UNVEILING THE COST DIFFERENTIAL: DRIVERS BEHIND THE INCREMENTAL COSTS OF GREEN OFFICE BUILDING CONSTRUCTION IN KUALA LUMPUR

SHAWN FOO SHAO ENN

MASTER OF BUSINESS REAL ESTATE DEVELOPMENT

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF ACCOUNTANCY AND MANAGEMENT

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Shawn Foo Shao Enn

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By

Shawn Foo Shao Enn

This research project is supervised by:

Chin Hon Choong
Assistant Professor
Department of Building and Property Management
Faculty of Accountancy and Management

DECLARATION

I hereby declare that:

(1) This Research Project is the end result of my own work, and that due acknowledgement has been given in the references to all sources of information be they printed, electronic, or personal.

(2) No portion of this research project has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

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Name of Student: Shawn Foo Shao Enn
Student ID: 22UKM06553.
Signature: *Shawn*
Date: 4/12/2023

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DEDICATION

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ABSTRACT

Green building practices, aimed at minimizing environmental impact through resource efficiency, renewable energy use, green design and eco-friendly materials, have been globally introduced to address environmental concerns. However, the adoption of such practices varies across countries. In Malaysia, the adoption of green building practices remains low, with various studies highlighting barriers such as the lack of professionals, green technology, market awareness, government initiatives, and incentives, as well as human perceptions and behaviours. Yet, the consensus among researchers points to incremental costs as a significant hindrance. This research focuses on understanding the specific factors causing incremental costs in green office buildings in Malaysia.

The choice of green office buildings as the research focus stems from their high resource consumption, including equipment and electricity for lighting, air handling units, and air conditioning. Face-to-face interviews were conducted with 20 respondents from diverse real estate professional backgrounds, including green certification organizations, architects, quantity surveyors, and a government green agency in Kuala Lumpur, Malaysia. Thematic analysis revealed four categories of incremental cost factors: active green design, passive green design, sustaining green equipment setup and maintenance, and indoor air quality management material.

The study also identifies government incentives and education and awareness as crucial strategies for promoting green office adoption in Malaysia. The research contributes valuable insights for stakeholders, allowing real estate professionals and developers to make informed decisions and budget effectively. Policymakers can use these findings to enhance government incentives and support systems for green construction. Ultimately, this thesis aims to provide essential input for advancing the adoption of green office buildings in Malaysia.

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ACEM	Association of Consulting Engineers Malaysia
AHU	Air handling unit
BAU	Business As Usual
BEEE	Bachelor of Engineering in Electrical Engineering
BIM	Building Information Modelling
BREEAM	Building Research Establishment Environmental Assessment Method
CBD	Central Business District
CBRE	Coldwell Banker Richard Ellis
CDIAC	Carbon Dioxide Information Analysis Center
CIDB	Construction Industry Development Board
CISs	Construction Industry Standards
CO2	Carbon dioxide
EA	Energy and Atmosphere
EE	Energy Efficient
EPA	Environmental Protection Agency
ESG	Environment, Social, and Governance
EV	Electric Vehicle
GBCA	Green Building Council of Australia's
GBI	Green Building Index
GBRTs	Green Building Ranting Tools in Malaysia Green Building Rating
GDP	Gross domestic product
GHG	Greenhouse Gas
GreenPASS	Green Performance Assessment System
GreenRE	Green Real Estate
GRHC	Green Roofs for Health Cities
GT	Grounded Theory
GWh	Gigawatt Hour
HDA	Housing Developers' Association
HVAC	heating, ventilation, air-conditioning
IEQ	Indoor Environmental Quality
JKR	Malaysian Public Works Departmen

KeTTHA	Ministry of Energy, Green Technology and Water
KL	Kuala Lumpur
LCC	Life cycle costing
LEED	Leadership in Energy and Environmental Design
Low-E	Low Emissivity
MDEC	Malaysia Digital Economy Corporation
MGBC	Malaysia Green Building Confederation
MGBRTs	Malaysian Green Building Rating Tools
MGTC	Malaysian Green Technology and Climate Change Corporation
MIDA	Malaysian Investment Development Authority
MR	Materials and Resources
MS1525	Energy Efficiency and Use of Renewable Energy for Non-Residential
MSDM	Master in Sustainable Development Management
MyCarbon	MyCREST stands out compared to the National GHG reduction
MyCREST	Malaysian Carbon Reduction and Environmental Sustainability Tool
NABERS	National Australian Built Environment Rating System
NGTP	National Green Technology Policy
PAM	Pertubuhan Akitek Malaysia
PASS	Sustainable Energy Low Carbon Building Assessment
PCs	Personal computer
PDS	passive design strategies
PGC	Penang Green Council
PHJKR	Penarafan Hijau Jabatan Kerja Raya
PSS	Passive Design on the Project Sustainable Success
PV	Photovoltaic
PWD	Public Works Department
REHDA	Real Estate and Housing Developers' Association
REITs	Real Estate Investment Trusts
RWH	Rainwater harvesting
SCEs	Specific Cost Elements
SS	Sustainable Sites
TA	Thematic Analysis
TBL	Triple Bottom Line
UNDP	United Nations Development Programme

US	United State
USA	United States America
USGBC	US Green Building Council's
UTAR	Universiti Tunku Abdul Rahman
VOC	Volatile Organic Compound
WCED	World Commission on Environment and Development
WE	Water Efficien

CHAPTER 1

INTRODUCTION

1.0 Research Background

As construction activities rely heavily on the earth's resources and cause substantial emissions, it contributes significantly to environmental degradation. Doan et al. (2017) emphasize the extensive resource consumption by the construction industry in their study. It is believed that the construction sector has caused a depletion in global resources. For instance, 25% of wood materials, one-sixth of Earth's freshwater withdrawals for human needs, and 40% of all fundamental materials during the building process.

Furthermore, research by Habert et al. (2020) underscores the environmental impact of concrete, the most widely used man-made material. While cement production comprised approximately 10% of concrete mass, it played a sizable role in CO2 emissions within the construction industry during 2010, accounting for 36% of the overall 7.7 gigatons of carbon dioxide globally discharged through construction.

A more recent study by Hamid et al. (2022) highlights the construction industry's direct link to increased environmental degradation. The significant environmental impacts of producing ubiquitous construction materials like masonry, steel, and mortar for buildings all around warrant consideration of more sustainable alternatives. These materials account for 10% of world energy supplies, yet their transportation and production contribute significantly to glasshouse gas emissions. As such, using more sustainable alternatives in the construction sector warrants consideration. Moreover, it highlights the construction industry's direct link to increased environmental degradation.

The operation of completed constructions also contributes significantly to environmental damage. Hassan et al. (2014) findings disclose that as much as 40% of total worldwide energy usage is currently attributed to structures, a proportion anticipated to escalate by 50% towards the year 2030 according to projections, with commercial alone accountable for approximately half of the entire amount expended. This corresponds to an approximate energy consumption of 38,645 GWh for commercial buildings and 24,709 GWh for residential structures.

Recent studies further elucidate the environmental impact of building operations. Belussi et al. (2019) stress the environmental impact of building operation, particularly due to energy consumption and pollutant emissions. Li et al. (2021) investigated the influence of meteorological elements such as temperature, humidity, ventilation, and haze on building energy consumption. Their findings reveal that energy consumption is not constant but varies with these factors, causing notable surges during periods of high humidity.

In addition, Ali et al. (2021) highlights the environmental consequences of building operations. Their research highlights electrical certain appliances, including air-conditioning, lighting, and PCs/laptops, as major factors in the overall energy consumption of buildings. For instance, air-conditioning accounted for (34%), lighting (18%), and PCs/laptops (10%) account for a large part of a building's overall energy consumption.

In short, these findings underscore the need for the construction industry to shift towards sustainable alternatives in material selection and building operation methods. Addressing resource depletion, carbon emissions, and energy consumption necessitates concerted efforts to adopt greener practices for a more sustainable future.

1.1 Potential solution: Green Buildings

Green construction and sustainable development are becoming increasingly important in the building industry as climate change and environmental concerns rise. Green construction takes a comprehensive approach, acknowledging the positive & negative impacts on the surrounding environment & residents of the building. The notion of green building consists of thorough assessment the process of planning, designing, constructing, and operating a building while giving priority to the factors, including energy efficiency, water conservation, indoor environmental quality, material selection, and the overall effect of the building on its surrounding site (Kriss, 2014). Nevertheless, Zuo and Zhen (2013) argue that there has been much discussion about what a green building is and what it should cover.

Indeed, the need for a defined definition of green building adds to the difficulties of promoting and implementing green buildings. It is worth mentioning that the term "green building" has been used interchangeably with "sustainable building" and "high-performance building" (Korkmaz et al., 2009). In this research, amidst the diverse definitions of green construction or building, we define it as the approach where, throughout a building's entire life cycle, seeks to enhance positive effects and mitigate negative ones, thus encompassing the fundamental principles of green building.

The advantages of green buildings for the economy and environment have been extensively studied. Most literature and initial scientific evidence indicate that green buildings outperform traditional (non-green) buildings in several performance areas. For instance, Kats (2003) did a thorough analysis of 60 LEED-rated buildings, highlighting the advantages of green construction. On average, these green buildings are 25-30% more energy-efficient than conventional ones. Moreover, they exhibit lower electricity peak consumption, showcasing their significant environmental and resource-saving benefits.

In a recent study conducted by Dwaikat and Aili (2018), which evaluated the economic performance of a green building in terms of energy consumption, significant savings were uncovered. The research revealed that the investigated green building achieves remarkable energy savings, approximately 71.1% compared to the industry baseline. This finding underscores the substantial environmental and economic advantages of green building practices.

The benefits of green building can be categorised into three aspects: health, environmental, and economic advantages. Balaban and Oliveira (2017) observed that the four health benefits of green buildings, in their case study, are better air quality, more natural lighting indoors, improved ambient air quality, reduced heat exposure for pedestrians, and enhanced thermal comfort.

From an environmental standpoint, applying energy efficiency measures in commercial buildings has led to an average reduction of 16% in carbon footprint (Kneifel, 2010). The author's research also illustrates how green buildings can increase life-cycle cost-effectiveness. In addition, green buildings were discovered to use 30% to 50% less energy and water than typical non-green buildings (Yudelson, 2010). In terms of economic and financial advantages, Madew (2006) identified green buildings as providing the following main economic benefits:

- 60% reduction in water and energy usage
- 1-25% boost in productivity
- Minimum 14% higher rate of return
- 10% increase in asset market value
- 5-10% increase in the rental rate
- Free promotion

Halim's (2012) research demonstrates that green buildings offer several compelling advantages in the real estate market. These benefits include the potential for higher rents, ranging from 2% to 16%, depending on the certification level of the green building. Additionally, green buildings experience quicker leasing, improved tenant retention, and higher occupancy rates.

Green building has proven to be an effective strategy in addressing environmental problems and other relevant occupant health issues associated with buildings. Various green building measurement techniques and certifications are used globally to analyse and recognise sustainable building practices. The US Green Building Council's (USGBC) and Leadership in Energy and Environmental Design (LEED) certification evaluate building design, construction, operation, and maintenance, focusing on energy efficiency, water conservation, indoor environmental quality, and material selection. The Building Research Establishment Environmental Assessment Method (BREEAM) in the United Kingdom evaluates buildings' environmental performance by considering categories such as energy, water, materials, waste, and ecology. The Green Building Council of Australia's (GBCA) Green Star rating system observes sustainability features in Australia, including energy, water, materials, indoor environmental quality, and innovation. The Malaysian Green Building Index (GBI) has its green building grading system that evaluates energy efficiency, water conservation, indoor environmental quality, sustainable site planning, and materials and resources. The Energy

Star program, managed by the United States Environmental Protection Agency (EPA), promotes energy efficiency and certifies buildings and items that satisfy particular energy performance requirements. These organisations and their respective green building certifications are imperative for promoting and standardising sustainable building practices. By providing comprehensive frameworks and guidelines, they establish distinct benchmarks for evaluating and recognising environmentally friendly and resource-efficient buildings.

In short, green buildings are essential for Malaysia's sustainable future. Malaysia's commitment to the Paris Agreement, which aims to reduce carbon intensity by 45% compared to 2005 levels by 2030, underscores the nation's ambitious climate goals. Green buildings are pivotal in achieving these targets, significantly reducing carbon emissions from the built environment through energy efficiency and renewable energy integration. Moreover, Malaysia's tropical climate, known for its heat and humidity, presents challenges to indoor comfort, which green buildings address by enhancing indoor environmental quality with advanced ventilation, natural lighting, and climate-responsive design, ultimately improving the quality of life and productivity for occupants. Green buildings not only align with Malaysia's environmental commitments but also promote the well-being of its citizens.

1.2 Problem Statement

Despite the numerous advantages of green building practices, the strategies adoption has been facing several challenges that hinder the progress. According to Chan et al. (2009), although green building and the notion of sustainability have been extensively researched for environmental problems, their business justification and related social concerns still need to be adequately explored and broadly recognized by the parties involved in the construction sector. The growth rates of green building certifications, specifically LEED certified, have been significant. Despite this growth, the proportion of LEED certified buildings in the total commercial stock remains small (Fuerst et al., 2014). Their study discovered that the proportion of LEED certified buildings is less than 1% of the total commercial building stock. This finding indicates that there is still a long way to go regarding the widespread adoption of green building practices in the commercial sector.

Similarly, in Malaysia, Ong et al. (2021) contends that despite the Penang State Government's early adoption of the green concept, including the establishment of the Penang Green Council (PGC), the adoption of green offices in Penang still in scarcity. Despite the benefits and progress in green building practices, widespread adoption faces significant challenges and limitations. Similarly, Roslee et al.'s (2022) study reveals that Kuala Lumpur, the primary city of Malaysia, also grapples with a deficiency in green buildings, encountering substantial obstacles to their implementation.

Adopting green building practices can be hindered by the perception that construction costs are more expensive than conventional construction methods (Darko & Chan, 2016; Knox, 2015; Hamad 2020). There are several reasons for this perception, one of which is that developers often assume that building green will come with greater initial costs. This is due to the belief that environmentally friendly materials and technologies are more expensive than traditional building materials and conventional construction methods (Darko & Chan, 2016). Subsequently, Ayarkwa et al. (2022) mentioned that adopting sustainable or green building practices can incur higher costs than conventional construction methods. The estimated increase in cost for sustainable building is mentioned to range from 1% to 25% more than conventional building. The article also highlights that sustainable building materials can cost 3 – 4% more than using traditional building materials. This could indeed form a perception that green building practices are more expensive than conventional methods.

Moreover, before investing in a project, private entrepreneurs are usually keener to understand if the green construction will incur additional costs. (Gabay et al., 2014). While there is consensus on various benefits of green building, the initial construction cost compared to a conventional counterpart is still contested. Various research, studies and surveys have suggested that practitioners in green building construction shows that the cost of building a green structure is notably higher than that of constructing a conventional building (Bin & Kashem, 2017; Gabay et al., 2014; Halim, n.d.; Hwang et al., 2017; Hwang & Tan, 2010; Taemthong & Chaisaard, n.d.; Yasinta et al., 2020). Notwithstanding, this perception being widely held among building owners and investors, there is still limited empirical evidence to support this view (Dwaikat & Ali, 2016).

Given that Kuala Lumpur is a prominent centre for office building development and plays a crucial role as Malaysia's primary business and financial hub, this research project investigates the factors that contribute to the cost disparity between green and conventional office buildings in the city. The primary objective is to determine whether green building construction is associated with a cost premium or cost savings. The purpose of this study is to provide real estate stakeholders with valuable insights and essential data by addressing this contentious issue. During analyses, these insights will aid developers in making informed decisions regarding the allocation of additional costs for green construction projects. Developers in Kuala Lumpur will be able to evaluate the risks and potential rewards of developing green buildings owing to the research findings. The objective of this study is to contribute to the development of financially and environmentally sustainable office building initiatives in the city.

1.3 Research Question

The research problem has given rise to the following research questions:

1. To what extent does a cost differential exist between green and conventional office buildings?

2. What factors contribute to the cost differential in green building construction?

3. What factors have influenced the perception that green buildings are more expensive than conventional office buildings?

1.4 Research Objective

In essence, addressing the research questions is intended to achieve the following goals:

- To identify the construction cost differential between the green office building and conventional office building in KL.

- To identify the factors contributing to the price difference between green and conventional office buildings in KL.

- To identify factors contributing to the perception of green buildings are expensive than conventional building.

1.5 Scope of the Study

This study aims to investigate the factors that cause construction cost differences between green and conventional office buildings in Kuala Lumpur, Malaysia, from the perspectives of property developers, quantity surveyors, and other relevant property professionals.

The research will begin with an exhaustive literature review to thoroughly understand the existing knowledge and research on the cost incremental factors and the differences in construction costs between green and conventional office buildings. This review will serve as the basis for subsequent chapter in our research endeavours.

The study will conduct semi-structured interviews with property developers and critical property professionals involved in developing and constructing office buildings in Kuala Lumpur to collect primary data and insights. These interviews will yield valuable qualitative data regarding their experiences, perspectives, and insights regarding the construction cost differential and its influencing factors.

Notably, the study's scope excludes a thorough economic analysis or a quantitative assessment of the cost gap. Instead, it will focus primarily on gathering qualitative insights from interviews and synthesizing them to identify key factors contributing to the difference in construction costs between green and conventional office buildings.

1.6 Contribution of the Study

This research contributes significantly by analysing the aspects that contribute to the extra costs of green building, with a particular emphasis on high-rise office buildings in Kuala

Lumpur. Though green construction is becoming more and more popular worldwide, Malaysia has still had a little uptake, with just around 389 certified green projects as of 2023, which is less than 0.01% of all structures in the nation. The research addresses a crucial gap in understanding why the cost of green building remains a significant barrier, especially in the context of Malaysia. By narrowing the focus to high-rise office buildings in Kuala Lumpur, where a substantial amount of energy is consumed throughout their operational lifetime, the study provides valuable insights for the building industry and government.

The importance of this research lies in its ability to uncover specific factors contributing to the incremental costs of green building, offering a nuanced understanding that can inform targeted efforts to promote sustainable practices. With Kuala Lumpur being the capital city and the central business district, the findings can guide policymakers and industry stakeholders in making informed decisions to overcome barriers hindering the widespread adoption of green building practices. Furthermore, the study analyses recommendations from interviewees, providing actionable insights for supporting the industry's transition towards sustainable building practices.

1.7 Outline of the Research

There is total of five chapters in this research report. The first chapter introduce the study by giving a summary of the research background, laying out the research objectives, and defining the scope of the investigation. This chapter provides a clear grasp of the goal and significance of the study on the reasons behind the incremental costs of green office building development in Kuala Lumpur by laying the groundwork for the research. This chapter also prepares the reader for the upcoming chapters.

The second chapter presents a thorough analysis of the existing literature with a focus on the trends and policies in green building development in Malaysia, green building ranting tools in Malaysia, barriers to green building implementation variables affecting the incremental cost of green office buildings, the estimated cost differences in construction.

Subsequently, the third chapter will describe the study's methodology, research design, and overall plan. The study employs a qualitative research methodology and takes an exploratory approach. The difference in construction costs between green office buildings and conventional green buildings, factors influencing the cost differential, can be thoroughly explored and analysed using a qualitative approach. The selected method for this study is a semi-structured one-on-one interview as the primary data collection technique. This strategy enables rich discussion and insightful understanding of the experiences and viewpoints of participants.

Key participants will be interviewed during the semi-structured interviews, entailing real estate developers and other pertinent industry experts. The interviews will be directed by pre-planned questions based on themes, but with room for exploration to elicit more in-depth responses. This method allows for participant input to create a thorough understanding of the research topic while ensuring consistency and systematic data collection. To analyse and interpret the interview transcripts, thematic analysis will be used to find recurrent themes and patterns in the data. This will help to create a rich understanding of the cost differences and associated factors in the construction of green office buildings.

Next, in the fourth chapter, a thematic analysis is conducted using the data collected from interviews and other sources is examined to identify the key influencing factors. Through a systematic analysis of qualitative data, the chapter provides discussion and insights into the financial effects of developing green office buildings. Cost factors and their effects are highlighted in the discussion of the findings.

The final chapter five, a succinct summary of the key findings from the research is given. The study's limitations are acknowledged, providing information about possible areas for additional research and development. The industry is given recommendations based on the findings, providing helpful advice on fostering the adoption of green office buildings and addressing the cost disparities. The chapter's final remarks emphasize the importance of the study's findings and their potential effects on Malaysia's real estate development industry especially the green office building.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The literature study in this chapter focuses on the primary determinants of the incremental costs of green building in Malaysia. The topic covers the evolution of the green building concept, an evaluation of the various green building ranting tools, an examination of the variables influencing cost differentials in green building construction, and the identification of impediments to acceptance. This review presents a theoretical framework and lays the groundwork for hypothesis formulation in later chapters.

2.1 The Evolution of Green Building

2.1.1 Rise and Need for Green building Worldwide

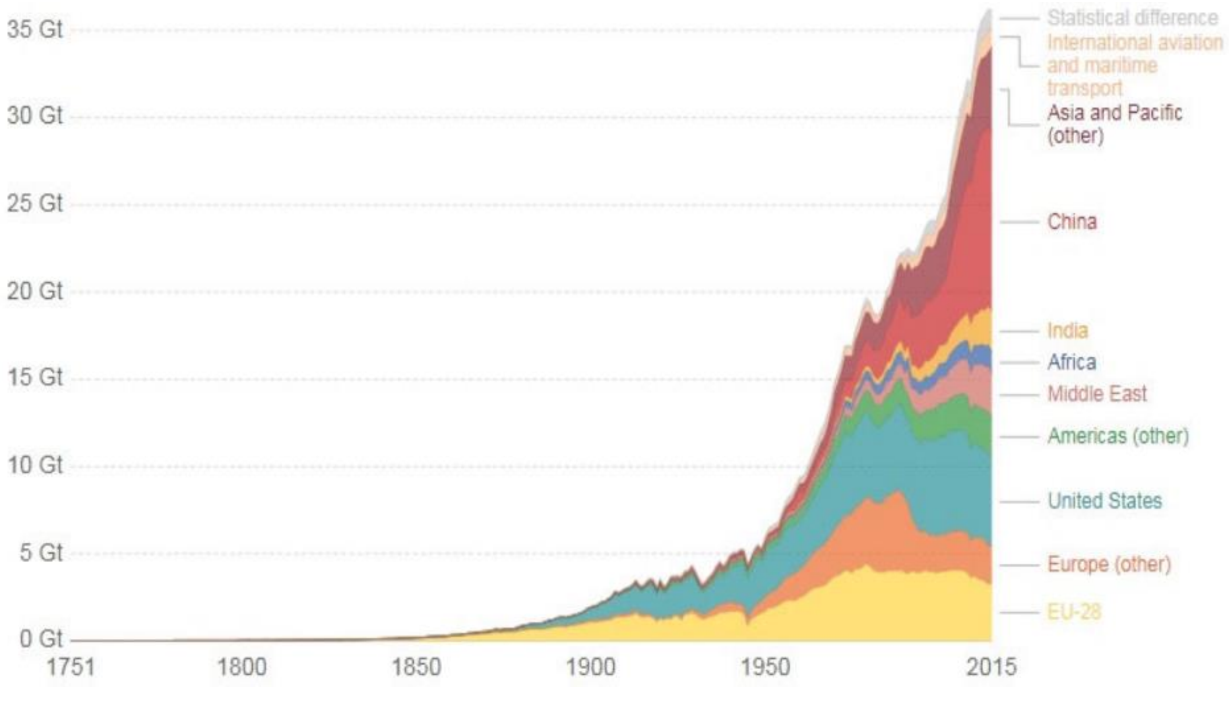
The building industry is one of the leading activities in terms of carbon footprint. According to Sizirici et al. (2021), in both developed and developing countries, entire construction and building operations process produces 33% of greenhouse gas (GHG) emissions and consumes 40% of world energy globally. The author finds that emissions are generally caused by the use of equipment, transportation, and the production of building materials. Furthermore, buildings generate 33% of GHG emissions and 40% of world energy consumption due to numerous activities related with their lifecycle, such as equipment usage, building material manufacturing, and transportation (Yan, 2010; Huang, 2018).

Major environmental impact that goes beyond GHG emissions, with far-reaching environmental, social, and economic consequences, has been caused by the building industry (Muse et al., 2014). The authors commented that construction's negative effects are visible throughout the construction stage, which is characterised by noise, dust, water pollution, traffic congestion, and trash disposal. The construction process uses a large quantity of natural and human resources, adding to its environmental impact. Nonetheless, the authors found that buildings have continuing environmental impacts even after they are completed.

According to Utomo et al. (2022), the building industry has been gradually contributing the most to carbon emissions, increasing global warming, particularly in developing nations such as Indonesia. In Indonesia, buildings utilize 50% of all energy and over 70% of all power. Moreover, the authors also mention 30% of all greenhouse gas emissions and 30% of all raw materials are produced by a building. Building energy consumption accounts for about 25% of overall building running expenses, with heating, cooling, ventilation, and lighting typically consuming about 50% of energy to produce artificial indoor conditions. Nonetheless, the authors forecast a 70% increase in worldwide energy use between 2000 and 2030, with far higher increases afterward.

In terms of carbon emissions, recent record show about 36 billion tonnes of carbon dioxide emissions, with the building sector contributing to climate change (Saleh, 2020). (Saleh, 2020). The author's research data provides compelling evidence of a notable surge in annual carbon dioxide emissions since the 1950s.

Figure 1. Annual CO2 emissions by world region



Notes: "Annual carbon dioxide (CO_2) emissions by world region" by CDIAC, n.d. (https://documents.dnrec.delaware.gov/energy/offshore-wind/comments/CO2%20Emission%20global%20submitted%20by%20J.%20Nichols.pdf).

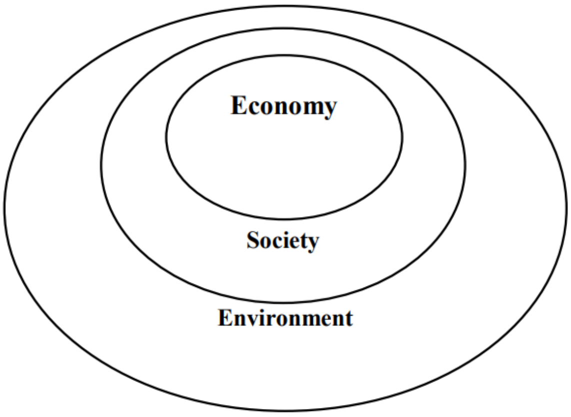
Khan (2019) presented that the critical importance of "Green Buildings" in tackling climate change and global warming issues while preventing natural resource degradation. To meet this need, the construction sector must pay special attention to growing the uptake of green-certified buildings. The grave global concerns of climate change and resource depletion need immediate effort to implement sustainable building design, construction, and operating practises. Green building practises have emerged as a feasible approach for mitigating and reducing greenhouse gas emission of the construction industry (Huyng, 2021). Thus, Green building methods decrease greenhouse gas emissions, energy usage, and promote resource-efficient, eco-friendly construction practices.

The urgent need to address climate change and develop more sustainable built environments is driving the global rise of green building practises. As environmental concerns grow, the construction industry needs to understands the benefits of green building concepts to create a more sustainable future.

2.2 Definition and Concept of Green Building

The concept and definition of sustainable development have been extensively explored in significant works. Sustainable development is defined in the "Our Common Future" as progress that satisfies the requirements of the current generation without jeopardise the capacity of future generations to fulfil their own needs (WCED, 1987). The responsible use of natural resources, ensuring their usefulness for future generations, and cautious use of non-renewable resources to help society transition to sustainable alternatives were further promoted by (Pearce et al., 1987). Researchers and scientists, engaged in various world forums on sustainable development, have strived to set goals and strategies with a multi-directional approach that addresses the Triple Bottom Line (TBL) aspects of "social, economic, and environmental," ensuring a development path that safeguards the well-being of future generations (Khan et al., 2019).

Figure 2.Three pillars of sustainability



Note: Adopted from “The Green Building Approach towards Achieving Sustainability” by Musa et al, 2014, *International Colloquium on Science and Technology*, p.92.

Sayce and Ellison (2003) discuss sustainable buildings as properties with characteristics that contribute to their impact on the environmental, social, and economic aspects of the TBL. These sustainable buildings are designed not only to reduce environmental impact during construction but also throughout their lifespan, including disposal (Myers, 2007). These buildings lower CO2 emissions, water, gas, and energy usage and decrease waste generation and use of natural resources. These features contribute to enhanced occupant health and comfort while simultaneously reducing their environmental footprint.

The urgency of sustainable development has led to the widespread adoption of green buildings, firmly interlinking the terms "sustainable development" and "green buildings" (Musa et al., 2014; Utomo, 2022). Green buildings align with the key requirements of sustainability, focusing on energy and water efficiency, reduced resource consumption, and environmental and health improvements (Dwaikat & Ali, 2018).

According to Ismail et al. (2008), green building is defined as a holistic approach to design, construction, and operation, converging the conservation of natural resources, energy efficiency improvement, and enhanced indoor air quality. Additionally, Li et al. (2014) argue that green building should encompass characteristics such as energy-saving, land-saving, water-saving, and material-saving, while being environmentally benign and pollution-reducing. The concept of green buildings emphasizes the improvement of resource use efficiency, including energy, water, and materials, while minimizing their impact on human health and the environment throughout their lifecycle (GBI, 2016). Kibert (2016) adds to this perspective by defining green buildings as healthy facilities designed and built in a resource-efficient manner, employing ecologically based principles. Achieving these objectives involves better siting, design, construction, operation, maintenance, and removal, all while striving for an ecological balance that optimizes environmental resources while safeguarding the environment (Guo & Zhu, 2017)."

Guo and Zhu (2017) distinguish green buildings from traditional ones by emphasizing conservation through the use of renewable energy sources and efficient land utilization, the use of green, low-carbon materials to create a harmonious indoor-outdoor environment, and an overarching goal of sustainability, aligned with the real estate industry's principles of sustainable development. Additionally, green buildings prioritize human well-being, seeking to improve living comfort and happiness by creating harmonious spaces that connect people, nature, and architecture.

The impact of development on environmental sustainability and quality has necessitated solutions like green buildings to minimize construction-related environmental damage (Yasinta et al., 2020). Green buildings, by harmonizing with nature, contribute to reduced pollution and better maintained health. However, it is acknowledged that green building concepts may require higher initial investments than conventional buildings due to the integration of various green technologies not commonly found in traditional construction practices, potentially impacting cost escalation (Khan, 2019).

Over several decades, the world has increasingly dedicated efforts towards green buildings as a pathway to achieve sustainable development and integrated sustainable development goals. In essence, green building entails optimizing water consumption, enhancing energy efficiency, conserving natural resources, and minimizing waste generation, all aimed at advancing the cause of sustainability (Ganesh & Senthilmurugan, 2020). To continue progressing in this field, it is essential to incorporate diverse viewpoints, integrate existing research findings, and explore innovative strategies that ensure green buildings' continued role in creating a sustainable and resilient future for generations to come.

2.3 Trends and Policies in Green Building Development in Malaysia

The trend of green building in Malaysia finds its origins in Prime Minister Mahathir bin Mohamad's forward-looking Vision 2020, introduced in 1991. Since then, Malaysia's government, businesses, and citizens have been dedicated to realizing the ideals of a clean, green, sustainable, fully developed, and harmonious nation (Jeshurun, 1993). This commitment has led to various measures including incentives for eco-friendly businesses, stricter industrial regulations, heightened environmental awareness, and an economic environment fostering sustainable development. This emphasis on cleaner and greener advancements has positioned Malaysia on a significant trajectory towards achieving this visionary goal (CleanMalaysia, 2015).

The roots of Malaysia's green development policies can be traced back to the 3rd Malaysian Plan, spanning from 1976 to 1980. This era marked the start of incorporating environmental considerations into development planning, recognizing the interconnectedness between environmental conservation and economic progress (Hezri and Hasan, 2006). The concept of sustainable development, a focal point of Malaysia's National Five-Year Development Plan from 1996 to 2015, further underlined this approach (Yiing et al., 2013).

However, the year 2009 stands out as a turning point for Malaysia's green building policies. The National Green Technology Policy (NGTP) was implemented, followed by the Green Building Index (GBI) (Suhaida et al., 2013; Rahmawati et al., 2020). The NGTP addressed various aspects of green initiatives encompassing energy consumption, construction practices, transportation methods, and waste management (MIDA, 2020). The goal of the NGTP is to encourage the use of energy-efficient materials in buildings.

Furthermore, to encourage technological such as including rainwater collection methods and solar photovoltaic systems. The incorporation of GBI was another vital component of this policy, contributing to sustainable practices across different stages of a building's life cycle. This comprehensive approach to environmental awareness aims to encourage not just economic progress but also a better environment for future generations (Rostami et al., 2015).

The commitment to sustainable practices has been showcased through the surge in green office building constructions in Kuala Lumpur as a direct result of these policies and initiatives (Ohueri et al., 2019). Developers are incentivized to create energy-efficient structures via national programmes such as the Promotion of Energy-Efficient Office Buildings (Yiing et al., 2013; Suhaida et al., 2013; Onuoha et al., 2017). Utilizing incentives like grants, tax credits, and low-interest financing is one method of encouraging developers to construct green office structures.

In the current context, the incorporation of recent green technology within the 12th Malaysia Plan takes centre stage. The 12th Malaysia Plan (12MP), as outlined by UNDP (2021), places a strong emphasis on "Advancing Sustainability" to ensure sustainable economic growth alongside environmental responsibility. To facilitate investments in eco-friendly infrastructure, the plan aims to establish green financing mechanisms and innovative incentive schemes. These measures target encouraging investment in energy, transportation, and housing sectors aligned with sustainable practices.

Additionally, the 12MP recognizes the power of economic instruments and environmental subsidies to further encourage businesses to adopt eco-conscious practices. By combining existing green financing incentives with these initiatives, the government aims to drive enterprises towards more sustainable operations (Loh, 2021). The 12MP's ambitious goals include achieving a harmonious integration of economic growth, resource efficiency, environmental preservation, and social inclusivity, while also bolstering the sustainability of the nation by mitigating pollution, reducing greenhouse gas emissions, minimizing waste generation, and preserving natural resources (MDEC, 2022).

Nonetheless, Budget 2023 in Malaysia demonstrates a strong commitment to sustainability and green technology, with extended tax incentives for green investments, enhanced Green Technology Financing Scheme, encouragement of EV adoption through tax exemptions and incentives for EV-charging equipment manufacturers, allocation for public transport improvements, and planned introduction of a carbon tax mechanism, all emphasizing Malaysia's concerted efforts towards a greener and more sustainable future (MGTC, 2023). The focus on green development in Malaysia is evident through various government initiatives and policies aimed at promoting sustainability and environmental responsibility.

Amidst these domestic efforts, it's important to highlight Malaysia's commitment to global sustainability initiatives. The country's commitment to sustainable development and environmental preservation is consistent with worldwide consensus such as the Paris Agreement. This Agreement imposes significant implications for Malaysia including an increased burden for climate action, the necessity for institutional and policy changes, the requirement for better climate change relevant information, the need to develop sustainable financial mechanisms for climate change, the creation of a National Adaptation Plan, emphasis on both mitigation and adaptation strategies, and obligation for regular and progressive reporting (Lian, 2018). By participating, Malaysia demonstrates its will to prevent climate change and to support global initiatives aimed at establishing a more sustainable environment.

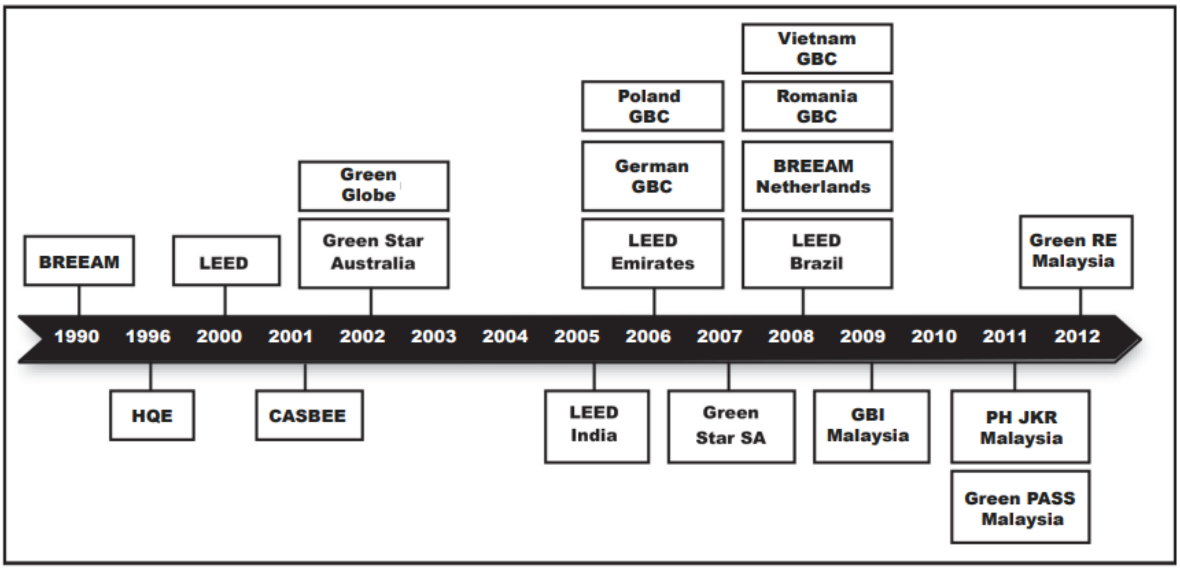
2.4 Green building ranting tools in Malaysia

Green Building Rating Tools (GBRTs) and environmental assessment schemes have been embraced by architects, engineers, and researchers for over two decades, serving as instrumental instruments to encourage environmentally sustainable construction practices. Among these rating tools, there is a significant focus on minimizing energy consumption and mitigating environmental effects throughout the construction, management, and operational stages of a building. These initiatives aim to address sustainability concerns by implementing practices that are environmentally friendly and resource efficient. (Chen et al, 2015; Matonni et al, 2018).

Similarly, green building rating tools in Malaysia play a pivotal role in advancing sustainable construction practices and fostering the adoption of environmentally friendly building methods. As highlighted by Razman et al (2023), Malaysia has followed the lead of other countries by introducing and promoting its own set of Green Building Rating Tools. Mun (2009) provides an exhaustive narrative on the formulation, implementation, and promotion of the pioneering Malaysian Green Building Rating Tools (MGBRTs), which is the Green Building Index (GBI). This rating system was developed with the intention of fostering more environmentally sustainable practices in building and construction within Malaysia's property industry. Among these, the Green Building Index (GBI) stands out as the most comprehensive and fully integrated tool, gaining widespread recognition within the Malaysian construction community. GBI was launched in 2009, aims to contribute to a 40% reduction in carbon emissions by 2020 compared to 2005 levels (Kamal, 2019).

Building upon the success of GBI's implementation in 2009, Malaysia has subsequently introduced several additional Green Building Rating Tools and construction policies. These include the Malaysian Carbon Reduction and Environmental Sustainability Tool (MyCREST), Green Real Estate (GreenRE), Green Performance Assessment System (GreenPASS), and Penarafan Hijau Jabatan Kerja Raya (PHJKR). These five rating tools are the focus of this paper, given their prominence within the Malaysian construction industry (Annuar et al, 2014; Hamid et al, 2014; Foo, 2018; Razman, 2023). Each of these tools has been meticulously crafted to further enhance environmental sustainability within the country's construction sector. The figure below demonstrated the timeline of the development of ranting tools.

Figure 3.Timeline of the development of ranting tools



Note: From "Towards a national green building rating system for Malaysia," by Hamid et al, 2014, *Malaysian Construction Research Journal, 14*(1), p.2.

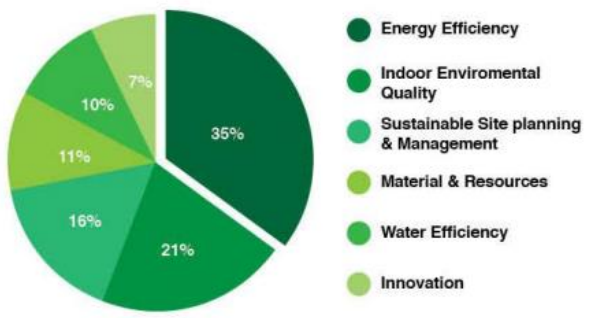
By incorporating these rating tools into their practices, construction professionals gain the capability to assess and monitor building performance concerning carbon reduction and overall environmental impact (Khan et al., 2019). These tools collectively empower the industry to make informed decisions that contribute to greener and more ecologically conscious construction practices.

2.4.1 GBI

The Malaysian Institute of Architects (PAM), the Association of Consulting Engineers Malaysia (ACEM), and the Malaysia Green Building Confederation (MGBC) In April 2009 jointly collaborated to launch the Green Building Index (GBI) in Malaysia. The primary objective behind the establishment of GBI was to introduce a comprehensive system for the assessment and certification of environmentally friendly buildings in the country (Sood et al., 2011).

Serving as Malaysia's pioneer green and sustainable grading system, GBI was designed while incorporating the core principles of renowned systems such as Australia's GREENSTAR and Singapore's GREENMARK. However, it was tailored to cater to the distinctive environmental, economic, and societal needs of Malaysia (GBI, 2011). Inspiration was also drawn from globally recognized green building rating systems like the United States' LEED (Leadership in Energy and Environmental Design) and the United Kingdom's BREEAM (Building Research Establishment Environmental Assessment Method) (Papargyropoulou et al., 2012).

Figure 4.GBI weighting on main criteria



Note. Adopted from" Build it green an overview of sustain," CIDB, 2022

The GBI rating system evaluates the environmental design and performance of buildings through six essential criteria: energy efficiency, indoor environmental quality, and sustainable site planning. Throughout the design and construction phases of a project, GBI assesses various aspects to ascertain its points and overall performance. With a total of 100 points achievable across all criteria, construction firms must adhere to specific requirements to earn these points, leading to the development of greener and more environmentally conscious buildings.

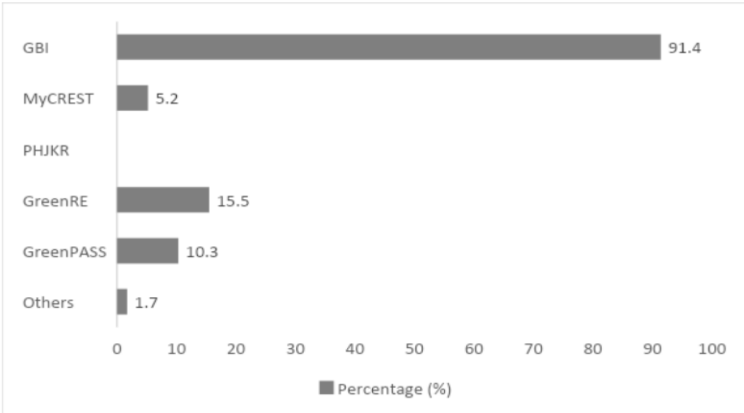
Figure 5.GBI Scoring system

POINTS	GBI Rating
86 to 100 points	Platinum
76 to 85 points	Gold
66 to 75 points	Silver
50 to 65 points	Certified

Note: Adopted from "GBI Rating System," by GBI, 2023. (https://www.greenbuildingindex.org/how-gbi-works/gbi-rating-system/)

Since its commencement, GBI has progressively expanded its scope to include a variety of building assessments. It now encompasses non-residential new constructions, residential new constructions, non-residential existing buildings, industrial new constructions, and industrial existing buildings. Furthermore, GBI extends its evaluation parameters to cover townships and existing buildings (CIDB, 2020; Foo, 2018).

Figure 6. Percentage of MGBRTs adopted in construction industry



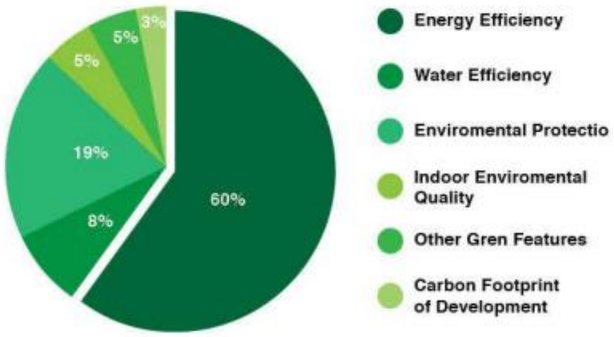
Note. From "Readiness of Malaysia's construction industry in adopting green building rating tools," Razman et al, 2023, *IOP Conference Series: Earth and Environmental Science, 12*(05), p.5.

GBI has undeniably emerged as the predominant and widely embraced green building rating system in Malaysia (Razman et al., 2023). Presently, the landscape boasts a significant number of GBI-registered projects, spanning diverse categories such as residential homes, corporate office spaces, towers, retail establishments, and government buildings, totalling at least 389 projects (Suhaidi & Naharul, 2023).

2.4.2 Green RE

Following the establishment of GBI, the Green Real Estate (GreenRE) rating tool emerges as a prominent green building certification organization in Malaysia. Introduced in 2013, GreenRE is a certification tool established by the Real Estate and Housing Developers' Association (REHDA), developed in close collaboration with relevant stakeholders from both public and private sectors, including industry professionals (Annuar et al., 2014). As mentioned by Lau et al. (2023), REHDA, originally known as the Housing Developers' Association (HDA), was founded in 1970 and serves as a pivotal platform for information exchange among its members regarding project progress and the growth of REHDA Malaysia. Additionally, REHDA Malaysia holds a significant role as the leading representative body for private property developers, actively influencing governance and advocating for industry interests.

Figure 7. GreenRE weighting on Main Criteria



Note. Adopted from" Build it green an overview of sustain," CIDB, 2022

Differentiating GreenRE from GBI lies in the focus and scope of their assessment criteria and the weight assigned to each primary criterion. According to Hamid et al. (2014), GreenRE's assessment criteria are divided into two main categories: Energy Related Requirements and

Other Green Requirements. Energy Related Requirements predominantly emphasize Energy Efficiency, recognizing various energy-efficient designs, practices, and features through credit allocation. Certification requires a minimum attainment of 30 credits from this category.

The Other Green Requirements encompass attributes such as Water Efficiency, Environmental Protection, Indoor Environmental Quality, other Green Features, and Carbon Emission of Development. This category appreciates water-efficient features, eco-friendly design practices, the incorporation of innovative green features, and the consideration of a development's carbon emissions. Certification necessitates a minimum attainment of 20 credits from this group. Similar to GBI, GreenRE evaluates the green criteria solely during the design and construction phase (CIDB, 2022).

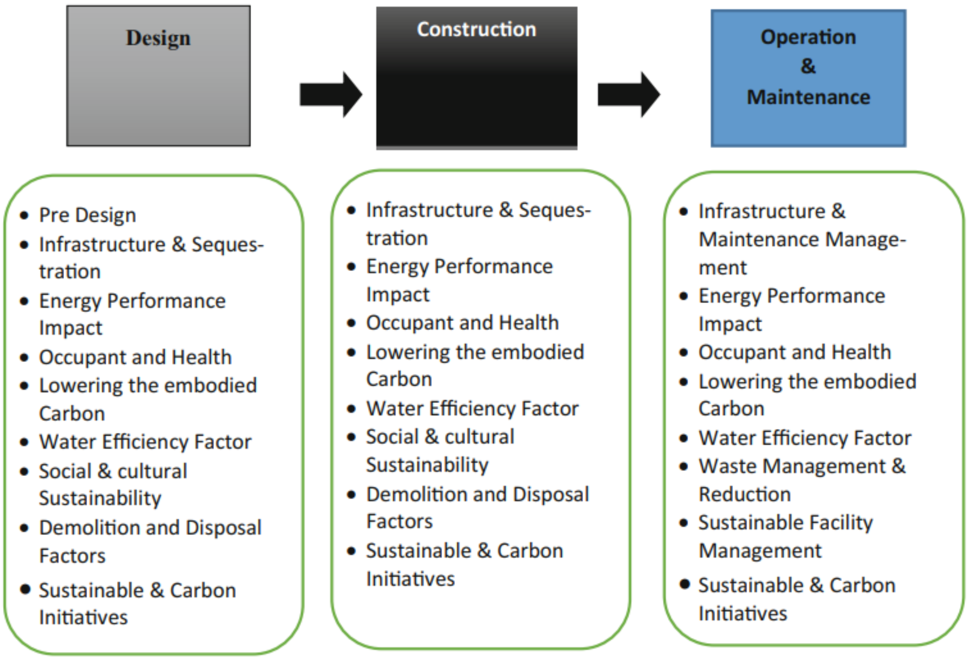
Nevertheless, Bahaudin et al. (2017) postulated that GreenRE presents efficient solutions for green certification at affordable costs. The authors highlighted that GreenRE operates as a non-profit initiative, dedicated to fostering sustainability within the Real Estate industry. This is achieved by encouraging voluntary adoption of eco-friendly building practices, contributing to the broader advancement of sustainable development objectives. Green RE claims to have more than 120 projects registered under their program covering over 70 million sq. ft in 2016 and continue to growth as Malaysia leading green rating tool (GreenRE, 2016).

2.4.3 MyCrest

In 2016, Malaysia's Carbon Reduction and Environmental Sustainability Tool (MyCREST) was the latest addition to Malaysia's Green Ranting tools arsenal introduced by both the Construction Industry Development Board (CIDB) and the Public Works Department (PWD). It aims to guide and facilitate efforts in curbing carbon emissions' impact on the constructed environment and reducing its overall ecological footprint (Bahaudin, 2017).

Distinguishing itself from the GBI and GreenRE rating tools, MyCREST presents a comprehensive approach to address carbon emissions and environmental impact throughout the entire lifecycle of the built environment (Razman et al., 2023). Unlike its counterparts, MyCREST's influence extends not only to the design phase but spans across construction, operation, maintenance, refurbishment, and even demolition stages (Foo, 2018; Ohueri et al., 2019). The tool employs a star-based rating system, ranging from one to five stars, contingent on the fulfilment of sustainability criteria and accomplishments in carbon reduction targets (Abdullah, 2017). MyCREST's design stage criteria and its 11 core criteria have been categorized into three stages, as outlined by (Khan et al., 2019; Ohueri et al., 2019).

Figure 8. MyCREST assessment criteria



Note. Adopted from "Preliminary Evaluation of Synergizing BIM and Malaysian Carbon Reduction and Environmental Sustainability Tool," Ohueri, e al (2019), Sustainability in Energy and Buildings 2018 p. 221.

Figure 9. MyCREST (Design Stage) Criteria's and Sub-Criteria

ID	Core Criteria	ID	Criteria	ID	Sub Criteria
IS	Infrastructure and Sequestration	IS-1	Low Carbon City Characteristics and Factors	IS-1.1	Development Within Defined Urban Footprint
				IS-1.2	Urban Connectivity
				IS-1.3	Brownfield Development
		IS-2	Carbon Accounting of Site for (Greenfield or Graded Land)	IS-2.1	Carbon Sequestration - Preservation (For Mature Trees)
				IS-2.2	Carbon Sequestration - Preservation/Restoration/New Planting
		IS-3	Environmental Management Plan (EMP)	IS-3.1	Environmental Management Plan (EMP)
		IS-4	Factors in Stormwater Management	IS-4.1	Control Of Storm Water Run-Off On Site
				IS-4.2	Storm Water Design - Quality
				IS-4.3	Integration Of Carbon Sequester Strategies
		IS-5	Low-Carbon Transport Factors	IS-5.1	Covered Pedestrian Walkway
				IS-5.2	Low-Emission Vehicle Designated Parking
				IS-5.3	Accessible Public Transport- Bus Line And LRT Station
		IS-6	Urban Heat Island Mitigation	IS-6.1	Heat Island Mitigation - Roof/Wall
				IS-6.2	Heat Island Mitigation - Non-Roof
		IS-7	Control in External Light Spill and Brightness	IS-7.1	Control In External Light Spill And Brightness

Note. Adopted from "Embedded Life Cycle Costing Elements in Green Building Rating Tool," Khan, e al (2019), *Civil Engineering Journal* ,5(4), p. 752.

Distinctively, MyCREST employs a verification and certification approach. Each stage of the project lifecycle such as design, construction, operation, and maintenance undergo evaluation by MyCREST, resulting in an individual rating for each stage. These individual ratings are amalgamated to produce an overarching cumulative rating. Depending on this cumulative rating, projects can attain a maximum of 5 stars (Kamal et al., 2019). To achieve a five-star rating, adherence to 80 to 100% of the assessment criteria is necessary. Should a project successfully meet all requirements across the three certification stages, it qualifies for the Carbon-Reduced Award Label (Ohueri, 2019). In cases where a green building does not meet certification standards for all three stages, it is bestowed an independent certification specific to the stage it has accomplished. This approach acknowledges the progress made at various stages of the project lifecycle, even if full certification has not yet been attained.

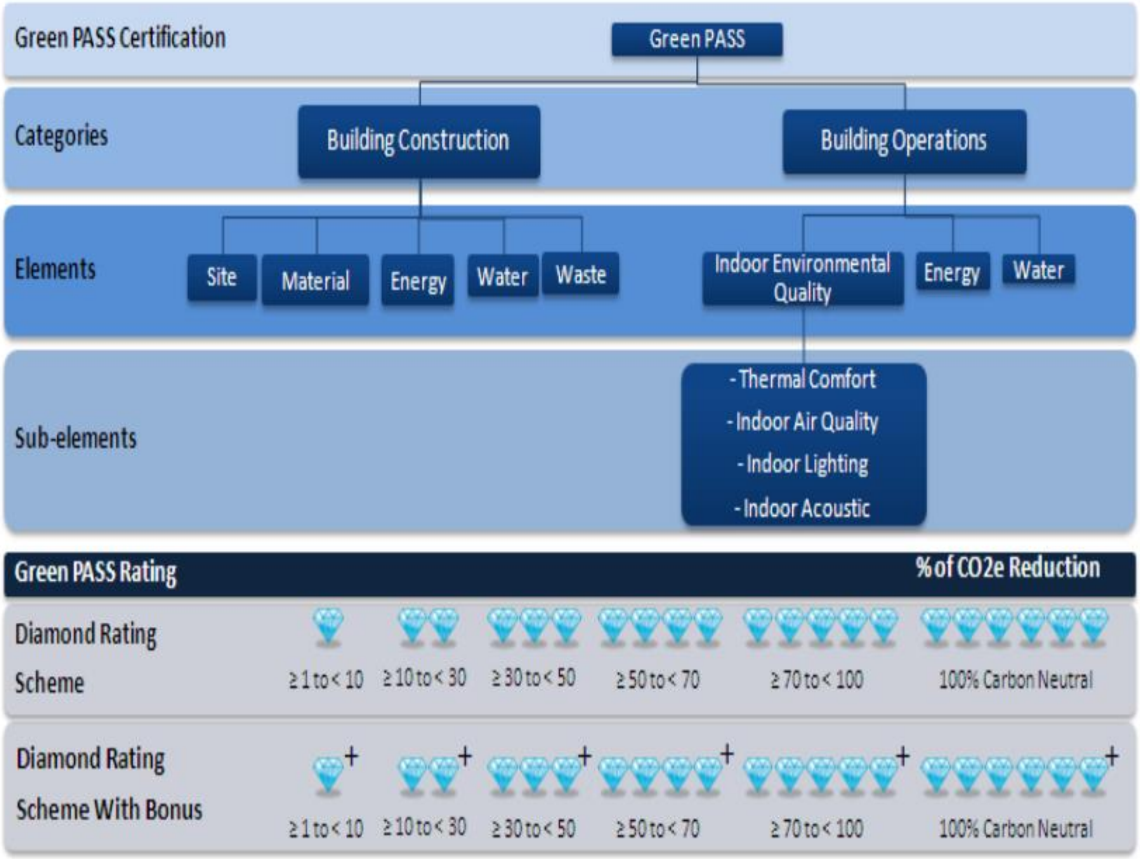
In summary, MyCREST stands out as a robust and inclusive rating tool in Malaysia, concentrating on quantifying and mitigating the environmental impact of the built environment with a specific focus on carbon emissions (Foo, 2018). Furthermore, Ohueri et al. (2018) suggest synergizing Building Information Modelling (BIM) with MyCREST, enhancing certification accuracy, efficiency, and providing more comprehensive insights into the building's sustainability performance.

2.4.4 Green Performance Assessment System (GreenPASS)

Green Pass is another assessment tool established in 2012 and comes under the management of CIDB alone. GreenPASS's initial design was influenced by the standards of the National Australian Built Environment Rating System (NABERS) and Green Globe USA (Annuar et al, 2014). According to Ghani et al (2021), Green PASS is conceptualized to fulfil the criteria by promoting the amalgamation of construction with other Construction Industry Standards (CISs) through conformity to specified rules and regulations. The authors further emphasize that Green PASS aims to reduce carbon emissions from building projects throughout the lifespan of a structure. It seeks to monitor and decrease the carbon footprint created during the various phases of construction, operation, and eventual demolition of the structure.

As CIDB (2021) highlighted, the structure of Green PASS certification is divided into two categories such as building construction and operation. Each element and sub-elements under the two categories are assigned specific weighting factors that contribute to the overall assessment score. The figure below demonstrated the entire structure and diamond rating.

Figure 10. Structure of Green PASS



Note. Adopted form "Standard Industri Pembinaan (Construction Industry Standard)," by CIDB, 2021.

Similar to MyCrest, Green PASS undertakes the evaluation of carbon emissions ranging from the construction phase to operation over an extended timeframe, accounting for the lifecycle of the building for a projected duration of 50 years (Hamid et al, 2014). The authors asserted a perfect score in Green PASS, denoted by six diamonds, signifies total carbon neutrality, and achievement of 100% carbon reduction. The baseline for carbon emissions is determined by summing the embodied and operational carbon emissions either observed or projected for a Business As Usual (BAU) scenario. The amount of carbon reduction for a project is equal to the difference between the CO2 emissions of the BAU scenario and those of the new or upgraded building.

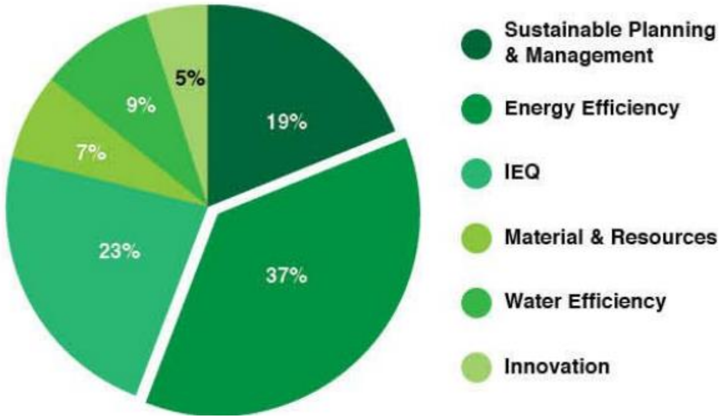
However, there is an argument that Green PASS is now being surpassed by the newer and more comprehensive rating tool, MyCREST (Bahaudin et al, 2017). As Hafizan et al. (2021) MyCREST, integrating both carbon quantification and factors of sustainable performance, offers a comprehensive sustainable rating system. This approach is based on performances linked to the lifecycle and continuity of Green PASS certification. The framework of MyCREST stands out compared to the National GHG reduction programme (MyCarbon), which only covers operational carbon. MyCREST goes one step further by including building embodied carbon as well. Furthermore, it is a performance-based assessment, meaning the evaluated development will be awarded based on the total carbon emission over the baseline year. This method enables a more comprehensive evaluation of the environmental effect of a construction.

2.4.5 Penarafan Hijau Jabatan Kerja Raya (PHJKR)

PHJKR or the Green Rating Assessment Scheme JKR, is an assessment instrument that was devised by the Public Works Department (JKR) in 2012. The Public Works Department of Malaysia (JKR) began incorporating green initiatives into their projects starting from the 8th Malaysian Plan. Compared to other green rating tools, PHJKR is a rating tool established to assess the sustainability performance of existing buildings. It is mostly intended to measure the government's construction projects align with sustainability goals (Abdullah, 2017). It prominently concentrates on two sectors: the building sector and the road construction sector (Zainol et al., 2017). The assessment tools primarily emphasize the design stage, encompassing evaluation across four distinct building categories: Non-Residential New Building, Non-Residential Existing Building, Non-Residential Without Air Conditioner, and the Health Service Building (Azis et al, 2021).

The nature of this green rating tool is similar to GBI where it focuses on the design stage of construction projects, with assessments revolving around key aspects of sustainability including planning and management, energy efficiency, internal environment quality, material and resource usage, and water efficiency (Yaman & Ghadas, 2020). Yet, Azis (2020) suggest that notable distinctions exist in the scoring points assigned to various assessment levels. The certification hierarchy is structured with 5 stars denoting the highest level of achievement, succeeded by 4 stars, 3 stars, and 2 stars. For a building to attain the esteemed 5 stars certification, it must amass a minimum of 85 points. For a building to be rated as four stars, three stars or two stars, respectively, it necessitates acquiring at least 70, 50 or 40 benchmarks. The below figure shows the weighting of PHJKR on the main criteria.

Figure 11. PHJKR Weighting on Main Criteria



Note. Adopted from" Build it green an overview of sustain," CIDB, 2022

2.5 Barriers to green building implementation

In Western countries, there have been notable advancements in the integration of sustainable building practices. For instance, CBRE (2018) report outlines the growth in the adoption of green building certifications across several international real estate markets. It's found that green building certifications have dramatically increased over the years in these markets. The reports highlighted the among the 10 markets studies, 18.6% of office space is now certified as "green," which is a significant increase from just 6.4% a decade earlier in 2007. Specific increases in certifications were noted in various cities, such as Vancouver and Stockholm. Despite the growth, there is considerable room for further expansion of green certifications in these markets.

However, it is important to recognize that these achievements may not be easily replicated on a global scale. Several authors have mentioned that countries in Asia have lower adoption pace of green building (Jaffar et al, 2022; Bohari et al, 2016, Nguyen et al, 2017; Lai et al, 2023). According to Hill (2023), only Singapore boasts a relatively high presence of green buildings, at 30%. In comparison, Beijing (11%), Shanghai (15%), Tokyo (8%) and Hong Kong (4%) are catching up with the progress. The Asian region presents its own set of unique challenges that impact its adoption of green building practices. These challenges act as barriers and hinder the rapid progress of sustainable construction in this region. It is crucial to acknowledge the discrepancies between the global narrative surrounding green buildings and their actual implementation in specific regions like Asia.

2.6.1 Difficulties in Green Building Adoption: Insights from Earlier Stages of Research

The earliest study conducted by Myers (2007) found that the key barrier to adopting green buildings is the uncertainty surrounding their financial viability and economic benefits. This is because of a lack of solid empirical data and market evidence supporting the concept that sustainable buildings could yield higher market value, command premium rents, or provide cost savings through reduced operating expenses. Despite research justifying sustainability by showcasing reduced operating costs or suggesting adjustments to valuation equations to incorporate sustainable benefits, they have not provided convincing proof, leaving the investment industry uncertain. Besides, the authors state that space occupiers or tenants are generally not willing to pay a premium rental for buildings with sustainable features, reducing the financial incentives for developers and investors to pursue sustainable buildings. This portrays the vicious cycle of poor realization of green building values.

Next, Hwang and Tan (2010), imply that the primary obstacle is high cost, both initial and operational, discouraging investors. Further, obstacles include ineffective communication within project teams, low market demand for green buildings, and lack of compelling research on their benefits. Despite these, the presence of considerable expertise in green building principles in Singapore's construction industry suggests the potential for overcoming these challenges. Increased costs due to energy-efficient design and materials, ineffective implementation of relevant policies, and a lack of familiarity with green technologies cause design and construction delays are the top barriers to adopting green building practices (Zhang et al, 2011).

The study by Hwang and Ng (2013) identifies several barriers to green building adoption. Key challenges include high uncertainty and costs associated with green materials and equipment, and difficulties in selecting subcontractors skilled in green construction. Addressing these challenges through enhanced strategies is paramount for wider green building adoption.

Specifically in Malaysia, Isa et al. (2013) highlighted high initial construction costs, lack of industry experience, and difficulty in sourcing appropriate building materials have been considered as the primary deterring factors. Aliaga et al. (2013) posit the top three barriers are risk of investment, higher final price and lacking demand. Despite the well-documented benefits, these challenges curb the widespread acceptance of green building standards. Future research should focus on addressing these issues to promote sustainable building practices.

2.5.2 Contemporary Challenges: Recent Findings on Barriers to Green Building Adoption

High Initial Investment Costs

One of the most recurrent themes across recent studies is the formidable barrier presented by high initial investment costs. Researchers in Japan, Singapore, and Malaysia agree that incorporating green technologies frequently comes at a high financial cost (Balaban and Olivera, 2016; Hwang et al., 2017; Chong et al., 2017; Ding et al., 2018; Kasayanondl et al., 2019; Ohueri et al., 2019; Lee et al., 2020; Leskinen, 2020; Saleh et al., 2020; Mustaffa et al., 2021; Wong et al., 2021; Utomo et al., 2022, Yee, 2023). This economic barrier is exacerbated by industry misperceptions about the true costs of green initiatives, which frequently result in budget overruns (Hwang et al., 2017). These findings highlight the essential importance of financial feasibility in persuading stakeholders to adopt sustainable construction practices.

Inadequate Awareness and Knowledge

The lack of awareness and information about green building methods is another major barrier to both consumer demand and industry engagement (Chong et al., 2017; Kasayanondl et al., 2019; Ohueri et al., 2019; Wong et al., 2021; Saleh et al., 2020; Mustaffa et al., 2021, Razman, 2023). This lack of understanding on the benefits of sustainable buildings impedes their widespread adoption. To promote informed decision-making and increase demand for greener construction solutions, efforts to bridge this knowledge gap are critical.

Complexity of Regulation and Policy

Regulations and laws governing green construction practices are complex and inconsistent, posing substantial challenges for stakeholders (Balaban and Olivera, 2016; Ding et al., 2018;

Lee et al., 2020). The difficulties of handling extensive compliance requirements are exemplified by Japan's diverse legal and institutional frameworks (Balaban and Olivera, 2016). These policy uncertainties erode trust in the adoption of sustainable practices, needing clear and consistent regulatory frameworks to encourage sector transformation.

Concerns about the economy and finances

In addition to the initial costs, scholarly investigations have highlighted other economic and financial challenges that are hindering the adoption of green building practises. (Balaban and Olivera, 2016; Hwang et al., 2017; Ding et al., 2018; Leskinen, 2020; Mustaffa et al., 2021). These include long payback periods, a lack of financial incentives, significant operational and maintenance costs, and inconsistent financial benefit research findings. Addressing these multiple economic difficulties is critical if stakeholders are to be encouraged to embrace sustainable construction.

Limited Government support

Inadequate government regulations, the absence of supportive building codes, and the absence of established green technology frameworks were all impeding green building uptake (Kasayanondl et al., 2019; Ohueri et al., 2019). These findings highlight the critical role of policymakers in creating an environment favourable to the transition to more sustainable construction techniques.

Attitudes in the Market and Industry

The construction sector has significant obstacles in embracing green buildings due to prevailing negative beliefs regarding their worth and a notable absence of commitment from stakeholders. (Ding et al., 2018; Mustaffa et al., 2021). Overcoming these prejudices will necessitate persistent efforts to illustrate the long-term benefits of sustainable practices and to develop an environment-conscious society.

Barriers to Technology and Training

Inadequate technical options, limited experience, and a lack of training opportunities impede efficient green building practice implementation (Hwang et al., 2017; Ding et al., 2018). To overcoming the obstacles, investment in talent development and technical knowledge distribution are required.

Environmental awareness and Demand

Green building approaches are hampered by a lack of demand and a lack of environmental knowledge among stakeholders such as developers, consultants, client and buyers (Wong et al., 2021). Improving stakeholder understanding of the broader benefits of sustainability will help in generating green building demand.

Holistic Approaches are Required.

The complexity and interconnectedness of these barriers underscore the need for comprehensive and holistic strategies. These strategies should address economic, regulatory, knowledge, and perception challenges simultaneously to unlock the full potential of green building adoption.

Recent research investigations have repeatedly identified a number of important barriers to the mainstream acceptability of green buildings. One prominent obstacle is the matter of cost, which remains a substantial barrier to the expansion of green building adoption at both the local and global level. It is commonly accepted that starting sustainable construction practices usually requires a higher initial investment than traditional building approaches. Therefore, it is vital to comprehend the supplementary expenses associated with sustainable construction.

2.6 Green building cost premium

Numerous research articles consistently highlight that green building construction comes with higher cost implications. However, quantifying this incremental cost proves challenging due to the variability observed across studies, regions, and project specifics, such as structure size and standard level (Gabay 2015; Halim, 2012). Additionally, the degree of cost increase is influenced by the type and level of green certification pursued. For example, the optimal alternative typically introduces a cost increase ranging from 4% to 12% (Gabay, 2014). Dwaikat and Ali (2015) further emphasize that over 90% of empirically studied green cost premiums fall within a spectrum ranging from -0.4% to 21%.

Constructing a certified residential green building with basic green options constitutes an approximate additional expense of 2.2% of the contract sum (Chong et al, 2017). When contrasting green building construction to conventional methods, the added cost is generally estimated to range from 0% to 10% of the total construction cost (Shabrin & Kashem, 2020).

Moreover, certain green building verification mechanisms provide indicative rates of green construction. The cost differential for LEED-certified office buildings, as reported by Plebankiewicz et al. (2019), ranges from 0% to 8.5%. In contrast, Chong et al. (2017) found that GBI-certified green buildings exhibit a cost variation of 1% to 13%. However, it is essential to note that certain studies reveal longer payback periods for green buildings, such as 7 years in the case of Halim (2012). In contrast, Shabin and Kashem (2017) argue that operational cost savings can reduce this payback period. Below table illustrates the rate of incremental cost of green buildings.

Table 1. Implementation costs in a certified building depending on the level of the certificate obtained.

The Level of the Certificate	Implementation Costs
LEED Certified	0–2.5%
LEED Silver	0–3.3%
LEED Gold	0.3–5.0%
LEED Platinum	4.5–8.5%

Note. Adopted from “Trends, Costs, and Benefits of Green Certification of Office Buildings: A Polish Perspective” by Plebankiewicz et al, 2019, *Sustainability*, p. 11.

Table 2. Cost implications to go green

GBI rating	BEI kWh/m^2 year	Energy savings: %	Incremental construction cost: %
Average Malaysian building	250	Base	Base
Meets MS1525	200–220	10–20	0–3
GBI certified	150–180	30–40	1–5
GBI silver	120–150	40–50	3–8
GBI gold	100–120	50–60	5–10
GBI platinum	<100	>60	6–13

Note. Adopted from “Cost implications for certified Green Building Index buildings,” by Chong et al, 2017, *Waste and Resource Management*, p.3.

Remarkably, Dwaikat and Ali (2015) highlight studies suggesting that green buildings can be on par with or even more cost-effective than conventional constructions. Supporting this perspective, Steven Winter Associates (2004) demonstrated a saving of -0.4% through comparative analysis of modelled green design costs for two buildings. Similarly, Xenergy and Sera Architects (2000) reported a saving of -0.3% after assessing the cost of redesigning three existing office buildings to meet specific LEED criteria. This research challenges the notion that green building inherently incurs higher costs. Instances of cost savings within green construction indicate that sustainable features can align with initial budgets. Nevertheless, it's important to acknowledge that the context has evolved since these reports, considering factors such as global inflation and geopolitical events like the Ukraine war that have impacted the construction industry. Therefore, a comprehensive examination of the contributing elements is essential for a contemporary understanding of the incremental costs associated with green building today.

2.7 Factors Influencing Cost Variations in Green Building Construction

The exploration of incremental costs associated with green building projects has gained substantial momentum due to its influence on the economic feasibility of sustainable construction. This understanding is pivotal in advancing sustainable practices while effectively managing project budgets. Researchers have identified an array of factors contributing to the observed cost variations in green building construction. These factors encompass a wide spectrum of considerations, ranging from material selection and design processes to regulatory frameworks.

2.7.1 Early Insights into Incremental Costs (2000–2013)

Between 2000 and 2013, the study of incremental costs in green building projects saw a pivotal phase. During this period, researchers delved into nuanced factors behind cost variations. Malin (2000) first points out that incremental green building costs arise from full-cost accounting and undervaluation of raw materials. Green manufacturers internalize usually externalized environmental costs, resulting in higher expenses. Industrial economies undervalue raw materials compared to human labor, raising costs for materials like adobe and rammed earth. The absence of an objective baseline for comparing green products to conventional assemblies, like straw-bale wall systems, can contribute to the perception of higher green building costs.

Subsequently, Hwang and Tan (2010) advanced the discourse by highlighting primary factors of incremental costs. Firstly, the high cost of green materials significantly affects budgets. For example, compressed wheat board, a green alternative to plywood, can cost up to 10 times more than its traditional counterpart. Secondly, additional expenses arise from seeking green alternatives and obtaining certifications for green buildings. Implementation of green techniques on the construction site also drives total costs. Finally, unequal distribution of benefits between developers and tenants influences costs. Benefits like a better indoor environment and energy savings don't easily transfer back to developers.

Zhang et al. (2011) extended exploration into diverse realms influencing incremental costs. Their inquiry illuminated multifaceted aspects of cost dynamics, encompassing material procurement and learning curves vital for green technology implementation. Specialized labor requirements intrinsic to sustainable technologies were also acknowledged as sources of incremental expenses. Moreover, the study highlighted the role of design intricacies, particularly late-stage changes, in compounding costs.

In a parallel vein, Rehm and Ade (2013) suggest that sustainable materials and systems in green buildings don't inherently make them more expensive. Some green buildings exhibit higher costs due to the heterogeneity of commercial building stock. Cohorts of 5 and 6 Green Star buildings show both cost savings and the highest cost premium, indicating variability in cost.

Collectively, studies during this period established foundational principles for understanding the intricate interplay of economic, environmental, and social factors shaping the premium cost variations in green building construction.

2.7.2 Factors Influencing Incremental Costs in Green Building Construction (2014-2019)

The period from 2014 to 2019 witnessed a surge in research on the cost implications of green buildings. Numerous studies during this timeframe examined facets contributing to incremental costs in constructing green buildings.

Gabay et al. (2014) proposed that enhanced design and construction processes, along with high-quality materials and advanced technologies, significantly contribute to incremental costs. This "excess cost" covers the entire building lifecycle, from construction to operation and demolition. Despite apparent upfront expenses, the study emphasizes long-term benefits from reduced resource use, highlighting a strong case for sustainable construction.

Shabin and Kashem (2017) introduced a three-tier cost categorization: initial, continuing, and rehabilitation costs. Initial costs encompass planning, design, and land acquisition, while continuing costs relate to operations, and rehabilitation costs account for major upgrades. Chong et al. (2017) focused on economic considerations aligned with environmental sustainability. Their study highlighted the inclusion of energy-saving technologies, like solar panels, enhancing building value despite additional costs.

Taking an opposing view, Taemthong and Chaisaard (2019) suggested that green buildings adhering to LEED standards might not inherently higher implementation costs. Sustainable design integration influences cost variance more than budget constraints.

Plebankiewicz et al. (2019) advocated for the shift toward sustainable construction, particularly given buildings' significant CO_2 emissions. However, costs linked with green buildings, such as documentation and certification, remain substantial considerations for investors.

Hwang et al. (2017) outlined factors escalating green building costs, including costly technologies and materials due to R&D expenditures and a scarcity of skilled professionals. Expanding the scope, Basten (2018) identified several potential cost-increasing factors, including site development, energy conservation, and regional priorities. These components integral to green building assessment criteria require additional resources, impacting overall costs.

Regarding financial aspects, Abidin and Azizi (2016) emphasized the significance of both hard and soft costs. While hard costs typically involve green technology and materials, soft costs include aspects like consultation fees and specific green requirements. This intricate interplay of multiple cost categories dictates the final investment for green construction. Building on this, Russ et al. (2018) highlighted elements elevating initial sustainable construction costs, such as design complexity, contractor expertise, sustainable material availability, and insurance coverage provisions.

Dwaikata and Ali (2018) underscored the importance of a holistic cost assessment method - life cycle costing (LCC). This method entails an exhaustive cost evaluation that includes design, construction, operation, maintenance, and end-of-life costs, providing a full perspective of a building's entire expenses.

Delving deeper into intricacies, Azizi et al. (2018) echoed green building construction involves unique cost elements known as Specific Cost Elements (SCEs). These include the addition of consultants, certifiers, and registration for green building accreditation. The complexity associated with green building construction results in additional costs, with the initial project development phase often requiring a greater financial allocation compared to traditional construction due to the increased number of SCEs. Lastly, the inherent complexities and size of green building projects equate to higher physical construction costs, which contribute to overall cost increments in green building.

In summary, the period from 2014 to 2019 saw comprehensive exploration of incremental cost factors in green building construction, unveiling key determinants. These encompass improved methodologies for design and construction, premium materials, and cutting-edge technologies. The analysis covered initial, ongoing operational, and rehabilitation costs. The incorporation of energy-saving technologies and early sustainable design criteria emerged as critical elements. Challenges like skilled professional scarcity and expenses tied to green technologies and materials were identified. Moreover, the importance of soft cost elements (SCEs), specific cost elements (SCEs), and the comprehensive life cycle costing (LCC) approach in understanding cost escalation intricacies was highlighted. These findings provide insights into the multifaceted landscape of incremental cost factors in the realm of green building construction during this period.

2.7.3 Factors Influencing Incremental Costs in Green Building Construction (2020 Onwards)

Analysing literature from 2020 onwards, this review aims to provide a comprehensive understanding of factors contributing to these incremental costs.

Weerasinghe and Ramachandra (2020) conducted a study that broke down incremental costs associated with green buildings. Their findings reveal that Indoor Environmental Quality (IEQ) features predominantly affect both maintenance (31%) and construction (6%) costs. Energy and Atmosphere (EA) features also contribute significantly, with 26% for maintenance and 7% for construction. However, costs for Materials and Resources (MR) features are relatively low, impacting 3% of construction and 9% of maintenance expenses. While Sustainable Sites (SS) and Water Efficiency (WE) features are considered cost-effective, specific cost data remains scarce. It's crucial to recognize that these percentages could change based on the project.

Taking a broader spectrum, Utomo et al. (2022) examined how the additional costs of green buildings influence their value using the Life Cycle Cost (LCC) method. Their study encompassed everything from the initial construction to ongoing yearly expenses, including energy and upkeep, as well as future costs. Their findings indicate that different green building designs and technologies impact these costs differently. For instance, while a slim building design might save money during construction, it could lead to higher ongoing expenses. Features like green roofs, smart lighting systems, and special building layers can increase costs, but they can also enhance the property's value. Interestingly, the utilization of eco-friendly materials and non-toxic wall paint emerged as a solution. This helps balance lower construction costs and ongoing expenses while simultaneously increasing the property's value over time. This implies that even though green building might appear more expensive initially, it can actually result in long-term cost savings and higher property value.

The latest study by Lau et al. (2023) adds a new dimension to this discussion by examining challenges stemming from limited resources. The study underscores that the absence of access to modern technology and a lack of necessary skills and knowledge are key contributors to higher costs in green building. The transition to sustainable construction necessitates specialized expertise and advanced technology. Unfortunately, many construction companies lack these resources, leading to expenditures on training or hiring experts. The integration of new materials and techniques also adds to the initial costs.

In reviewing literature from 2020 onwards, it becomes evident that several key factors contribute to incremental costs in green building construction. These variables include a variety of things, such as how much maintenance and construction costs are affected by Indoor Environmental Quality (IEQ) and Energy and Atmosphere (EA) features, how different sustainable building designs and technologies affect overall costs and property values, and how important resource constraints are because of a lack of advanced technology and specialised knowledge. These studies collectively highlight the complex and evolving nature of incremental cost factors in the pursuit of sustainable construction practices during this period.

2.8 Theoretical Frameworks and Hypothesis

Based on the discussion earlier, the following framework summarizing the factors influencing cost premium perception:

Figure 12. Theoretical Framework 1

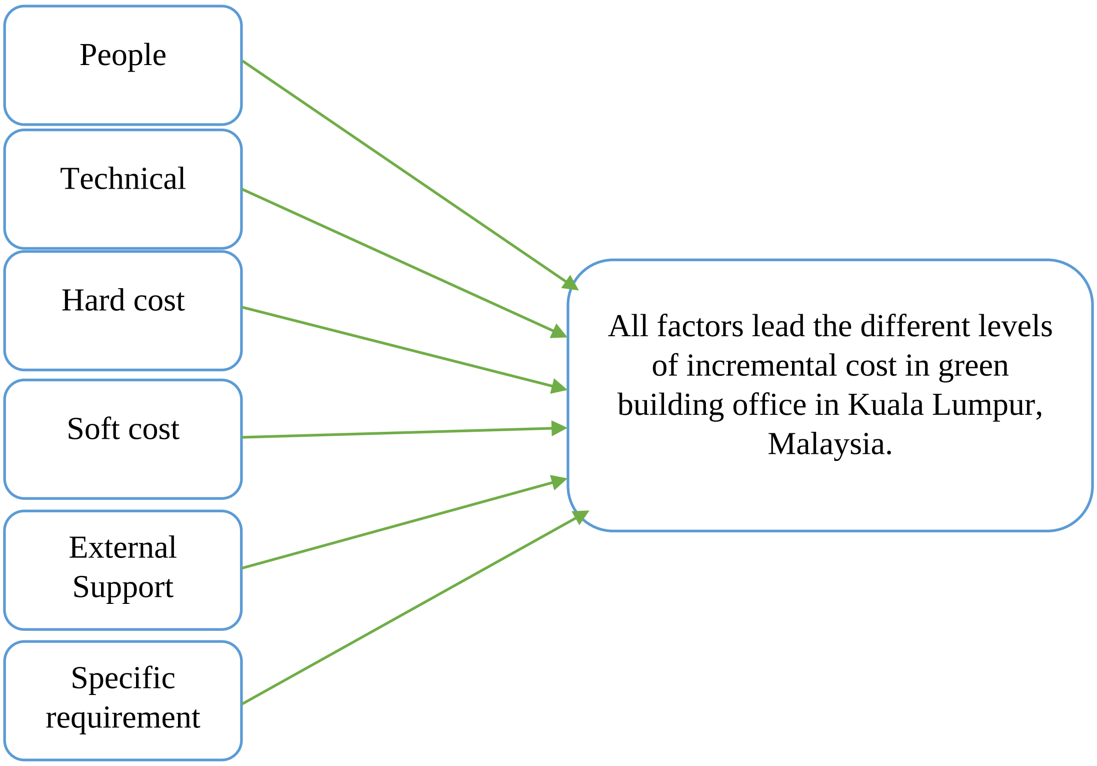
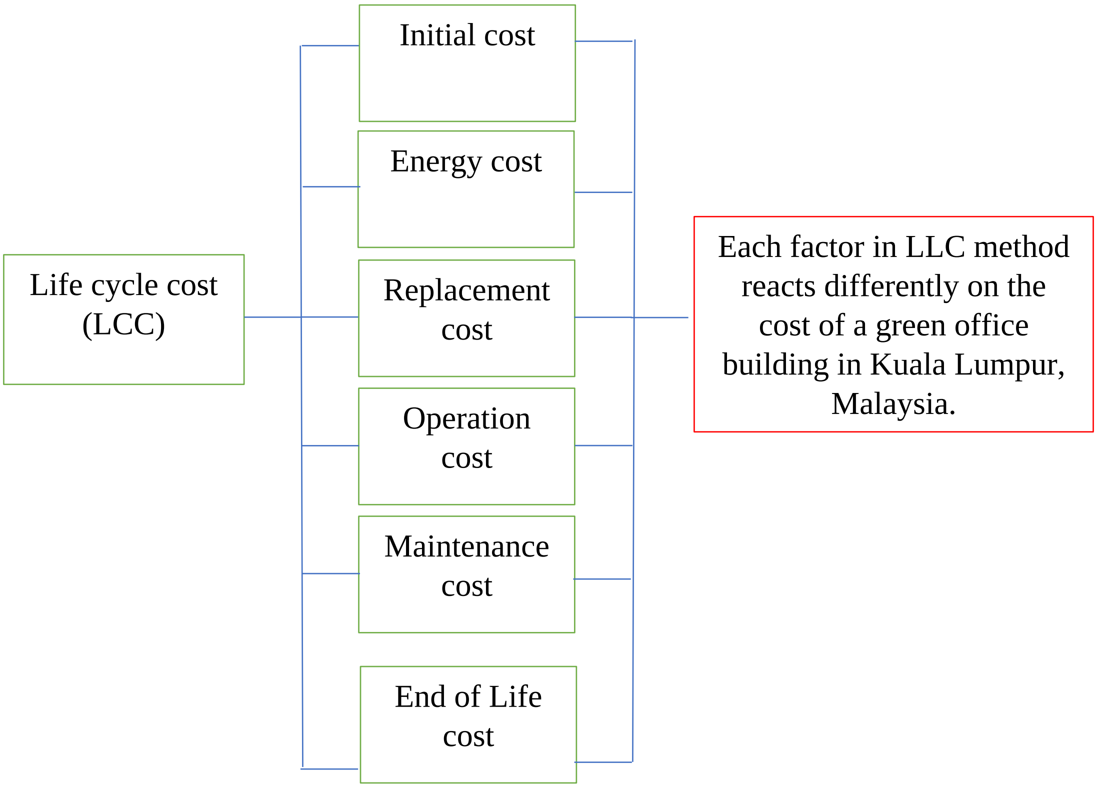


Figure 13. Incremental cost differences on green office building based on Life cycle cost (LCC) methods.



2.9 Conclusion

To summarize, this literature review chapter provides a comprehensive overview of the evolution, definition, and concepts of green building, tracing its development in Malaysia over time. The discussion encompasses relevant green rating tools in Malaysia, barriers to implementation, the cost premium associated with green building, and the various factors influencing cost variations in construction. The findings are presented in a chronological timeline, offering a structured understanding of the key elements and factors shaping the landscape of green building in Malaysia. The insights derived from this review lay the groundwork for the subsequent chapters, informing the study's exploration into the specific challenges within the context of high-rise green office buildings in Kuala Lumpur.

CHAPTER 3

RESEACH METHODOLOGY

3.0 Introduction

This chapter introduces the methodologies approaches used in this thesis. A methodological strategy has been carefully constructed to fulfil the thesis's purpose while also improving overall research quality. It begins by explaining the chosen study strategy and approach. Following that, it explains the phases of the study process, in accordance with our planned framework. These phases include research design and methodology, data collection method, interview design, sampling and data collection procedure. This thorough methodological approach serves as a solid foundation for our research.

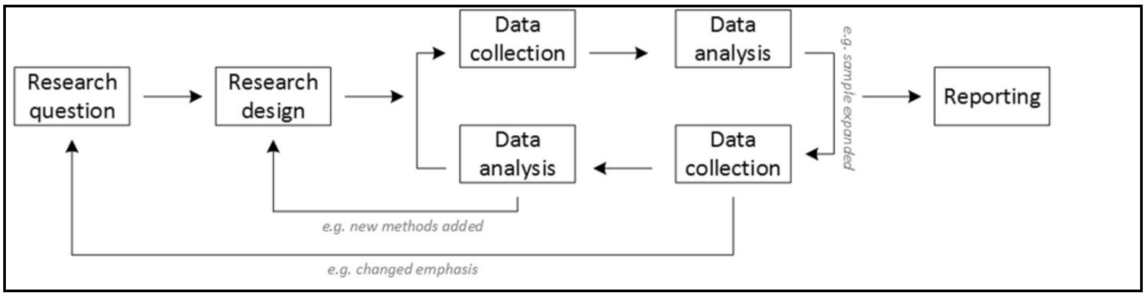
3.1 Research Design

The realm of research encompasses two fundamental methodological approaches: quantitative and qualitative techniques. Quantitative analysis, as elucidated by Apuke (2017), is centred on the systematic investigation and quantification of variables through numeric data. It deploys statistical methodologies to address research inquiries, validate preceding experiments, propose potential solutions, and either substantiate existing theories or formulate new ones. Survey research, correlational research, experimental research, and causal-comparative research are the four common research methods under this approach. Conversely, qualitative data analysis entails the process of interpreting non-numeric data to extract insights into concepts, opinions, or experiences. It often involves the identification of recurring themes or patterns, as underscored by Fakis et al. (2013).

In the pursuit of this research's objectives, an exploratory approach is deemed most suitable, insuring the utilization of qualitative research methodology. Qualitative research provides a dynamic framework that facilitates real-time follow-up on responses from respondents, fostering meaningful dialogues on the subject matter. This capacity for in-depth exploration and understanding of the opinions and thoughts of real estate stakeholders and professionals concerning the incremental cost factors associated with green office buildings whereas a quantitative research methodology might be unfeasible.

Moreover, this research will adhere to the procedural framework portrayed by Busetto et al. (2020), illustrated in Figure 1. The primary aim is to discern the cost differential between green office buildings and their conventional counterparts, along with the factors that exert influence on this differential. In order to accomplish this, the most suitable methodology is the implementation of individual semi-structured interviews.

Figure 14. Iterative research process



Note: Adopted from " How to use and assess qualitative research methods.". By Busetto et al., 2020, *Neurological Research and Practice 2*(1), p2.

3.2 Data collection methods

Data collection, as defined by Mazar et al. (2021), is a meticulous and systematic procedure that gathers, assesses, and analyses precise insights to advance research objectives, relying on authenticated methodologies for dependable data acquisition. It's a pivotal research process. In the following discussion, we explore primary and secondary data, highlighting their roles and significance in our research.

3.2.1 Primary data

Primary data is directly gathered from first-hand sources before publication, ensuring reliability and authenticity. Research can be conducted without secondary data, but solely relying on it may reduce credibility and introduce biases, as secondary data can be privately altered before release. Primary data sources encompass questionnaires, interviews, surveys, focus group discussions, document analysis, and reviews (Mwita, 2022).

This research adopts Grounded Theory (GT) as its qualitative research approach to address the research questions. Developed by Glaser and Strauss in 1967, GT is a systematic methodology emphasizing the inductive generation of theories firmly rooted in empirical data. Unlike conventional methods, GT does not rely on pre-existing hypotheses or predetermined themes. Conversely, it promotes the attitude of researchers towards the study being receptive to new ideas and theories as they arise organically from the data. This approach is particularly valuable when exploring research areas with limited existing literature, where establishing theories from prior knowledge is challenging.

Moreover, GT offers significant flexibility, making it a preferred choice for researchers across various fields investigating unique phenomena using diverse data sources. This characteristic also renders GT particularly appealing to novice researchers, including graduate students, as it provides a clear and adaptable framework for conducting comprehensive studies (Briks et al., 2019). In summary, GT aligns perfectly with the objectives of this study, enabling the exploration of a relatively under-studied research area with limited existing literature while offering the versatility required for a thorough investigation.

Nonetheless, a semi-structured interview with a total thirteen questions were prepared to interview with real estate professionals such as green accreditation and facilitators, developers, contractors in Kuala Lumpur, Malaysia. As opposed with unstructured interview, semi-structured interviews use a loosely structured guide with open-ended and probing questions to sufficiently address research objectives while allowing for individualized and natural conversation flow in each unique interview (Adeoye‐Olatunde & Olenik, 2021).

Additionally, there are two pre-formulated questions corresponded to the research questions were structured. This ensured that the question asked was properly addressed, while allowing a certain flexibility. Before the actual interview sessions, the questions have gone through review and ethical clearance by the university's board.

3.2.2 Secondary data

Secondary sources, according to Ajayi (2017), are data that was previously obtained by someone else. Secondary data are those collected by a party unrelated to the research endeavour but collected for a different reason and at a different time in the past. If the data is used by the researcher, it becomes secondary data for existing consumers. Government publications, websites, books, journal papers, and internal records are examples of secondary data sources.

Secondary data sources have proven beneficial in improving the study focus, developing a comprehensive literature evaluation, and formulating precise research objectives. Extensive searches were carried out in the UTAR library. Important databases such as Scopus, Emerald, Science Direct, and Sage Publications were also utilized. In addition to these academic databases, the resources of ResearchGate and Google Scholar were very helpful. To assist an efficient literature search, specific keywords were carefully chosen. These keywords covered critical parts of green building research, including incremental cost factors, impediments, life cycle costs, green building elements, and green building accreditation requirements.

The emphasis on life cycle costs in this study was motivated by the need to get a thorough understanding of the factors within green buildings that may lead to long-term cost expenses, especially from the perspective of diverse real estate experts. Prior study has mostly examined the hurdles to green building uptake, with little attention paid to the factors determining extra costs in the construction of green office buildings. This study tries to illuminate differing viewpoints on these significant elements by interviewing a varied group of real estate experts.

A systematic review was also undertaken to investigate the evolution of green building practises, current trends and policies, definitions, green building rating methods, impediments to adoption, and variables contributing to cost variances in green building projects. The ideas gathered from this broad literature analysis were critical in defining the development of interview questions for this study.

Table 3. list down the questions asked during the interview sections. A detail format of the interview form can be referred to Appendix

Interview Questions
1. Can you provide an overview of your experience and involvement in the construction of green office buildings?
2. In your opinion, do you think green construction practices is important in building offices in KL.
3. Do you think green building is cheaper or more expensive?
4. Identifying Key Cost Incremental Factors in Green Office Building Construction in KL.
5. Please rate the percentage increase in costs for each factor when comparing green office buildings to conventional office buildings.
6. Can you share any case studies of significant cost differences between green and conventional office buildings?
7. In your opinion, are there certain building elements or features that you think notably affect the cost differences between green and conventional office buildings in KL?
8. Other than cost, have you noticed any specific challenges or obstacles that arise during the construction or development of green office buildings in KL?
9. How do you weight the long-term financial benefits and drawbacks of green office buildings versus traditional office buildings?

10. How do you see the level of awareness and understanding of green building practices among construction stakeholders, including contractors, developers, consultants and professionals like yourself?

11. In your opinion, what are the key drivers or incentives that encourage developers to invest in green office buildings despite potential cost differences?

12. Based on your expertise, what recommendations would you give to overcome the challenges and encourage greater industry adoption of green office buildings in KL.

13. Do you think there is a need to make green building certification mandatory in Malaysia?

Source: Develop from the research based on literature review

3.3 Sampling

The goal of qualitative research is to choose participants who can provide various and informative viewpoints on the study matters. A non-probability purposive sampling method was used for this investigation. As described by Cornesse et al. (2020), probability sampling refers to sampling methods that give each member of a population a known, non-zero chance of being selected. Such methods often result in samples that are representative of the population which makes them more accurate. In contrast, non-probability sampling methods do not ensure selecting of every member of the population, hence introducing potential bias and reducing the accuracy of the obtained samples. In this case, participants needed to be either professionals in green office building or real estate professionals that have experience in building green building to be included in the sample.

Within purposive sampling, a homogeneous sampling strategy was utilized. This focuses on candidates who share similar traits or specific characteristics. For example, participants in homogenous sampling would be similar in terms of ages, cultures, jobs or life experiences as explained by Etikan (2016). In this research, the shared experience was being knowledgeable and experienced in different aspects of green building.

A total of twenty participants were approached, encompassing various professional backgrounds. This diverse group included eight individuals from the real estate sector, six from green certification firms, two with architectural backgrounds, two with quantity surveying backgrounds, and one from a government green agency. The adoption of snowball sampling in this study, where each participant was recommended by a previous one, ensured both an ample number of participants and the reliability of their responses.

Each participant was thoroughly briefed about the study's objectives and provided explicit consent before proceeding with any data collection activities. Notably, efforts were made to promote diversity among the participants, encompassing both male and female individuals from different occupations with real estate related background. Furthermore, the participants exhibited heterogeneity with respect to their degrees of professional experience, accomplishments, and credentials.

Before participating in physical audio-recorded or online interviews conducted through Microsoft Teams, all informants were furnished with detailed information about the study's goals. Nevertheless, English was utilized as the primary language for these interviews to ensure effective communication.

3.4 Target respondence

This study project interviewed a total of 20 respondents from the field. Each interview was anticipated to last 30 to 60 minutes. Comprehensive information on the respondents is provided and can be cross-referenced in Chapter 4. It is important to note that all interview sessions were physically audio-recorded or recorded by the Microsoft team exclusively for academic purposes and will be transcribed into written form after the interviews are completed.

3.5 Thematic Analysis

According to Alhojailan (2012), thematic analysis (TA) is a qualitative analytic approach used to reveal categories and find themes or patterns within a dataset. It is ideal for our thesis since it enables the examination of experiences, thoughts, or actions across a dataset (Kigera & Varpioa, 2020). The commonly acknowledged methodology for conducting thematic analysis consists of six steps: familiarizing with the data, generating initial codes, recognizing themes, reviewing these topics, defining and labelling them, and finally publishing the report.

When employing TA, there are two basic process approaches: inductive and deductive. Researchers examine data through pre-established theoretical conceptions in order to disprove, expand on, or replicate prior research (Joffe & Yardley, 2004). The aforementioned approach aligns with the scientific method, wherein the researcher formulates and verifies hypotheses.

While the use of a deductive technique does not always indicate that a research endeavour is only designed to examine a hypothesis. A researcher's pre-existing views come into play in almost any study aimed at detecting themes (Joffe & Yardley, 2004). Nonetheless, it is vital to emphasize that qualitative researchers, on general, rely less on logical procedures than their quantitative counterparts. Similarly, an inductive approach will be more suitable for investigating and identifying new ideas, comprehension, and reactions from interviewees.

It is critical to recognize thematic analysis's versatility. To ensure the legitimacy of their findings and interpretations, researchers using this method must clearly describe their paradigmatic orientations and assumptions. It is crucial to note, however, that theme analysis is not a full approach with a guiding theory. Methodologies cover a wide range of research components, such as guiding theories and linguistic orientations. Methods, on the other hand, give researchers with a wide range of possibilities, such as data kinds and guiding theories (Braun & Clarke, 2022).

Following the completion of interviews and data summaries, an inductive analytical procedure produced an initial set of codes and associated themes. Through the inspection of transcripts and summary materials, these preliminary codes were thoroughly reviewed and expanded. To ensure the consistency and reliable of the analysis, two independent researchers independently interpreted the data, engaged in comparison conversations, and iteratively refined the themes. This iterative procedure was repeated until no new codes appeared, with any inconsistencies handled by a clear articulation of code criteria. This thematic analysis's comprehensive findings are reported in Chapter 4 of this thesis.

3.6 Findings and Discussion

The study's findings and subsequent discussions were illustrated through the use of tables, graphs, and detailed narratives. The data-derived themes have been properly sorted and presented. With the existing empirical evidence in hand, these findings will be examined further. Further elaboration and thorough information are available in Chapter 4.

3.7 Conclusion

In this methodological section, we have established a foundation for our research. Employing grounded theory as our qualitative approach, we have carefully designed interviews and sampling strategies to gather valuable insights from diverse real estate professionals.

Thematic analysis will enable us to uncover patterns and themes in our data. This comprehensive methodology ensures that our study will provide a thorough exploration of green office building incremental cost factors. As we proceed to Chapter 4, the TA methods will facilitate analysis and insightful interpretation of our findings.

CHAPTER 4

FINDINGS AND DISCUSSION

4.0 Introduction

This section provides a comprehensive overview of the participants' profiles and backgrounds engaged in our study. These profiles are pivotal in establishing the context necessary for a nuanced understanding of the viewpoints and insights articulated during the interviews. Our research benefits from the diverse spectrum of backgrounds represented by these participants, ranging from real estate industry professionals to experts in green accreditation and government officials. We establish the legitimacy and significance of their contributions to our study by conducting a comprehensive analysis of their professional experiences, credentials, and occupations. This preliminary section serves as a solid foundation for delving into the emerging themes and subthemes extracted through the thematic analysis, which will be discussed and contextualized in relation to existing literature.

4.1 Interview and analysis findings

4.1.1 Interviewees and respondent's profile

Table 4. Participant Profiles and Professional Backgrounds

No	Company position	Education background	Occupation	Years of Experience
R1	Executive	Electrical & Electronics Engineering (BEEE)	Building management	6 years

		Sustainable Development Management (MSDM)		
R2	Managing Director	Architectural	Green building facilitator	13 years
R3	Assistant Vice President	Civil Engineer	Infrastructural design	22 years
R4	General Manager for contract & procurement	Quantity Surveyor	Developer	20 years
R5	Project Architect	Architectural	Architect	10 years
R6	Associate Director	Quantity Surveyor	Quantity Surveyor	6 years
R7	Executive	Oil and Gas	Green consultant	6 years
R8	Consultant	Quantity Surveyor	Quantity Surveyor	40 years
R9	Director	Technology management	Green consultant	20 years
R10	Contract manager	Quantity Surveyor	Developer	10 years
R11	Chief Executive Officer	Quantity Surveyor	Developer	32 years
R12	Director	Architectural	Green consultant	15 years

R13	Executive	Mechanical Engineering in Manufacturing	Green consultant	9 years
R14	Senior Manager	Quantity Surveyor	Contractor	26 years
R15	Director	Electrical & Electronics Engineering	Green consultant	13 years
R16	Head of the property management, property investment, occupational safety and health	Electrical & Electronics Engineering Degree in medicine Master's in business management and financial analysis.	Developer	10 years
R17	Executive	Energy sustainability	Developer	6 years
R18	Founder	Quantity Surveyor	Architectural firm	30 years
R19	Manager	Science in Energy Management	Government green service	20 years
R20	Senior manger	Quantity Surveyor	Developer	20 years

Source: Develop form the research

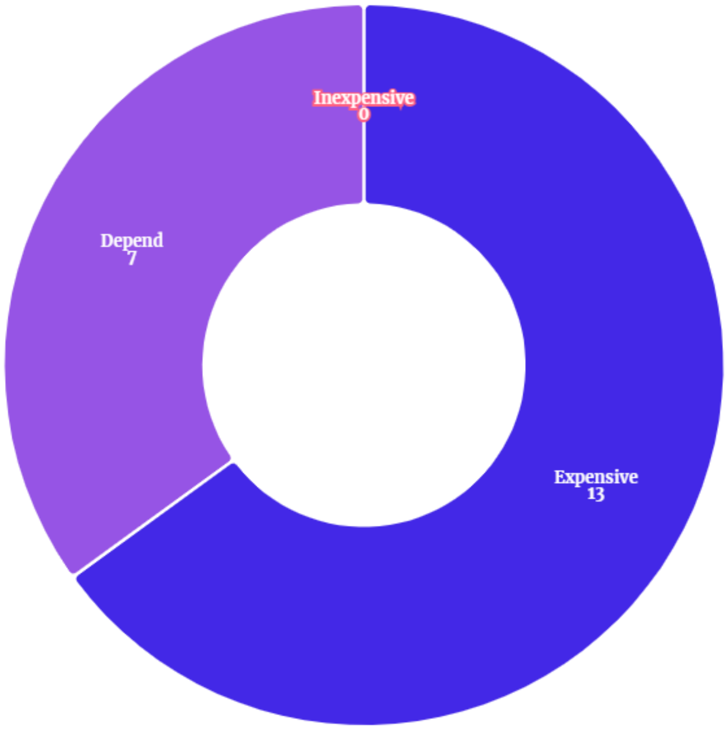
A summary of the respondents' backgrounds is comprehensively presented in the contents of Table 4.1. It provides information on their occupation history, years of professional experience, education, and current position within their respective companies. The respondents comprise a total of eight individuals from the real estate industry, six individuals from green certification organisations, two individuals with architectural credentials, two individuals with quantity surveying backgrounds, and one individual from a government green agency. The respondents each possessed no less than six years of experience in their respective occupations. The inclusion of a varied group of participants enabled the researcher to get a range of perspectives based on their occupational experiences within the real estate business.

Furthermore, the utilisation of snowball sampling in this research, wherein each participant was referred by a preceding one, guaranteed the inclusion of a sufficient number of participants and enhanced the dependability of their responses. After the interview, the participant was asking to suggest at least one or more candidate they though are appropriate for the research topic. The majority of individuals in question are either individuals who work with the participant or those who share a professional affiliation. However, the interview procedure was halted after reaching twenty respondents due to data saturation.

The subsequent part presents the conclusions derived from a theme analysis that was undertaken utilising the interview responses. The presentation includes the identification of themes, subthemes, and the inclusion of participant quotes that match to these themes.

4.1.2 Cost Perception of Green Building

Figure 15. Cost Perception of Green Building



This section examines the cost perceptions of green building development in Kuala Lumpur (KL) as expressed by a diverse variety of stakeholders. The responses show a wide range of views on the subject.

"For now, probably is more expensive. Because the technology is not there yet to full scale." – *R3*

"Green building will be slightly expansive in early investment."– *R6*

"For us, time being is not cheaper…. In Datum Corp our project we see that is expensive" – *R10*

"It is expensive, this is due to the materials being premium" – *R14*

A significant majority, 13 out of 20 respondents, believe that green building in KL is more expensive than conventional construction. This increased cost is attributed to variables such as modern materials, energy-efficient technology, and specialist components like as insulation and specialised glass. They emphasise the initial capital expenditure required for green development, characterising it as costly.

"Of course, it depends on the type of building because green building is largely practice in medium or high-end category of building." – *R4*

"Yes and no, definitely in short term the answer will be yes. Because the initial capital upfront will be great…. However, in the long term it will comeback from the electricity bills reduction." – *R5*

It depends …. because if you are the owner, you're going to own the building because you're going to pay for the utility then definitely it's cheaper. – *R9*

"The question is too broad to be answered correctly. When referred to MS1525 as a basis and is cheap, but different projects may be very expensive" – *R12*

However, 7 responders provide a more different viewpoint. They suggest that cost perception is affected by a variety of factors, including the style of building, the level of green elements integrated, and the architectural solutions adopted. Interestingly, interviewee who answered "depend" are either developers or green building consultants. According to this viewpoint, whether green building is more expensive or not is dependent on the unique project circumstances.

Notably, none of the respondents believe that green development in KL is inexpensive. Even those who emphasise the possible long-term cost savings acknowledge that the early costs are higher. In conclusion, these diverse opinions highlight the challenges in balancing between initial expenses, long-term advantages of environmental sustainability and financial feasibility in the context of green development in KL.

4.1.3 Rankings of green office building cost incremental factors

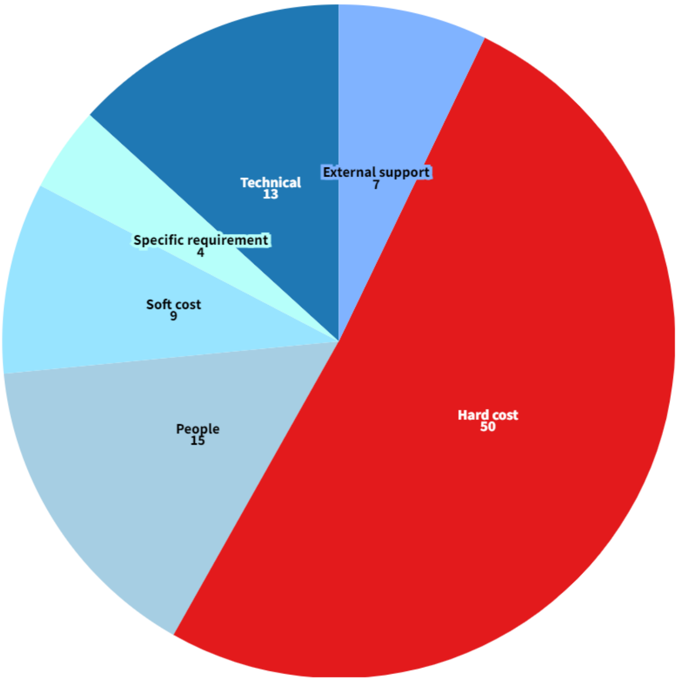
Table 5. Non-Building Operators

No	People	Technical	Hard cost	Soft cost	External Support	Specific requirement
R1	30%	15%	15%	15%	5%	5%
R3	10%	10%	40%	10%	20%	10%
R5	20%	5%	30%	15%	5%	5%
R8	5%	30%	50%	5%	5%	5%
R12	7%	1%	85%	3%	2%	2%
R13	15%	15%	70%	0%	0%	0%
R14	10%	5%	70%	5%	5%	5%
R15	5%	8%	80%	10%	1%	0.5%
R17	10%	22%	40%	15%	8%	5%
R18	15%	15%	50%	10%	5%	5%
R19	40%	20%	20%	15%	20%	5%
Average	**15%**	**13%**	**50%**	**9%**	**7%**	**4%**

Table 6. Building Operators

No	Initial cost	Energy cost	Replacement cost	Operation cost	Maintenance cost	End of life cost
R4	80%	5%	1%.	3%	3%	0%
R9	10%	0%	30%	10%	30%	20%
R10	50%	20%	5%	5%	15%	5%
R16	55%	5%	5%	15%	10%	10%
Average	**49%**	**8%**	**13%**	**8%**	**15%**	**9%**

Figure 16. Average rankings of green office building cost incremental factors (non-building operators)



Note: The average percentage of each factor, as derived from the interviewee responses, pertaining to non-building operators.

When the cost incremental components for high-rise green office constructions are evaluated, it is clear that various elements contribute to the overall cost, with varying degrees of influence. Each element represents a different portion of the budget, with varying weights. This variation in cost allocation reflects the complexities of green office development and its numerous requirements.

People-related expenses, which include features such as professional function and service, green expertise knowledge, and wage changes, contribute for an estimated 15% of overall costs. This emphasises the important role that the professions in play in green office development, as their experience and services contribute to the construction being sustainable and environmentally responsible.

Technical considerations such as additional limitations, rules, procurement problems, permit difficulties, implementation time, and project delays account for roughly 13% of total expenses. These considerations highlight the sophisticated technical components and procurement process of green office development, to navigating complex permission processes and approval.

The initial cost component includes expenses related to the establishment of the structure, physical building activities, implementation of sustainable technology, engineering work, and labour costs. This component represents the predominant portion of the overall expenditures, accounting for 50% of the total. This demonstrates the significant financial expenditure required for physical construction as well as the incorporation of green technologies and practises into the structure.

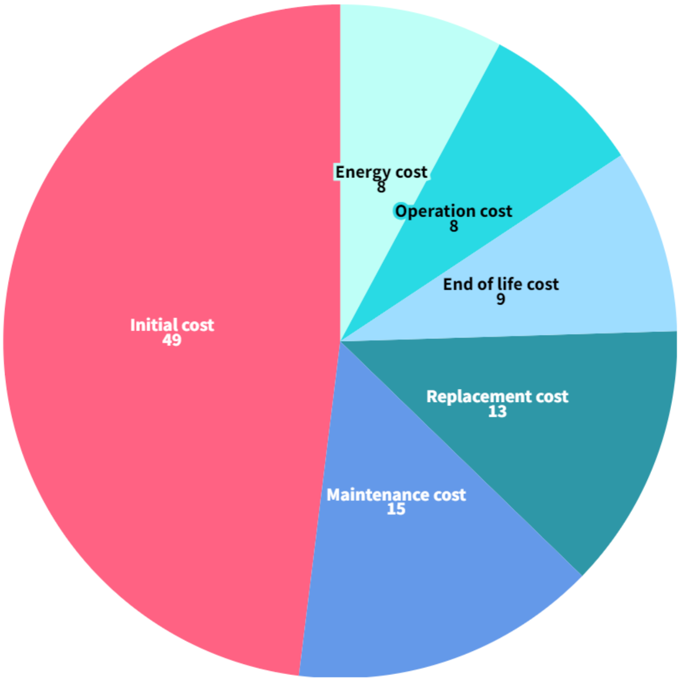
Soft costs, in contrast, account for 9% of overall expenditures and include management, planning, documentation, marketing, and insurance. These costs are associated with the administrative and strategic components of green office development, such as project management and marketing.

Financial restraints, government assistance, rebates, subsidies, incentives, professional organisation cooperation, and financial institution loans account for around 7% of total expenditures. These criteria emphasise the need of external stakeholders and support mechanisms in reducing the incremental costs of green office building.

Specific requirement account for approximately 4% of overall expenditures and include spending for green consultants, certification, facilitator fees, green assessment compliance, commissioning processes, and adopting green practises throughout the design phase. These regulations emphasise the importance of specialised knowledge and adherence to green construction standards.

In conclusion, the cost incremental variables are scattered across multiple dimensions, emphasising the complex and diverse character of high-rise green office development. Cost allocation varies, with the bulk attributable to hard costs, while other elements such as people and particular requirements also contribute considerably to total costs.

Figure 17. Average rankings of green office building cost incremental factors (Building operators)



Note: The average percentage of each factor, as derived from the interviewee responses, pertaining to building operation.

In this investigation, we look at the average rankings of green office building cost additional variables as viewed by building operators who understand the complete life cycle cost. The rankings indicate the weight given to each factor in the context of the complete life cycle of a high-rise green office construction.

The initial cost component, which has the highest degree of weight, is recognised as being 49% of the total life cycle expense. It includes planning costs, building raw material costs, construction costs (including land, building, equipment, logistics, and installation), green feature costs (in accordance with policies and regulations, use of green materials and equipment, and green building assessment), and professional services (including design, supervision, construction management, and green inspection and certification).
The cost of energy accounts for 8% of the life cycle cost and is therefore critical. It includes costs for power, energy-efficient lighting, daylighting systems, AHU (Air Handling Unit) fans, and air-conditioning systems. It also considers the cost of water.

Replacing photovoltaic (PV) systems, rainwater harvesting (RWH) systems, daylighting systems, and pumps entails costs that involve these ecologically sustainable elements. This cost constitutes 13% of the overall life cycle cost.

The operation cost, which accounts for 8% of the total cost, includes human expenses for both management, technical people and sewerage charges.

Maintenance expenditures, which account for 15% of the life cycle cost, include the price of maintaining green building features, replacing PV and RWH systems, security services, green certification renewal, landscaping, gardening, and healthcare and sanitary goods.

The end-of-life cost comprises 9% of the total life cycle cost. It covers the costs of site clearing, waste transport, waste processing, labour, demolition, disposal, and the recovery of useful recyclable units, after the building has been obsolete.

Each of these aspects adds up to the total life cycle cost of a high-rise green office development. In this setting initial are the most significant, accounting for 49% of overall life cycle cost.

4.1.4 Percentage changes in each factor when comparing with conventional office

Table 7. Non-Building Operators

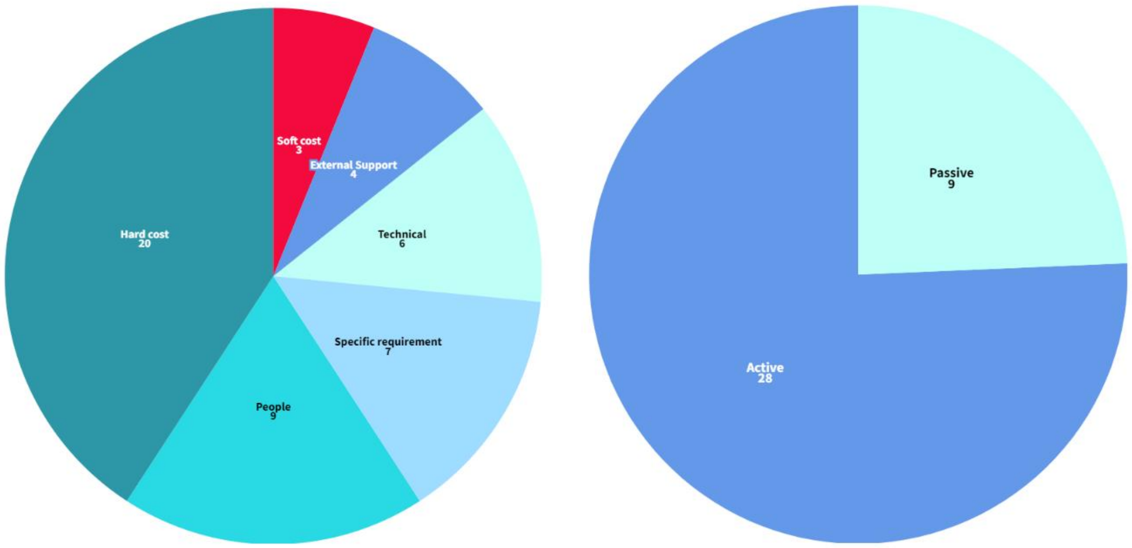
No	People	Technical	Hard cost	Active green design	Passive green design	Soft cost	External Support	Specific requirement
R1	30%	-15%	40%	25%	-15%	5%	10%	20%
R3	20%	10%	25%	10%	10%	10%	10%	10%
R5	20%	20%	-10%	20%	0%	-10%	0%	5%
R8	0%	10%	50%	30%	15%	10%	0%	10%
R11	0%	3%	2%	0.5%	0%	0%	0%	0.1%
R13	0%	0%	5%	4%	1%	0%	10%	5%

R14	5%	5%	35%	50%	50%	10%	5%	10%
R15	0%	0%	5.5%	90%	10%	0%	-5%	0.5%
R17	3%	7%	20%	17%	3%	0%	0%	0%
R18	2%	12.5%	10%	5%	5%	5%	2.5%	5%
Average	**9%**	**6%**	**20%**	**28%**	**9%**	**3%**	**4%**	**7%**

Table 8. Building Operators

No	Initial cost	Energy cost	Replacement cost	Operation cost	Maintenance cost	End of life cost
R4	15%	-7.5%	2%	-5%	-5%	0%
R9	5%	-30%	0%	0%	0%	0%
R10	20%	-10%	-10%	-10%	-15%	5%
R16	15%	-7.5%	10%	2.5%	3%	20%
R19	50%	-10%	0%	-5%	0%	5%
Average	**21%**	**-13%**	**0.4%**	**-4%**	**-3%**	**6%**

Figure 18. Average Percentage changes in each factor when comparing with conventional office (non-Building operators).



This section compares high-rise green office buildings to conventional high-rise office buildings and examines the percentage changes in key cost elements. The analysis focuses on non-building operators, who are primarily concerned with building costs rather than operational expenses.

When the "People" aspect is considered, which includes professional roles and services, understanding of green practises, and wage changes, the expenses for high-rise green office buildings increase by around 9% when compared to conventional office buildings.

Green office constructions cost is 6% more than conventional counterparts due to "Technical" considerations such as additional constraints, procurement challenges, complications in permission processes, and the time required to implement green construction.

"Hard Cost" aspects such as construction, green technology, architectural work, mechanical work, electrical work, and labour contribute to an 20% increase in overall costs for green office buildings when compared to conventional ones.

"Active Green Design" components, which include solar panels, efficient air conditioning, ventilation technology, and ecological data collection, result in a significant 28% within the "Hard Cost".

In contrast, "Passive Green Design" features such as green roofs, landscaping, natural lighting, and rainwater harvesting contribute to an 9% within the "Hard Cost".

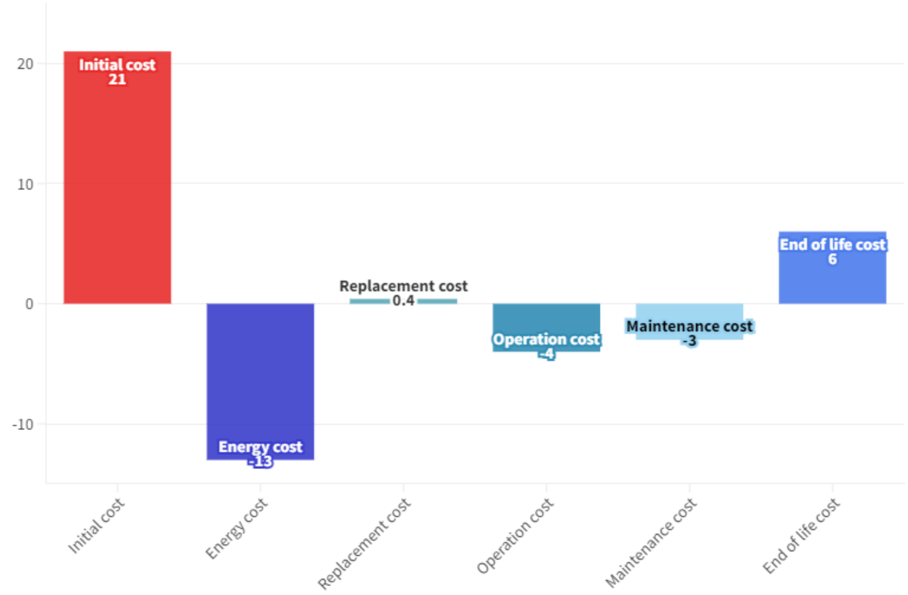
"Soft Cost" concerns, which include fees for administration, planning, documentation, marketing, insurance, and design, contribute marginally, with green office projects incurring a 3% cost increase.

Factors related to "External Support," such as government assistance, incentives, collaboration among professional organisations, and loan opportunities from financial institutions, add an additional 4% to the overall costs of green office buildings.

Finally, additional green consultants, certification costs, green facilitator fees, compliance with green assessment requirements, complex commissioning processes, and the implementation of green practises during the design phase all contribute to a 7% increase in cost for green office developments.

An intriguing conclusion drawn from this analysis is the substantial influence of "Active Green Design" components, like solar panels and energy-efficient air conditioning which adds up to a quarter of the cost of high-rise green office buildings when compared to conventional buildings. This highlights the significant financial expenditure needed to put in place innovative energy-efficient technologies and monitoring systems.

Figure 19. Average Percentage changes in each factor when comparing with conventional office (Building operators)



The comparison of cost elements of green office buildings with conventional non-green office buildings, with an emphasis on building operators that consider life cycle costs, provides useful insights into the cost dynamics of high-rise office building. To begin, the initial cost of green office buildings is 21% greater than that of conventional counterparts. This higher initial investment covers R&D costs, green materials, and compliance with environmental requirements. While the initial expenses are more significant, the lasting financial and ecological advantages of employing green building may compensate for the disparity in cost over the life of the building.

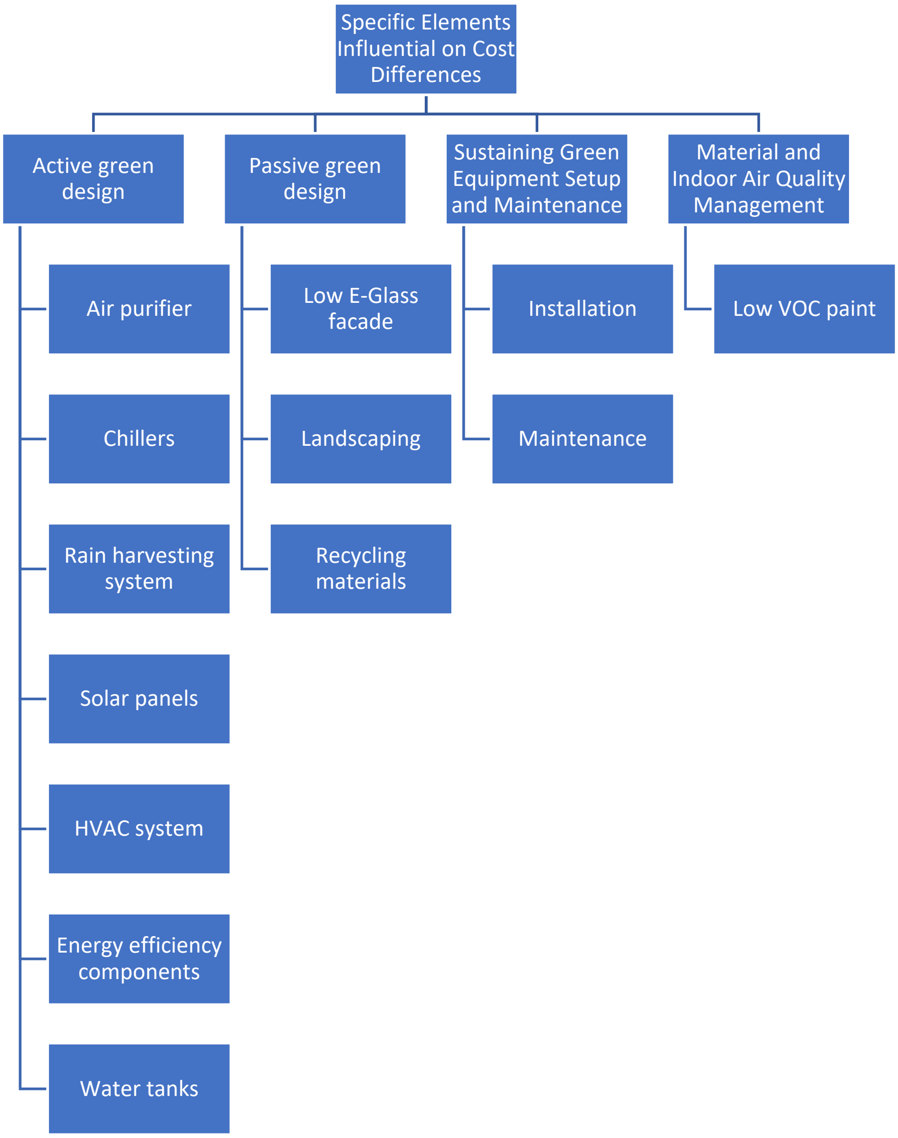
On the other hand, green office buildings are expected to save 13% on energy costs, according to the findings. This significant reduction can be attributed to green buildings' energy-efficient technologies and environmentally conscientious practises. This data emphasises the enormous cost savings and environmental sustainability benefits associated with green office facilities, making them a long-term financially viable and environmentally conscious decision.

The research also shows a 0.4% increase in replacement costs for green office buildings, highlighting the durability and longevity of green features that help offset replacement costs. This proves that green buildings could be as cost-effective as conventional ones in replacement costs. Furthermore, high-rise green office buildings have -4% lower operational expenses than their conventional counterparts. In terms of operations and maintenance, this reduction indicates the long-term cost-efficiency and environmental responsibility of green buildings.

Finally, maintenance expenses have decrease by only 3%, indicating the durability of green building elements and systems for optimal operation. However, end-of-life expenses have increased by 6%, indicating a commitment to ecologically responsible disposal practises and reflecting the life cycle considerations of green buildings. These findings highlight the financial and environmental benefits of green construction practises, making them a desirable option for building operators in high-rise office buildings.

4.1.5 Specific Elements Influential on Cost Differences: Green vs. Conventional Office Building

Table 9. Specific Elements Influential on Cost Differences



Note: Interviewee opinion on the specific elements influential on cost differences.

The analysis of interviews with industry professionals reveals particular variables that have a major impact on the cost discrepancies between green and conventional office buildings. These factors are divided into 4 themes including active green design, passive green design, Sustaining Green Equipment Setup and Maintenance, Material and Indoor Air Quality Management each of which contributes to cost differences and strengthens the case for green office building practises.

“I would say your air conditioning system. Air conditioning for offices. That is where your biggest cost”– *R15*

*“*EE features to me is the bigger contribution” *– R10*

"Active Green Design," includes dynamic components that have a direct impact on energy usage and operational efficiency. Air purification systems, chillers, rainwater harvesting systems, solar panels, HVAC systems, and numerous energy efficiency features are examples of key components within this theme. These active elements are costly, but they contribute to energy efficiency, which ultimate contributed many points in the green building practises.

“Landscaping can be very expensive, especially in urban city” *– R2*

“Second one is glazing; glazing will cost you millions.” *– R13*

In contrast, the implementation of "Passive Green Design" features requires less reliance on active energy use, but at a significant cost. The enhancement of passive energy efficiency can be achieved by including many aspects, including the use of low-E glass facades, strategic landscaping, and the integration of recycled materials. When compared to standard single-glazed glass, the high cost of double-glazed low emissivity glass facades emphasises the financial commitment involved with passive design components.

“So, the two main things are simple. The facade, the glass and the installation” *– R17*

“Green wall will even kill you because you need system you need piping, you need immigration system” *– R2*

Another cost components are the installation and upkeep of green building equipment. Interviewees emphasised the long-term financial commitment required for the installation and maintenance of green equipment and environmentally friendly systems are a major cost concern.

“We using low VOC paint is actually costing I can say that costly” – *R1*

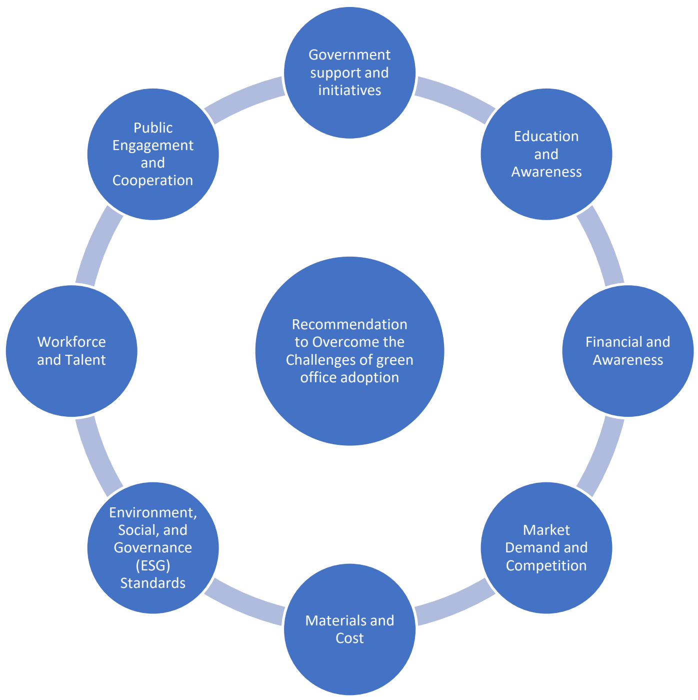
“The additional cost is mainly on the green energy facilities such as …. the special low VOC paint” – *R18*

The theme "Material and Indoor Air Quality Management" discusses the usage of Low Volatile Organic Compound (VOC) paint, which helps to improve indoor air quality. Although it is not seeming as expensive as some other active and passive design features, but still consider as a cost factors. Nevertheless, its influence on occupant health and well-being is substantial."

These findings provide light on the multidimensional character of green building design, emphasising the several elements that contribute to cost differences between green and conventional office structures. Recognising these subtle factors is critical for making informed decisions in green building construction and operations, as they represent a large financial investment.

4.1.6 Recommendation to Overcome the Challenges of green office adoption

Figure 20. Recommendation to Overcome the Challenges of green office adoption



Note: interviewee suggestions to overcome the challenges of green office adoption.

The transcript provides a wide range of solutions for overcoming the problems involved with the implementation of green office buildings. These guidelines are divided into eight distinct topics, such as Government support and initiatives, Education and Awareness, Financial incentives and Benefits, Market Demand and Competition, Materials and Cost, Environment, Social, and Governance (ESG) Standards, Workforce and Talent, Public Engagement and Cooperation.

“Government support and financial institutions support that is those two are very, very important” – *R1*

Participants emphasised the critical importance of **government support and initiatives** in developing green office developments. They urged for all stakeholders to have a thorough understanding of the goals of green building certification. Interviewees also emphasised the potential benefits of enacting gazette laws or acts, as demonstrated by countries such as Singapore, which has made green construction compliance mandatory. Furthermore, participants emphasised the appeal of financial incentives, such as tax breaks, in attracting private developers to participate in green projects. Methods for increasing awareness and comprehension of green construction practises included public campaigns and early teaching of engineering students.

The R3, R14 and R20 respondents agreed that **education and awareness** among all stakeholders is critical to the development of green office buildings. They called for educational initiatives, workshops, and seminars to promote information about green building practises. Some participants also suggested that early exposure to green concepts during young engineers' university education should help raise awareness and knowledge of green building practises. Nonetheless, several interviewees stated that public knowledge of the benefits of green buildings has already improved, thereby diminishing the importance of more educational efforts.

“Or by way of financial assistance or relieve from the government in a way to get more involve” – *R4*

"Think money is still the most attractive incentive" – *R2*

Monetary incentives have been identified as effective motivators for the adoption of green office buildings. Participants emphasised the crucial relevance of tax exemptions, rebates, and incentives in encouraging developers to use green practises. They also advocated for government subsidies or financial aid to make green building more economically viable for developers.

"If purchasers ask for this then developers are pulled to build more because there are demands for it." – *R12*

Respondents emphasised the importance of **developing a market demand** for green office buildings. They stated that raising market demand and making green projects more saleable will provide a major motive for developers to participate in green development.

"When we have substantial economic of scale then it will bring down the cost" – *R6*

The **cost of green materials and technologies** has emerged as an obstacle to adoption. Participants suggested lowering the cost of such materials to make green building more affordable. They proposed government assistance in lowering material costs or the development of economic scales that could reduce expenses.

"I will say yes, that ESG is pushing them forward." – *R8*

Environmental, social, and governance (ESG) standards were viewed as a critical component of the green building adoption rate. Participants emphasised the necessity of adhering to these criteria and suggested incentivizing developers who adhere to ESG principles.

"Talents now is the big challenge as the awareness is getting better" – *R9*

Skilled experts were regarded necessary for the successful adoption of green building practises. Participants agreed that education and awareness activities should go hand in hand with efforts to cultivate talent in the industry, since competent individuals are critical to pushing green initiatives.

“The occupants also need to practice low carbon practice.” – *R19*

The R19 and R20 interviewees agreed on the importance of **coordinated initiatives involving the government, stakeholders, and the general public**. They emphasised the importance of public awareness and cooperation, in conjunction with government actions, for the success of green building uptake.

In summary, the interviewees' recommendations indicate that overcoming these challenges associated with the adoption of green office buildings requires a comprehensive approach that combines government support, financial incentives, education, market demand, cost reduction, adherence to ESG standards, a skilled workforce, and public engagement. These insights can help stakeholders in the construction and development industries embrace sustainable and environmentally friendly building practises.

4.2 Discussions on findings

Green building has grown tremendously in recent years, notably in response to the net-zero carbon objective for 2050 and development authorities' focus on Environmental, Social, and Governance (ESG) principles. The Green Building Index (GBI) and different legislative initiatives are supporting this expansion, emphasising the necessity of sustainable practises in the building sector. Previous literature consistently identifies cost as one of the most significant hindrances to the progress of green building in Malaysia. While the importance of cost as a barrier is well-established, most studies failed to address and neglected to pinpoint which specific factors and the degree of it contributing to cost increments in local green building projects.

In our study, a discovery emerges as we explore the factors contributing to the incremental costs of constructing green office buildings. Notably, hard costs, encompassing expenses directly related to the physical aspects of construction, including green technology integration, architectural and mechanical work, electrical components, and labour (Abidin & Azizi, 2016), continue to be the predominant financial driver, accounting for 50% of the total expenses. This finding reaffirms previous research, which already concluded the significance of hard costs and their substantial impact on the financial landscape of green office development (Hu & Skibniewski, 2021; Yasinta et al, 2020).

Our study also further supports the findings of Plebankiewicz et al. (2019), emphasizing people-related expenses as significant cost factors in the realm of green office development. In this research, people cost including role and service fee of professional's knowledge in green building. While there is broad agreement on their significance, it is essential to perform a more in-depth examination of the underlying elements that generate these expenses. As elucidated by Plebankiewicz et al., the costs linked to people are influenced by an array of variables, including building type, dimensions, certification ambitions, market dynamics, and consultant proficiency. These multifaceted factors result in regional variations in pricing. Their research observed the necessity of establishing precise parameters and standards for costing consultations within the green building sector, ultimately enhancing cost efficiency and effectiveness.

In comparison to conventional office buildings, our study similarly reveals that people-related costs also rank as the second most significant incremental cost factor in the life cycle of green office buildings. This finding aligns with the observations made by Abidin and Azizi (2016), emphasizing the pivotal roles and services of professionals who plan, design, deliver, and maintain the infrastructure and built environment. It is worth noting that these professionals are essential players in addressing the growing demands for green building, constituting approximately 3-5 percent of the life cycle cost.

Surprisingly, for building operators, our investigation uncovers maintenance costs as the second-highest cost contributor over the entire life cycle of green office buildings. This observation raises intriguing questions, as prior research has seldom highlighted maintenance costs as a potential barrier. In order to elucidate this phenomenon, we direct our attention to the research study conducted by Zainol et al. (2014), which offers valuable insights into the factors influencing the higher proportion of maintenance costs in the development of green buildings. The research identifies the following key issues related to maintenance and operation in Malaysia:

1. Failure to consider maintainability during the design stage
2. Inadequate knowledge and skills of facilities management personnel in O&M
3. Lack of proper communication and coordination among stakeholders throughout the building life cycle
4. Shortage of trained personnel in the field of green building O&M
5. Dearth of green building O&M guidelines and best practices
6. These critical factors may contribute to the prominence of maintenance costs in the life cycle cost of green office buildings. Addressing these factors could potentially lead to lower maintenance costs, enhancing the long-term economic viability of green office building development.

In contrast, our research shows green building still have a lower maintenance cost in comparison with conventional office building. Hence, it's noteworthy that our study supports the findings from Weerasinghe (2020) as one would expect that the increased construction cost due to the implementation of sustainable features should offset saving on operation and maintenance (O&M) costs, revealing a reduction in maintenance costs when comparing green office buildings with their conventional counterparts.

As highlighted in the study by Ping and Chen (2016), maintenance work primarily addresses issues related to the wear and tear of various building components, including wall painting, electrical light fittings, ceiling panels, roofing systems, and mechanical services. Their research demonstrates a notable cost-saving of 40.4% in non-residential buildings that have achieved non-GBI ratings when compared to non-rated buildings. It is essential to emphasize that this effect is more noticeable in higher green-rated buildings, resulting in even higher maintenance cost savings. Several factors contribute to this trend, including optimized office building operation usage, controlled operation hours, and the implementation of natural ventilation systems. As a result, our research shows how green building practices and technologies may result in long-term financial benefits.

Additionally, it is imperative to optimize green building design. As highlighted by Latief et al. (2017), emphasizing the importance of optimizing the operational and maintenance phases of green buildings through energy and water conservation is crucial. Their research underscores that in new green buildings, three major aspects significantly impact premium costs: energy efficiency and conservation, appropriate site development, and material resource utilization. Hence, green buildings' energy-efficient and environmentally friendly design principles may contribute to long-term maintenance cost savings.

In our analysis, we discovered a 13% decrease in energy expenses when comparing green office buildings to their conventional counterparts in terms of life cycle costs. While energy savings in green buildings are well-documented (Bin & Kashem, 2017; Chong et al., 2017; Dwaikat & Ali, 2018; Gabay et al., 2014; Halim, 2012; Kats, 2003; Kneifel, 2010; Liu et al., 2014; Olubunmi et al., 2016; Utomo et al., 2022; Zaid & Kiani, 2016. According to Anisah et al. (2017), the degree of energy savings depends on factors such as building design, certification levels, and chosen energy-saving strategies.

In additional, an interesting finding from our study is that occupant behaviour plays a significant role in the energy efficiency of green buildings, in line with Ohueri et al (2017) research. To address this, it's crucial to consider factors that influence occupant behaviour and their interaction with green building features. This understanding is vital for more integrated and cost-effective green building operations.

Having recognizing that initial costs are the most significant portion of overall expenses, our study investigates specific incremental cost components in high-rise green office constructions. Within this realm, hard costs emerge as the predominant cost category, and our study distinguishes itself by delving into its constituent parts, shedding light on the complexity of cost variations in high-rise green office projects.

Upon analysis, our study has revealed four key thematic such as Active design, Passive design, Sustainable Green Equipment Setup and Maintenance, Material and Indoor Air Quality Management that significantly contribute to cost disparities between green and conventional office buildings.

To differentiate active design from passive design, passive design encompasses the implementation of strategies that are specifically intended to decrease energy consumption. This includes considerations such as building form, layout, building envelope, thermal mass, daylighting, and ventilation strategies. Passive design relies on natural energy sources and doesn't necessitate active mechanical or electrical systems. In contrast, active design uses mechanical or electrical systems for lighting, HVAC, and other building functions. (Chen et al., 2015; Kang et al., 2015; Liu et al., 2022).

The first theme, "Active Green Design," includes components directly affecting energy consumption and operational efficiency. The participants emphasized that active green design elements are among the most expensive. Our findings align with recent research by Lau et al. (2023), which also highlights the high initial and maintenance costs associated with active design elements in Malaysia, such as solar, green roofs, and rainwater harvesting. However, their study did not explicitly mention HVAC and air conditioning systems as part of the expensive active green design elements in Malaysia. While earlier research from Chen et al. (2015) had mention Active design involves making more energy efficient heating, ventilation, air-conditioning (HVAC) systems, hot water production, lighting and any other building services application Therefore, our study confirms that most active design elements pose significant barriers to the implementation of green office buildings similarly in Malaysia.

In contrast, "Passive Green Design”, our second theme, involves elements necessitating less energy usage. These encompass the adoption of low-E glass facades, eco landscaping, and the integration of recycled materials, all contributing to passive energy efficiency. Although our research find that the cost of passive design still considers lower than active design, many of the interviewees still encounter challenges and cost constrain. There is limited study on the reason behind and also the measurement for the benefits of passive green design, unlike active design as there is systematic approach to measure the electrical spend and safe. This statement also supported by Waqar et al (2023) research stating, there is limited evidence to completely analyse the influence of integrating passive design on the project sustainable success (PSS) of projects throughout their existence.

Notably, many participants have commented that the heightened costs associated with double-glazed low emissivity glass facades and maintenance of landscaping underscore the financial commitments intrinsic to passive design elements, reinforcing the significance of "passive green design." One recent research initiated by Juffle and Rahman (2023), indicate that there are thirty-five motivators and forty-six challenges to the adoption of passive design strategies (PDS) in hot, dry, and humid climate zones. However, their result only mentions high initial investment and the lack of awareness as one of the main considerations but did not specify which elements in passive design is expensive. Hence, our study provides further insight to the stakeholders in real estate development field.

Moreover, we emphasize the importance of "Sustaining Green Equipment Setup and Maintenance" as the third thematic strand. This component highlights the persistent financial commitment needed for the installation and maintenance of eco-friendly systems, reflecting the prevailing perspective that sustaining green equipment demands substantial financial resources. This discussion on this component has been previously mentioned.

Lastly, our fourth theme, "Material and Indoor Air Quality Management," examines the cost and significance of Low Volatile Organic Compound (VOC) paint in green buildings for the purpose of enhancing indoor air quality. Some interviewees emphasized the notably higher cost of such paints, which can impact the overall cost of green building projects. This observation supports the results reported by Utomo et al. (2022), which indicated that the increased cost of low-VOC wall paint is justified by its level of quality. However, in contrast to their research, it is noteworthy that Malaysian developers have demonstrated greater awareness and adoption of low VOC paint, leading to increased availability and usage in the market. Nonetheless, our research aligns with their final outcome, which highlights that the highest cost in green building is incurred during the initial stages, while non-green buildings tend to face higher operational and maintenance costs."

4.3 Conclusion

This chapter presents the results of the analysis of participant transcripts and provides an in-depth discussion of these findings. The following chapter will offer a summary of the accomplishments, implications, and limitations of this research

CHAPTER 5

CONCLUSION AND RECOMMEDATION

5.0 introduction

This final chapter will conclude the research study by summarizing and emphasize the key research findings in relation to the research aims and objectives. The section will also suggest how the findings may be important as well as the value and contribution thereof. It will also provide and review of the limitation of the research and propose recommendation for future study.

5.1 Research Objective Attainment

Our study delved into the incremental cost factors that make green office buildings more expensive to construct and develop, a persistent challenge in the realm of green building implementation in Malaysia. In order to attain a comprehensive comprehension of these challenges, we sought the insights of a diverse group of real estate specialists. A thorough literature evaluation first laid the groundwork for our investigation.

Our research successfully addresses the first objective, as all participants was found unanimously agreed that the cost of constructing and developing green office buildings is unquestionably higher than that of their conventional counterparts. This finding aligns with the prevailing consensus in existing literature, which predominantly supports the idea that green building comes at a premium. While a few studies suggest that it can be cost-competitive, still they lack substantial data to substantiate this claim. Our research supported that in Kuala Lumpur; green office building construction remains an expensive compared to non-green alternatives.

Furthermore, our research tackles the second objective, which aims to identify the variables contributing to the price differential between green and conventional office buildings in Kuala Lumpur. The responses from our interviewees underscore that initial costs are the primary contributing factors. This is not to diminish the importance of other cost factors in the construction of green offices, such as certification expenses or consultant fees, which some participants highlighted as significant. However, the scarcity of experts in this field can lead to additional charges, and the labor market's fragility, particularly in the post-COVID recovery phase, can hinder development progress and inflate costs. Nevertheless, when the focus shifts to green office building development, the overwhelming agreement still points to initial costs as the most substantial factor.

To delve deeper into the intricacies of initial costs, our research identifies the specific elements that exert the most significant influence on cost increments. Four overarching themes emerge and are discussed in chapter 3. For instance, glass materials such as low-E glass, double glazing glass windows and air-condition system has been mentioned and observe by participant as the most significant cost factors. The prominence of these elements may be attributed to Malaysia's hot, bright, and humid climate, as well as the aesthetic preferences for glass in building design. Additionally, the specific green building certification requirements in Malaysia significantly impact these factors. To attain certification points, developments must adhere to these requirements, which can have a notable effect on project feasibility and acceptance. Careful scrutiny of these requirements is essential to ensure the future feasibility of adopting green building and construction practices.

5.2 Research implication

5.2.1 Navigating Cost Obstacle in Green Office Adoption

Our study examined the insights and recommendations made by the interviewees, which gave significant information for overcoming and mitigate the incremental costs. Government Support and Initiatives, Education and Awareness, Financial Incentives and Benefits, Market Demand and Competition, Materials and Costs, Environmental, Social, and Governance (ESG) Standards, Workforce and Talent, and Public Engagement and Cooperation are the eight key areas covered by these recommendations.

Two proposals emerge from our interviewees as prominent in the route to promote green workplace adoption in Malaysia. Participants consistently emphasized the critical significance of government incentives. The interviewees constantly pushed for the increase and improvement of government incentives aimed at green project developers. The incentives include various forms of financial support, tax refunds, and other economic advantages that enhance the attractiveness and financial viability of green building practices. This joint request for government assistance emphasizes the importance of policymakers in driving the expansion of green office complexes.

While some participants acknowledged the existence of government incentives, they also mentioned the difficulties they encountered due to a lack of particular direction and assistance in getting such benefits. Addressing these issues with clear, accessible guidelines will help improve incentive take-up and inspire more real estate professionals to engage in green office building.

Second, education and awareness campaigns are of equal importance. Interviewees underlined the importance of increasing public awareness and knowledge of green construction principles. They advocated for educational initiatives, workshops, and seminars to disseminate information about the benefits of green building. It is recommended to begin introducing green concepts and subjects since primary school. These educational initiatives not only educate future professionals, but also impact public acceptability and increase the marketability of green-certified properties. Thus, education and awareness, together with strong government incentives, are considered as the dynamic duo fuelling the progress of green office construction techniques in Malaysia.

5.2.2 The Implementation of Compulsory Policies for Green Building

Furthermore, while the initial cost of green office construction and development remains a substantial barrier to adoption and implementation, the majority of respondents emphasize the need of Malaysia implementing mandatory laws. These initiatives are mediated critical to meeting our country’s ambitious objective of reducing carbon intensity as a percentage of GDP by 45% by 2030, compared to 2005 levels. This illustrates that industry players recognize the critical need to address environmental sustainability and battle climate change. Despite concerns about rising construction costs, the general agreement favours policy-driven reform as a means of ensuring a sustainable and environmentally responsible future.

These implications can provide readers and stakeholders with vital insights, recognizing the importance of green building policies in contributing to national environmental goals. It emphasizes the significance of proactive measures, as well as necessary policies, in meeting sustainability goals, even in dealing with initial financial hurdles.

5.3 Limitation of Study

The first limitation of the study is the lack of research on other significant cost element in other factors such as people, technical, soft cost and external support towards green building construction and development. Many factors have been mentioned in literature review, yet I only further addressed and dive into specific element of the initial cost that causing incremental cost. Therefore, failed to demonstrate deeper insight for other factors that might hinder the implementation of green building construction and development.

The second limitation is this research only examined the KL area and focussing on office building. Other areas might not have the same factors that hinders the development of green office development. Also, all interviewees are having experience in only KL area. Therefore, it cannot be generalized to green office building in the entire Malaysia.

Nevertheless, A total of 20 interviews across different professionals have been interview, but the equilibrium of each professional is not equal. Which the numbers of each professional are not equally interviewed and that’s why some element has been repeated many times compared to other elements. Additionally, the lack of credibility is evident due to the absence of systematic measurement in the response, and the judgments are highly influenced by one ‘s past knowledge and personal experience.

5.4 Recommendation and conclusion

While we recognize the study's limitations, there are areas for improvement in understanding the economic elements that impact the construction and growth of green buildings. We advocate more detailed and particular research that focuses on people, soft costs, external assistance, and technological concerns. Such a study would provide stakeholders in real estate and government agencies with a better knowledge of the causes that need to be addressed, whether via mitigation or further assistance.

A second suggestion is to concentrate on a select set of specialists rather than a wide range of real estate experts. This technique would guarantee that responders have the requisite knowledge about cost-related issues. We recommend targeting experts in the construction procurement or quantity surveyors since they have the necessary data and expertise.

Third, there is different level in green building certification. For instance, GBI has 4 levels including certified, silver, gold and platinum, depends on one achieved scoring for their project. Still, this study only asking opinions on high rise green office building without any specification on different levels. The reason behind is the time constrain and create difficulties for interviewee to answers on the spot. Hence, future study can further explore the results based on different rankings of green buildings.

In conclusion, this thesis provides stakeholders and readers with significant insights into the expenses involved with the construction and development of green office buildings in Malaysia. Real estate experts and developers can now make more informed judgments and budget more efficiently, while legislators may adjust government incentives and green building support systems. Furthermore, our study identifies cost-cutting options, notably about glass materials and air-conditioning systems. This information enables development and construction experts to design and execute green office building projects more effectively. Finally, our study helps Malaysia's environmental goals by raising knowledge of the obstacles and opportunities in green building implementation, paving the path for a more sustainable future.

6.0 Appendixes

Appendixes A
Questionnaire for Non-Building Operators

Main Theme	**Sub Theme**	**Reference**
People	Role and service of the professionals	Abidin and Azizi (2016)
	Knowledge in green and expertise	Choi (2008) Abidin (2010) Robichuad and Anantatmula (2011) Esa (2011)
	Fluctuation in wages	Azizi (2014)
Technical	Additional restrictions, guidelines and requirement (GBI & GreenRE)	KeTTHA (2008) Hakkinen (2011)
	Technical Procurement concerns (limited of green materials)	KeTTHA (2008) Hakkinen (2011)
	Complexity of the permit and approval processes	Davis (2001) Abidin & Azizi (2016)
	Time taken to implement green construction	Abidin & Azizi (2016)
	Project delays	Choi (2008)
Hard cost	Cost of erect the building	Colliers (2014)
	Physical construction work	Amanjeet et al (2011)
	Green technology	Zhang et al (2011)
	Architectural work	Amanjeet et al (2011)
	Mechanical work	Amanjeet et al (2011)
	Electrical work	Amanjeet et al (2011)
	Labour	Abidin & Azizi (2016)
Active green design	Solar panels	Talhar & Bodkhe (2017)

	Efficient Air conditional	Sankar et al (2010)
	Efficient equipment and appliances for natural ventilation technology	U.S Department of Energy (n.d) Zhang et al (2011) Yuan et al (2020)
	Ample ventilation for pollutant and thermal control	U.S Department of Energy (n.d) Zhang et al (2011)
	Green technology monitor and maintenance system control	U.S Department of Energy (n.d) Zhang et al (2011)
	Ecological data collection technology	Noguchi (2003)
Passive green design	Green roof	Fauzi (2013) GRHC, n.d.)
	Landscaping	Guo et al (2010) Hussain 2014)
	Building orientation and specific design	Kim et al (2016) Abanda and Byers (2017)
	Natural lighting	Neyestani (2017)
	Low-E energy saving insulation window glass	Lee et al (2012)
	Fix shading appliance (Louvres & Eaves)	Glicksman (2001)
	Rainwater harvesting	Kucukkaya et al (2021)
	Insulating glass blinds and double window	Doherty, (2004)
Soft cost	Management	Susong (2006)
	Planning	Susong (2006)
	Documentation	Susong (2006)
	Marketing	Susong (2006)
	Insurance	Abidin & Azizi (2016)
	Design	Yudelson (2011)

External Support	Financial constraint of green construction	Sood (2011)
	Government support	Samari (2013) Abidin and Azizi (2016)
	The availability of rebates, subsidies, and incentives	Esa (2011) Olubunmi 2016)
	Cooperation between professional organisations	Abidin et al (2013)
	Possibility of choosing a loan from a financial institution	Abidin et al (2013)
Specific requirement	Additional green consultant	Azizi (2015) Abidin and Azizi (2021)
	Cost for green certification	Khalil et al (2021)
	Green facilitator fees	Onuoha et al (2018)
	Compliance with green assessment requirement	Abidin et al (2013)
	Complex process of commissioning	Hwang and Tan (2010)
	Implementing green practises when in the design phase	Abidin and Azizi (2016) Ahn et al (2016)

Source: Develop from the research based on literature review

Appendixes B
Questionnaire for Building Operators

Green office cost incremental factors: Life-cycle cost (LCC) methodology	Initial cost
	Energy cost
	Replacement cost
	Operational cost
	Maintenance cost

	End of life cost

Source: Develop from the research based on literature review

Appendixes C
Cost Perception of Green Building

No	Statement	Expensive	Depend	Inexpensive
R1	Yes, the chillers…. Plus, differences our materials wise, our building…. Buildings we have to source for the sustainable materials	✓		
R2	So, I said, if you're going to build a very advanced green building, definitely it will be more expensive by looking by comparing the total construction cost…. If you are going to a just to a baby step OK to build a very nominal green building. OK, so that means it will be more to passive architectural solutions…. It could be exactly the same cost like a conventional construction.		✓	
R3	For now, probably is more expensive. Because the technology is not there yet to full scale. But over the long run, the green building will be cheaper.	✓		
R4	Green building is more expensive than the conventional building. Of course, it depends on the type of building because green building is largely practice in medium or high-end category of building. Rarely we see affordable home for example, or rumah mampuk milik or rakyat.		✓	
R5	Yes and no, definitely in short term the answer will be yes. Because the initial capital upfront will be great…. However, in the long term it will comeback from the electricity bills reduction.		✓	
R6	Yes, definitely more expensive. On certain item, when you say green building, you require to put in certain item such as the insulation and the glass.	✓		

R7	Green building will be slightly expansive in early investment. However, it will be cheaper in long-run.	✓		
R8	More expensive. Because I think the products they use and the system they use are more expensive. Basically, you go to design to suit.	✓		
R9	Is depends …. because if you are the owner, you're going to own the building because you're going to pay for the utility then definitely it's cheaper. But if you are not maintaining it and then for example you have all these features at the end, you are bypassing it without understanding the function or this thing then and up you're Long Run cost.		✓	
R10	For us, time being is not cheaper…. In Datum corp our project we see that is expensive. Consultant might not say expensive.	✓		
R11	Definitely more expansive.	✓		
R12	The question is too broad to be answered correctly. When referred to MS1525 as a basis and is cheap, but different projects may be very expensive		✓	
R13	It doesn't think is not more expensive as the MS 1525 is stated as a base requirement	✓		
R14	It is expensive, this is due to the materials being premium. Material such as iron beam is required to be refractive	✓		
R15	The passive design, the orientation of the building, window and wall ratio, the shadow you provide, the natural ventilation. Here I would say, you can make the building cheaper to operate with little or small cost premium…. So yes, it can be expensive if you stick to the same aesthetic looks, then you have gone for expensive glazing, low E-glass will definitely increase your costs		✓	
R16	I think, yes, it's actually a bit more expensive than it used to be, you know, because I think the whole world is feeling this, the recovery, and then I think with the world, with the global economy is somewhat in a recession	✓		
R17	It's cheap if you only want to go to Certified…. The problem is that it will be more expensive as you go higher. So for		✓	

	example, like the platinum project, the one that we're trying to do, it's going to cost a bit more, the green premium			
R18	It is more expensive; this is due to the extra things within the materials and constructions.	✓		
R19	…. a little bit expensive because of the you can import something like you want to put a photovoltaic or you put a double-glazing window or single glazing insulation	✓		
R20	As a developer, it's actually more expensive. lot of compliance to enhance the things.	✓		

Appendix D

Specific Elements Influential on Cost Differences: Green vs. Conventional Office Building

No	Statement	Code 1	Code 2	Theme
R1	we using low VOC paint is actually costing I can say that costly a little…. make sure that the indoor air quality…. air purifier…c Another thing is about energy consumption…. Chillers is actually the main consumption that actually triggers the energy consumption	VOC paint Air purifier Chillers	Active green design Green building materials	Active green design
R2	Three things, first is the solar penal. Second things are a rain water harvesting system…. Last one is landscaping. Landscaping can be very expensive, especially in urban city…. Green wall will even kill you because you need system you need piping, you need immigration system, you need soil	Solar panel Rain harvesting system Landscaping Maintenance	Passive green design Maintenance	Passive green design Sustaining Green Equipment Setup and Maintenance

R3	To install solar panels. Initially is not cheap…. higher celling costs, as you want to have natural cooling effect without air conditioning	Solar panels Wider space needed	Energy efficient technologies Heat disperses and indoor air ventilation design	Material and Indoor Air Quality Management
R4	We want to maintain the comfortableness temperature within the building. So architectural play a role when we talk about glass facade in office. So, we spend a little bit more glass facet…. You don't want them start buying something from let say you in JB, they don't allow procurement more than 100km…. The other one on the recycle material, if the contractor utilizes the recycle material as much as possible, they are ranting given by the client.	Glass facade Recycle materials	Green equipment installation process	
R5	The aircons, it cannot avoid in Malaysia. A lot of architect or designer, they to design the natural open environment. But is not successful and sustainable	Aircon		
R6	Building materials will be more expensive and having limited option…. To me it will be the specification of the materials. Glass and Aircon. For glass, let say normal one is cost around RM800 but go for entry level of green building the glass will start at RM 960. Building insulation, window glass selection, air-	Building materials Glass Air-conditioning Solar Panel		

	conditioning and solar energy.			
R7	In green building construction, two major cost factors stand out: the expense related to glazing and the active design components of the building, including building automation systems and ACMV (Air-Conditioning, Mechanical Ventilation) systems…. The glass more expensive than the aircon.	Glass Glazing (More expansive) HVAC system		
R8	I think sound. Especially if you're building is next to LRT line. So that's why I said that some area has to be double glace,	Glass specification		
R9	So, if you say not impact is hard, maybe the solar at this moment. Yeah, it's either the solar or the aircon side of a system is either the air conditioning system or the renewable energy because of the initial cost	Aircon system Solar panel		
R10	In green building, is the energy efficiency elements…. EE features to me is the bigger contribution.	Energy efficiency components		
R11	I would say the glass which cost the most. The second one is aircon	Glass materials Aircon		
R12	The cost for passive is Overall Thermal Transfer Value (OTTV), or thermal transfer value. The cost for active is the BEI, the building energy intensity. These are the two major costs in a green building.	Thermal transfer solution Building energy consumption		

R13	Active side, AC is 60% of the energy consumption…. Second one is glazing; glazing will cost you millions.	Air-conditional Glass material		
R14	Water tanks and solar panels installed within the office building.	Water tanks Solar panels		
R15	low energy office where GTC is, they want to be net zero…. so, they must have long solar panels all over the building, and at that time solar panels were very expensive…. I would say your air conditioning system. Air conditioning for offices. That is where your biggest cost	Solar panels Air conditioning		
R16	Basically, because chiller represents a very significant amount of investment into a building because it's not that cheap to have a chiller system in your building.	Chiller		
R17	So, the two main things are simple. The facade, the glass and the installation…., ok, if it's talking about office building, then glass, then glass and the aircon. Aircon	Specific façade and glass Installation Air conditioning		
R18	The additional cost is mainly on the green energy facilities such as solar panel and the special low VOC paint (green paint). Frames, glass, materials and insulations are all part of the cost.	Solar panels VOC paint Glass materials		
R19	…. I think window, insulation, insulation, then maybe energy efficient chiller or aircon. So maybe a little bit higher.	Glass materials Air conditioning		

R20	I would say is the glass, the facade is very expensive. We are using a double-glaze compared with the normal one, they just using single-glaze	Glass facade		

Appendix E

Recommendation to Overcome the Challenges of green office adoption

No	Statement	Code 1	Code 2	Theme
R1	Government support and financial institutions support that is those two are very, very important…. really understand what is the objective behind GBI… every party that is working on the project, they have to understand they should be on the same page.	Government support Understanding of Green certification requirement	Government initiative and support in green building initiatives Provide clear guidance of green scoring requirement standards	Government support and initiatives
R2	I think money is still the most attractive incentive. If the government side, …. actually, money as incentive, that is the only way to move it for now. By law, if let's say our country dare to implement gazette law or acts. Singapore, all building compulsorily to be green buildings. Which is seven years ago now, they are looking at all existing building compulsory to green building.	Financial incentives Mandatory policy	Compulsory green building mandatory policies.	Education and Awareness
R3	I think to entice the private developers, the government has to step in. they should	Government financial incentives	Green building education	Financial incentives and Benefits

	give them developers back something…. Government needs to have more campaign. Those in the engineer, they should introduce more concept of green during the university to those young engineers.	Government green campaign and initiative Education	Tax relief benefit	
R4	For green certified building example, these are the far items that eligible the developers to be given tax tariff or tax rebate. This is the simplest way to…. by technology advanced, it will help the ease of promoting the green building. Or by way of financial assistance or relieve from the government in a way to get more involve. Green building fall into every cent and dollar. Therefore, it subject to subsidy.	Tax relief Government financial aids	Affordability of Green building materials	Market Demand and Competition
R5	Education. However, now I don't see the issue as the awareness is there already. However, what I mean is that education should start early.	Education	Expanding the benefits to the public users.	Materials and Cost
R6	To me is the government tax incentive. But, provide to the manufacturer those who produce green materials…. Then, when we have substantial economic of scale then it will bring down the cost. To me, is always the materials	Government tax incentives. Lower materials cost	Increase public awareness towards green building.	Environment, Social, and Governance (ESG) Standards

R7	For Malaysia, we do have incentives for green building. But is for own operated building by developer. For example, you build office and operate it, yes. For residential no. If you used to own the office then you sell, then cannot. There are not many issues with the developers. It just the public we had to educate…. These include educational campaigns, workshops, and seminars	Green incentives for general public users Education Create more awareness	Market demand and competition Enhancing the standard of ESG. Skilled and talented green building professionals	Workforce and Talent
R8	You got no choice but to keep up with the industry, the industry is going towards green buildings.	Market competition	Clearer guidance for claiming the government green incentives	Public Engagement and Cooperation
R9	I would say is uh the government incentive…. I will say yes, that ESG is pushing them forward. Talents now is the big challenge as the awareness is getting better…. continuous create all these awareness	Government incentives Upkeep the progress of ESG More talent in green building Create msore awareness	Increase Saleability of green building will be the push factors	
R10	You said about the tariff, for us we just certified currently. We actually do not eligible to claim for tariff. Doesn't help us much. We know there is claimable tariff but is not easily claimable in reality.	Eligibility for a claim of Government Green incentives	Increase the salary of green professionals to encourage and retain the talents	
R11	Tax incentives. At the moment, to us the tax system is not very clear. Even though the government announce giving out green incentive for green building.	Clearer green incentives guidance Government offers green	Cooperation between general public users, developers government authority.	

	Is not clear at all, we done this before for claim and is not easy to prove that or quantify that. …. there is a policy where you must own and manage…. If government willing to implement incentive there, providing green building for the public which mean we don't have to pay extra.	incentive to green building users.		
R12	If there is a benefit for green building and if purchasers ask for this then developers are pulled to build more because there are demands for it.	Market demand		
R13	Tax exemption is the best driver to push them (developers) into green buildings…. Awareness campaigns, DBKL needs to promote said campaigns to educate the public about green buildings and sustainable constructions.	Tax exemption Awareness campaign		
R14	The government plays a big role…. implementation of subsidies and increase of population awareness	Government incentives Public awareness		
R15	Developers who are building to sell…. what is needed from the government is to get them to invest in an is incentives. That is severely lacking…. The pool factor can only come with greater awareness, education, maybe once again increase in wages.	Saleability of project Government incentives Greater awareness and education Increase wages of green professionals		

R16	If you have a government policy that encourages developer in terms of giving them incentive, like tax breaks or even like tax incentive in….	Government policy and incentives Tax benefits		
R17	Meaning that development authority already said you have to do. So, no matter what, they probably have to do.	Authority enforcement		
R18	Increase the awareness to the people, the public needs to know and the government needs to collect data….	Increase awareness Government initiatives		
R19	I think if it's incentive from the government…. maybe tax reduction? let's say, if you have a very good ESG point, for example, you can maybe have a very easy, in PBT, for example, for full BT, very easy for them to get development approval…. any developer develops their building at the low-carbon zone, maybe get a special treatment from DBKL or special tax or special incentive from DBKL…. The occupants also need to practice low carbon practice.	Tax reduction Benefit ESG initiatives Special treatment from Local Authority People must coordinate and act their part in green practices		
R20	I think our governments and our authority had to work it harder…. I think we go back to very simple. One hand, you won't be able to clap. You need both hands to clap…. I think the other one is that I think education. Education still had to create awareness to the all party.	Cooperation and coordination between general public, stakeholder and government. Education Public awareness		

		Government effort on green building		

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