the adoption of low-carbon design/features in Johor housing development and its cost implications. Five landed and high-rise housing case studies were gathered and analysed from both expert interviews and document analysis. Findings indicate that landed housing exerted more low-carbon design/features than high-rise housing due to design economics implications with an additional cost of 17.5% for high-rise and 10% for landed. The hard costs accounted for 83.5% of high-rise projects and 66% of landed ones, while the soft costs accounted for 16% of high-rise projects and 27% of landed ones. The remaining land costs depend on the developer's land bank and the land's book value. In conclusion, despite the higher development costs, low-carbon design/features adoption is worth considering for a more sustainable housing development in Malaysia.

Keywords: Low-Carbon Adoption, Development Cost Implications, Gross Development Costs, Housing Development, Malaysia.

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INTRODUCTION

The living space environment is deteriorating annually due to the steadily increasing degree of environmental harm (Chengchao et al., 2021). People began to understand the urgency of saving the planet as natural disasters and climate change began to sound alarms and send sick sirens across the planet (Fawzy et al., 2020). In response, countries around the world have begun to implement a variety of effective policies, mostly aimed at achieving social, environmental, and economic benefits. It allows the maximisation of improving the serious environmental situation through low-carbon developments.

According to the United States Environmental Protection Agency, there have been various changes, which include the positive and negative effects on people, society, and the environment, including plants and animals in the report by indicators (United States Environmental Protection Agency, 2022). Based on the 2020 Global Status Report for Buildings and Construction, the emissions from building operations are about 28% of total global energy-related CO2 emissions in 2020. When emissions from buildings are included, this proportion increases to 38% of total global energy-related CO2 emissions (Global Alliance for Buildings and Construction, 2020). Emissions must be decreased by 45% by 2030 and achieve net zero by 2050 if the Paris Agreement's goal of limiting global warming to 1.5°C is to be met. With goals of attaining this by 2050, Malaysia is completely committed to playing an important role in the worldwide shift to a low-carbon, and eventually carbon-neutral society (United Nations, 2022).

However, there is a cost barrier to adopting sustainable components that produce sustainable developments. The perception that sustainable products are more expensive than conventional ones is already widespread (Lawrence, 2020). Since most people do not understand low-carbon or sustainable products, their understanding towards this concept is that the adoption will be expensive. Although the upfront costs may be higher in many circumstances, the overall life cycle costs are much lower because the products may be in use continually and sustainably (Luay et al., 2018). Hence, there is an evidence gap to debunk the perception that sustainable development, particularly housing is expensive as it is not always true, and choosing a sustainable choice is better for the environment and the wallet (Gammage, 2022). In terms of long-term benefits, this adoption is not only saving unnecessary expenses but also brings advantages to people. For example, efficient use of energy, water and other resources, usage of renewable energy to reduce the waste of energy, pollution, waste reduction measures, as well as the enabling of re-use and recycling (British Assessment Bureau, 2021). The utilisation of sustainable components will effectively reduce the impact of climate change.

Hence, it is crucial to study the adoption of low-carbon design/features and its development cost implications for better cost analysis as well as the return of investment analysis to encourage future adoption of low-carbon for the long-term benefits of ensuring a more sustainable housing development in Malaysia.

LOW-CARBON DESIGN / FEATURES OVERVIEW

Low-carbon design/features is a method of design that combines sustainable practices and energy efficiency practices to minimise the environmental impact of a structure or a product (Chang, 2021). It is a comprehensive method of design and building that incorporates modern, ecologically friendly, and energy-efficient techniques utilised to create an improved future. In order to lower carbon emissions and advance sustainability, low-carbon design can be implemented in buildings, items, and even cities (Gustafson, 2023). The primary purpose of low-carbon building design is to optimise the building's orientation, structure, window/glazing position, size, and material selection in order to reduce carbon emissions and improve energy efficiency. Low-carbon design entails using low-carbon materials for building structures and finishes, minimising destruction, and reusing buildings and construction materials whenever practical. Reducing the carbon footprint of a building or product can also be accomplished by adopting awareness during the design and construction phases (Chang, 2021). Additionally, landscaping, massing and space layout; window design; shading device design strategies; cooling and heating system (HVAC); natural ventilation; building design, and design strategies are elements of low-carbon sustainable home design (Naief et al., 2015).

Low-Carbon Adoption in Malaysia

According to Malaysia’s finance minister, Malaysia is striving to move towards a low-carbon development and climate-resilient economy as its goal, which could allow the country to tackle a turning point in the climate and biodiversity crisis (Ministry of Finance, 2021). Malaysia also announced the launch of a comprehensive national energy policy soon following the release of the 12th Malaysia Plan (12MP), which aims to provide direction towards a low-carbon long-term strategy. According to Kasturi Nathan, KPMG's Head of Governance and Sustainability in Malaysia, the government has an important role to play in reaching the goal of net zero emissions by 2050. Firstly, the government needs to develop a clear implementation policy. Secondly, the support for small and medium-sized enterprises and investment in research and development will allow the public to realise their innovative potential. Thirdly, is to create market value for low-carbon services and products (KPMG, 2021).

National Low-Carbon Cities Master Plan

In 2021, Malaysia announced a National Low-Carbon Cities (NLCCM) Master Plan at a conference on the theme of "Empowering Cities Towards a Low-Carbon

Pathway". The purpose of the master plan is to plan the strategies and objectives for the practice of low-carbon cities and the methods or actions to be taken in practice. The master plan emphasises the definition of three main elements, which include the pursuit of a systematic approach, the adoption of regional strategies and the setting of ambitious greenhouse gas reduction targets. Six of these categories demand a significant change in the way low-carbon development is carried out. The six categories are governance and implementation frameworks, urban planning, community engagement, finance and capacity building, data collection and analysis as well as built environment and physical infrastructure (Ministry of Environment and Water (KASA), 2021). The key directions, actions, and targets for the master plan are depicted in Figure 1.

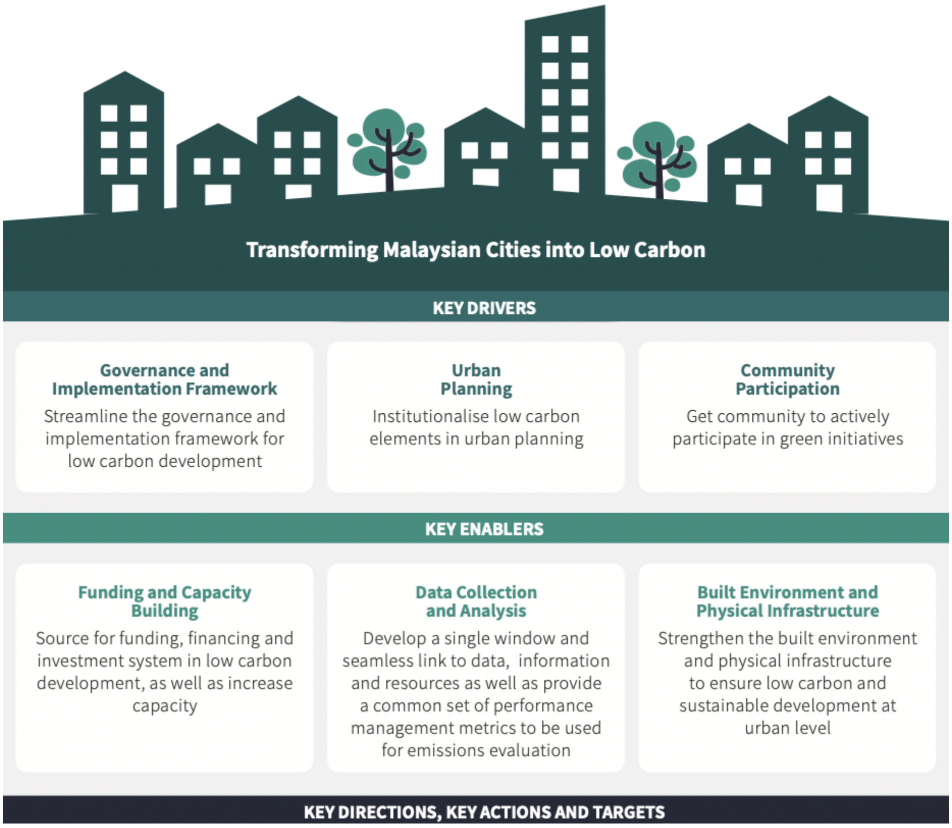

Figure 1: National Low-Carbon Cities Master Plan
Source: Ministry of Environment and Water (KASA) (2021)

The primary directives of the National Low Carbon Cities master plan are further cascaded down into project planning and implementations, especially at the pre and post-contract stages. The following section explains the execution of the low-carbon initiatives adopted in the Malaysian construction industry.

Green Building Index

Sustainable or green developments are certified through the assessment tools or the environment rating system. In Malaysia, one of the well-established green building assessment tools is called Green Building Index (GBI) (Sollar et al., 2022). When a building achieves six GBI criteria such as Energy Efficiency, Indoor Environment Quality, Sustainable Site Planning & Management, Materials & Resources, Water Efficiency, and Innovation, it will receive a GBI certificate. The aim is to demonstrate that the building is compliant with low-carbon or sustainable design criteria. GBI is a guideline and criteria for developers, project team members, and building owners to build low-carbon or sustainable buildings which will bring benefits to the Earth. The utilisation of the Green Building Index tool does not grant the user or any other entity the right to publicly disclose the Green Building Index rating received without formal certification by an independent accredited GBI Certifier (Green Building Index, 2013). In addition, it is designed to encourage the construction of environmentally sustainable buildings in Malaysia and promote a more sustainable built environment. Buildings that meet the required criteria are awarded a GBI certification based on their level of achievement. GBI rating is divided into four categories, which are Certified (50 - 65 points), Silver (66 - 75 points), Gold (76 - 85 points), and Platinum (86 - 100 points). The higher the GBI rating point, the higher the level of achieved GBI criteria (Green Building Index, 2022).

Common Low-Carbon Design / Features In Malaysian Housing Development

With respect to the Green Building Index certification, building elements were developed with low-carbon designs/features, which are portions or features of a structure or development that are designed and built with a lower carbon footprint and fewer greenhouse gas emissions in mind. These components can include a variety of design methods, construction materials, and energy systems that aim to reduce the energy consumption and carbon emissions associated with building-related processes. Hence, the adoption of Low-Carbon can be in the form of either the process, the design, the construction, or the materials. Each option is totally up to the client and the design team to choose. Energy-efficient lighting, rainwater harvesting systems, green roofs, the Digital Industrialised Building System (IBS), and natural ventilation are all examples of low-carbon features (Ramli et al., 2023). These characteristics might be considered when adopting materials and construction processes.

DEVELOPMENT COSTS IMPLICATIONS FROM LOW-CARBON ADOPTION IN MALAYSIA

Typically, there are three development cost components in Malaysian home development: land costs, hard costs, and soft costs. Each component has its own elements and yardsticks, and the weightage varies depending on the project's location and scope.

Theoretically, compared with conventional buildings in the past, green buildings cost more but have lower operating and maintenance costs. Typically, green buildings cost about 28% more than conventional buildings, and costs for operation and maintenance are 35 to 41%, 26 to 30% and 6 to 18% lower than conventional buildings. Green buildings' life cycle costs are also 24% to 28% lower than conventional buildings (Achini Shanika Weerainghe, 2017). In order to meet the GBI rating criteria, developers will incorporate sustainable or low carbon in either the form of green systems, materials, or components. Each component and material used vary in terms of quality and price, which subsequently affect the final cost of the overall development costs. The differences between conventional building costs and low-carbon building costs should be explored in more depth as the corresponding analysis and conclusions. This analysis especially should focus on the differences in price between the hard costs, soft costs, and land costs of a low-carbon housing development and a conventional housing development.

Land Costs

One of the main development costs which varies due to the project locality is land cost. The cost includes all costs related to purchasing a specific piece of property, as well as those related to preparing the site for construction (Saltler, 2020). Land is scarce in major cities and the prices depend on the location in terms of connectivity and scale of development. For a piece of land located in an established development area, the transaction costs would be higher. The conversion of land ownership to residential use will eventually lead to higher land costs. When the land costs increase, the overall development costs will also increase (Boon et al., 2018).

Hard Costs

This cost component carries the highest weightage in any typical conventional housing development cost (Construction Industry Development Board Malaysia, 2021). It is a cost that is directly associated with building construction, which can be observed in both housing townscape and building scope (Megan Keup, 2022). From the building scope perspective, hard cost is the cost associated with building elements such as frames, finishes, and external works. Hard costs can be further debunked into expenses for elements like raw materials and direct labour for construction which raise the likelihood of a project's completion (Srivastav, ND). Hard costs also include additional expenses and other supplemental needs. When a project is in the construction stage, hard costs are incurred. Market circumstances have an impact on the cost of materials, labour, and project scheduling, which makes hard cost estimation reliant on them. A project's hard costs are calculated from its inception until the completion of the building process. Making a list of all the supplies and machinery needed for the construction tasks according to local prices will help in estimating the hard costs. The labour costs are then determined by comparing and investigating the number of man-hours needed for a comparable job in the past (Neenu, 2022).

Soft Costs

Soft costs are not directly related to and do not contribute to the actual building's construction. These are extra expenses that are not immediately connected to building development. Due to the possibility of it continuing even after the project has been finished and delivered, it is difficult to quantify and difficult to predict (Srivastav, ND). Some soft costs will be recurring and become a continued expense for maintenance and maintenance insurance. Throughout a project's lifespan, they could happen at any moment. These soft costs are certainly moving targets, but that doesn't mean it's impossible to estimate and monitor them. When forecasting the budget, it is vital to thoroughly consider everything from pre-construction to post-construction. Soft costs may be easy to overlook but once missed could account for between 25% and 75% of the overall construction budget. Some examples of soft costs are studies fees, equipment expenses, project management costs and taxes, and others (Megan Keup, 2022). To obtain a precise estimation of soft costs, it is crucial to take into account different scenarios and anticipate the potential cost range. This is because soft costs could be grown and altered (Thompson, 2022).

LOW-CARBON ADOPTION IN HOUSING DEVELOPMENT

A better understanding of the low-carbon design/features implemented within housing development is required as there is no standard currently. Hence, this research proposed the well-established Green Building Index's six criteria as the basis to outline the common low-carbon design/features adopted within the housing development (Ab. Azis, 2021). The six GBI criteria are Energy Efficiency, Indoor Environment Quality, Sustainable Site Planning & Management, Materials & Resources, Water Efficiency, and Innovation. Each of the GBI criteria can also be observed in both townscape and building elements in a typical housing development.

RESEARCH METHODOLOGY

The research design was qualitative, with descriptive analysis using project case studies. This study delves deeper into the design and features of low-carbon dwelling development by Malaysian housing developers. The study's major goal was to review previous case studies with low carbon design/features and Green Building Index certification to determine the monetary effects of their adoption. For this study, the collected case studies are limited to low-carbon designs/features adopted by Johor housing development and the development costs were attained to study the monetary implications of the low-carbon adoption. To ensure a similar basis for comparison, low-carbon housing projects with a minimum of Certified Green Building Index certification, either for a new building or a retrofitting of a building are considered a suitable case study. Every housing development that is considered must have been carried out using low-carbon development. Therefore, all selected projects must apply several low-carbon designs/features in the housing development. The characteristics of the case studies are (1) housing projects achieved with GBI certification, (2) low-carbon design/features implemented in the housing projects with six GBI criteria: EE, EQ, SM, MR, WE, IN, as well as (3) the provision of ECA comprises land costs, hard costs, and soft costs.

Table 1 depicts a collection of five low-carbon Johor housing development projects, all of which have Certified Green Building Index accreditation. All case study information was gathered through interview sessions to determine the adopted low-carbon design/features and project development costs, which were then examined using document analysis. It was based on Malaysia's National Low Carbon Cities Master Plan principles as well as the six criteria in the Green Building Index (GBI), with a special focus on the developers' approach to designing and implementing low carbon design/features in their housing construction.

Table 1: Five Case Studies Details

	Projects				
	1	**2**	**3**	**4**	**5**
Type of Residential	High-Rise Apartment	High-Rise Apartment	Landed – Double-Storey Terrace House	Landed – Double-Storey Terrace House	Landed – Double-Storey Semi-Detached House
Type of Development	Mixed Develop-ment	Mixed Develop-ment	Township	Township	Self-Contained Township

Source: Authors

RESULTS AND DISCUSSION

The interview questions were separated into three sections: part A, part B, and part C. The participating developers gave five case studies during the interview sessions. All five case studies were certified with the minimum GBI standard. The interview consisted of 20 questions designed to achieve Research Objectives 1 and 2, which were to determine the low-carbon design/features in the project case studies development and the development cost for the low-carbon home construction. The interviews were conducted in person.

Low-Carbon Adoption in Johor Housing Development

Research Objective 1 is to study the low-carbon adoption in Johor housing development according to six GBI criteria. As highlighted, each of the criteria can be adopted in either or both housing townscape and building per say. Based on the five case studies provided by the developers, the common low-carbon designs/features adopted in Johor housing development were identified and illustrated in Table 2. The data is analysed according to the six criteria of GBI as explained previously.

Table 2: Low-Carbon Adoption in Johor Housing Development

Low Carbon Designs/Features	Project 1 (high-rise)	Project 2 (high-rise)	Project 3 (landed)	Project 4 (landed)	Project 5 (landed)
Energy Efficiency (EE)					
LED Lighting	√	√	√	√	√
Renewable Energy	√				
Lower Accumulation Heat			√		
Indoor Environment Quality (EQ)					
Daylighting	√		√	√	√
Air-conditioning system	√	√			
Natural Ventilation			√		
Sustainable Site Planning & Management (SM)					
Reservoir			√		
Replanted Trees			√		
Material & Resources (MR)					
3R Recycle Center			√		
Motion Sensor			√		
Solar Water Heater			√		√
Low Volatile Organic Compound (VOC)		√			√
Tempered Glass					√
Floor-to-ceiling Window					√
Water Efficiency (WE)					
Rainwater Harvesting System		√	√	√	
Water Efficient tap & fittings		√			
Innovation (IN)					
Green Park				√	

Source: Authors

As observed, in terms of energy efficiency, the cost components can be categorised within both townscape and building. According to the common low-carbon designs/features adopted in Johor housing development identified as shown above, Project 3 has the highest number of low-carbon design/features adoption compared to other projects. Moreover, based on the analysis, it can also be found that every low-carbon housing development project adopted LED as the main lighting in their development. Besides that, daylighting is also one of the low-carbon designs/features that was accounted for in almost all of the case studies. It was observed that the developers focussed more on energy efficiency (EE) and indoor environment quality (EQ) features compared to sustainable site planning and management (SM), material and resources (MR), water efficiency, and innovation (IN). For high-rise projects, the application of LED lighting is adopted in all projects. For the high-rise projects, Projects 1 and 2, the adoption of LED was mainly in the common areas compared to landed projects as observed in Projects 3, 4 & 5. The adoption of LED lighting for landed projects is mainly observed in townscape components mainly for street and common space lighting. It is interesting to observe that the low-carbon design adoption varies from high-rise and landed housing development.

Development Cost Implications from Low-Carbon Adoption in Johor Housing Development

Research Objective 2 is to study the development cost implications of low-carbon adoption in Johor housing development according to the aspect of land costs, hard costs, and soft costs. The housing developers have provided Elemental Cost Analysis (ECA) for the case studies as a basis to prove their figures as well as to justify their business strategy and decision-making regarding the low-carbon adoption in their housing development. To justify the cost implications, the gross development costs (GDC) and gross development value (GDV) of the five case studies were obtained and presented in Table 3 below.

Table 3: Development Costs Implications from Low-Carbon Adoption in Johor Housing Development

Element	**Project**				
	1	**2**	**3**	**4**	**5**
	Cost (RM)	**Cost (RM)**	**Cost (RM)**	**Cost (RM)**	**Cost (RM)**
Total Construction Cost	152,345,343.00	118,065,387.00	50,673,999.00	279,017,023.00	87,072,651.00
Land Cost	1,237,444.00	3,963,543.00	5,115,541.00	6,919.00	7,700,558.00
Hard Cost	127,249,298.00	101,377,396.00	37,718,256.00	181,970,815.00	36,193,142.00
Soft Cost	19,317,250.00	12,530,230.00	7,840,202.00	91,491,128.00	50,781,355.00
GDC	156,586,591.00	118,065,387.00	50,673,999.00	279,017,023.00	87,072,651.00
GDV	169,778,600.00	161,358,750.00	70,325,995.00	395,015,279.00	41,183,200.00
	High-rise		Landed		
Cost/sqft	493.58	475.53	279.00	332.78	887.10

Source: Authors

Based on the table shown above, Project 4, a landed double-storey terrace project has the highest total construction costs and gross development value (GDV) although it is among the minimal low-carbon design adoption. In comparison to the conventional double-storey landed terrace, the adoption of low-carbon design/features increased the overall GDV from RM 200+ per square feet to RM 279+ per square feet, an increase of 39.5%. As for high-rise buildings, a 58.3% increase was observed from RM 300+ square feet to RM 475+ square feet. Although it is interesting to observe the cost increment, it is more interesting to observe the selling price increment of the low-carbon design adoption. For instance, Project 2 adopted mainly townscape features but have a much higher GDV compared to Project 1. Surprisingly, Project 3 adopted many features but did not receive as many GDV compared to Project 4. This suggests that the selection of low-carbon design be it at building cost or townscape cost did not have a direct correlation to the overall GDV of the project. Typically, for all case studies, it was found that the hard costs are the main costs that contribute to development cost implications. However, it was also noteworthy that different types of housing developments adopted different types of low-carbon designs/features according to the suitability of the project characteristics, as previously highlighted in the literature. It was obvious that the selection of design features was based purely on the developer's preference and their business strategies.

CONCLUSIONS AND RECOMMENDATION

A greater understanding of the low-carbon design/features used by Johor housing developers, as well as the development costs associated with low-carbon adoption, has been achieved. The low-carbon design/features were identified using six GBI criteria, and because of the additional features compared to conventional housing, low-carbon adoption was slightly higher, with 17.5% for high-rise housings and 10% for landed housings. Interestingly, the pricing increase was predicated on the minimum GBI certification. The increased cost can be detected from either the townscape or the building scope, or a mix of both, depending on the project's characteristics. It is preferable to assess the cost implications of low-carbon design/features using the Elemental Cost Analysis (ECA) format, which is a well-known international format. However, due to confidentiality concerns, respondents were reluctant to give detailed costings, limiting the cost analysis to the conventional building element categories.

Despite the higher development cost implications, low-carbon adoption is still worth looking at from the long-term benefits of ensuring a more sustainable housing development in Malaysia. Additionally, the knowledge obtained from this study can assist industry players in the decision-making process to better understand the benefits of low-carbon adoption and its corresponding development cost implications as each low-carbon design/feature adopted will have a monetary impact on the housing development costs. The results of this study should also be explored in more depth as future research, focussing on the differences between land costs, hard costs, and soft costs of a low-carbon housing development compared to a conventional housing development.

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