The implementation of the environmentally sustainable indicators during the design phase for privatised building projects in Malaysia

A Thesis Submitted for the Degree of Master of Philosophy

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LIST OF ABBREVIATIONS

BedZED	The Beddington Zero Energy Development
BOT	Build-Operate-Transfer
BREEAM	Building Research Establishment Environmental Assessment Method
CO_2	Carbon Dioxide
CPD	Continuing Professional Development
EIAR	Environmental Impact Assessment Report
ESG	Environmental, Social and Governance
EU	European Union
EY	Ernst & Young
GBI	Green Building Index
GHG	Greenhouse Gas
HVAC	Heating, Ventilation and Air Conditioning
ISO	International Organisation for Standardisation
KPI	Key Performance Indicator
LBC	Living Building Challenge
LEED	Leadership in Energy and Environmental Design
OECD	Organisation for Economic Co-operation and Development
PBPIM	Privatised Building Projects in Malaysia
PFI	Private Finance Initiative
PPIAF	Public-Private Infrastructure Advisory Facility
PPP	Public-Private Partnership
PwC	PricewaterhouseCoopers
RII	Relative Importance Index
SBTool	Sustainable Building Tool
SI	Severity Index
SMART	Specific, Measurable, Attainable, Realistic and Timely
SPV	Special-Purpose Vehicle
UNEP	United Nations Environment Programme
UNCSD	United Nations Commission on Sustainable Development
UKAS	Unit Kerjasama Swasta Awam
UK	United Kingdom
USA	United States of America
WB	World Bank

CHAPTER 1

INTRODUCTION

1.1 Background of Research

Privatised building projects, which are frequently implemented via Public–Private Partnerships (PPPs), Build-Operate-Transfer (BOT) contracts, or Private Finance Initiatives (PFI) have emerged as a predominant global strategy for infrastructure provision. Governments are encountering increasing demands for contemporary infrastructure amidst limited public funds, leading to an expansion of private-sector participation across various sectors, including transportation, energy, healthcare, housing, and urban development. This trend has transformed the methods by which nations fund, construct, and manage critical infrastructure (Hodge and Greeve, 2017; World Bank, 2020; Asian Development Bank, 2019).

Based on HM Treasury (2012), Europe has been at the forefront of adopting approaches to privatised building projects. The United Kingdom's Private Finance Initiative (PFI), operational from the 1990s to the 2010s, resulted in the construction of numerous hospitals, schools, prisons and transport infrastructure. Despite being contentious due to financial concerns, it illustrated the potential for the swift construction of extensive social infrastructure with private investment. In Eastern Europe, EU-funded public-private partnerships initiatives have enhanced motorway networks in Poland, Croatia, and Turkey (European Investment Bank, 2020).

Asia exhibits numerous highly ambitious privatised megaprojects. For instance, although China's development model is state-led, private capital is progressively engaged in substantial urban development and rail projects via mixed-partnership frameworks. Countries such as Malaysia, Indonesia, and the Philippines employ public-private partnerships for airports, power plants, and water services (Regan, Smith and Love, 2015). India is a prominent global market for public-private partnerships, particularly in highways, metro rail, ports, and airports. The Golden Quadrilateral highway system encompassed significant build-operate-transfer and design-build-operate-transfer projects (Asian Development Bank, 2017).

In the Middle East, the United Arab Emirates and Saudi Arabia are undertaking extensive privatised building projects including metro systems, desalination facilities, and smart city programmes like NEOM, partially funded by international private investors (PwC, 2020). Meanwhile in Qatar, stadiums, train lines, and water treatment facilities are significantly dependent on foreign private investment (EY, 2019). Privatised projects are progressively developing in Africa, especially in the energy and transportation sectors. South Africa has a prominent public-private partnership market featuring successful projects in healthcare facilities, prisons, and the Gautrain high-speed rail system (African Development Bank, 2018). Increasing participation of private developers in housing, infrastructure, and solar energy projects can also be seen in Kenya, Ghana, and Nigeria (World Bank PPIAF, 2021).

Looking at North and South America, public-private partnerships are extensively utilised for highways, bridges, schools, and water systems, though federal assistance varies by state (Federal Highway Administration, 2020). Canada is recognised for possessing one of the most stable public-private partnerships frameworks particularly in the sectors of healthcare, transportation, and energy (Infrastructure Ontario, 2016). Meanwhile, Brazil, Chile and Colombia depend significantly on long-term concessions for the development of highways, ports, and energy plants (Engel, Fischer and Galetovic, 2014). Privatised building projects are important because they can mobilise large amounts of capital. The global need for infrastructure far exceeds the financial capabilities of governments alone. Private investment reduces immediate governmental spending and assists nations in constructing essential facilities without significant budgetary pressure. Private companies frequently execute projects with greater expediency owing to competitive bidding, explicit performance incentives, and specialised proficiency in engineering, construction, and operations.

This is particularly crucial in rapidly developing areas necessitating swift infrastructure growth. Privatised building projects transfer certain risks from government, such as building delays, cost overruns, and operational failures, to private contractors. This promotes rigorous project management and mitigates long-term financial risk for governments. Numerous public-private partnerships contracts require the private operator to maintain the asset for a duration of 20 to 30 years. This guarantees enhanced maintenance, superior construction quality and enduring functioning instead of temporary solutions. This differs from conventional public procurement in which maintenance is frequently inadequately financed. Private organisations present advanced construction technology, contemporary project management systems, optimised materials and design strategies, practise sustainable and energy-efficient construction. These technologies frequently disseminate throughout the broader building sector.

Privatised building projects promote employment in construction and operational sectors, expansion of local supply chains, enhanced transportation and energy infrastructure that bolster corporate productivity. Infrastructure development is crucial to economic growth and competitiveness for numerous countries. Amidst swift global urbanisation, private developers significantly contribute to affordable housing, intelligent urban areas, transit-oriented development, and infrastructure for water and waste management (Grimsey and Lewis, 2004; Yescombe, 2011; OECD, 2012). Privatisation was introduced in Malaysia over two decades ago in response to the economic recession. The government turned to the private sector for economic activities and development (Ismail and Rashid, 2007). Since then, numerous privatisation policies have been implemented and in 2009, Public-Private Partnership (PPP) and Private Finance Initiatives (PFI) were introduced to further enhance privatisation efforts in Malaysia (EPU, 2013).

PPP and PFI involve funding public projects with private financial resources, typically awarding contracts to concessionaires (or special purpose vehicles) for long-term periods of up to 30 years. PFI is a subset of PPP, and both are considered forms of privatisation. Privatisation projects encompass buildings, highways, infrastructure and more but this research focuses solely on buildings. Since PPP and PFI are often used interchangeably, the general term “privatisation” will be used throughout this research. The rise of privatised building projects in Malaysia (PBPIM) underscores the need for sustainability. This arises from the fundamental idea of PBPIM where contracts are often granted based on the lowest bid for a concession period typically ranging from twenty to thirty years (UKAS, 2009).

A robust correlation exists between sustainability and the building design phase as neglecting sustainability in decision-making can lead to operational and maintenance challenges for the buildings (Wang, 2011). The optimal period for implementing sustainability is mostly during the initial phase when decisions remain flexible, hence facilitating the attainment of the best possible outcomes (Cotgrave and Riley, 2012; Wang and Horner, 2007). The concept of sustainability will necessitate additional expenses for PBPIM, which must be mitigated. The sole method to counter this prevalent perspective is to integrate sustainability at the project's inception, allowing for its quantification in financial terms throughout the entire project life cycle.

In Malaysia, sustainability has yet to garner attention from the government, especially with privatised building projects. This is attributable to the fact that PBPIM are still very young (Ismail and Harris, 2014) and typically prioritise cost-effectiveness over environmental impacts, despite (Abdullah *et al.*, 2015) highlighting that these projects might improve sustainability in Malaysian building projects. Most research on privatised building projects focuses solely on value for money. For example, Takim et al. (2009) presented a methodology for assessing value for money that encompasses three primary dimensions: economy, efficiency and effectiveness. As previously noted, the PPP guideline in Malaysia indicates that sustainability is a fundamental component of the projects, yet no sustainability issues are addressed in the guideline. Building designers, mainly architects and engineers are essential to achieving sustainability, and it is imperative that sustainability be included in PBPIM. The main reason for this is that building designers possess the ability to define, evaluate and assess sustainability issues. Moreover, they exert significant influence throughout building projects. Building designers are tasked with managing the project, thus they possess diverse input that may assist in selecting the most appropriate options for building elements.

The United Kingdom and the United States of America have established comprehensive sustainability guidelines, however, for Malaysia to implement these guidelines, it is essential to examine and formulate suitable sustainable indicators (Ros, Ismail and Hassan, 2012) to ensure their practicality and relevance to local requirements. Wong, Perera and Eames (2010) conducted a study on diverse sustainable indicators. Nevertheless, the research necessitates additional refinement, and he suggested that a methodology should be established to evaluate different sustainable indicators to facilitate decision-making regarding the most cost-effective options.

Zhou et al. (2013) emphasised the importance of incorporating sustainability into privatised building projects and highlighted the advantages of examining sustainability in this context to successfully achieve sustainable building projects. Nonetheless, a recent study by Highton et al. (2012) indicates that the application of sustainability is impeded due to the absence of a standardised methodology for sustainability. To incorporate sustainability into privatised building projects in Malaysia, it is essential to first standardise the sustainability strategy among building designers in Malaysia. Subsequently, the environmental sustainable indicators can be combined to formulate a cohesive strategy for sustainability for PBPIM.

This research aims to address the issues with the environmental sustainable indicators in PBPIM. Addressing issues regarding privatised building projects is relevant due to the extended concession duration which ranges from 20 to 30 years. Therefore, if building designers participate in the early stages of the projects to address sustainability issues, one may anticipate advantages in environmental aspects. Furthermore, (Alnaser, Flanagan and Alnaser, 2008) emphasise that environmental viability is regarded as the paramount component in decision-making for selecting the most cost-effective sustainable alternatives in a building. Sustainability must be considered for PBPIM to guarantee that the environmental aspects of alternative building elements are evaluated before their selection.

The findings of the research are crucial for enhancing the application of the environmental sustainable indicators by building designers in PBPIM through a complete guideline that serves as a guiding foundation. According to the framework, building designers will be able to select the optimal design alternatives for building elements hence contributing to environmentally sustainable privatised building projects. Choosing the optimal building elements at the initial stage when decisions remain flexible can optimise long-term whole life cost and performance of the projects. This research is noteworthy, emphasising the importance of building designers. According to Sarpin, Yang and Xia (2016), equipping them with the necessary knowledge and tools may yield enduring value for the projects.

In conclusion, this research develops guidance and recommendations for the implementation of the environmental sustainable indicators during the design phase of PBPIM. This can effectively assist building designers in improving their sustainability practices for PBPIM, enabling them to make informed decisions at the project's inception regarding alternative building elements, while considering environmental sustainable indicators. These factors will guarantee that privatised building projects are environmentally sustainable during the extended concession duration. Therefore, the effective execution of PBPIM may be improved in terms of sustainability.

1.2 Problem Statement

The construction sector significantly influences economic development; yet, it is acknowledged as a major contributor to environmental deterioration because of excessive energy consumption, greenhouse gas emissions, resource depletion, and waste production. The United Nations Environment Programme (UNEP, 2023) states that the buildings and construction sector is responsible for roughly 37% of world carbon emissions and more than 34% of global energy consumption. As a result, there is mounting pressure on governments and industry stakeholders to incorporate sustainability principles into building projects, especially during the design phase when pivotal decisions impacting environmental performance are determined.

In Malaysia, privatised building projects, typically executed via Public–Private Partnership (PPP) frameworks, have emerged as a significant procurement method for providing public infrastructure and facilities. Despite the objective of enhancing efficiency, creativity, and cost-effectiveness, current research reveals that sustainability factors are insufficiently incorporated into the planning and design phases of these projects. Abdul-Aziz and Kassim (2021) noted that Malaysian PPP projects predominantly prioritise economic and financial performance, but environmental sustainability objectives are afforded relatively minimal consideration. Rahman et al. (2022) indicated that the implementation of sustainability in Malaysian construction projects is inconsistent due to the lack of comprehensive environmental assessment frameworks and standardised evaluation standards.

The design phase is recognised as the stage with the most significant potential to impact a building's environmental performance over its entire life cycle. Research conducted by Darko and Chan (2022) emphasised that initial design choices profoundly influence energy efficiency, material usage, carbon emissions, and operational sustainability. Currently, there is no formal standard or structure expressly intended to facilitate the application of environmentally friendly indicators during the design phase of privatised building projects in Malaysia. Current sustainability assessment systems, such as the Green Building Index (GBI), predominantly emphasise overall building sustainability and fail to consider unique characteristics and procurement needs of privatised building projects.

Moreover, recent research has revealed certain limitations that impede the proper execution of environmental sustainability in construction projects. The challenges encompass a deficiency in sustainability competence among project stakeholders, poor legislative mandates, absence of environmental performance data, budgetary limitations, and insufficient sustainability guidelines (Aghimien et al., 2023; Hwang et al., 2021). Simultaneously, elements including governmental legislation, stakeholder dedication, corporate environmental accountability, and heightened knowledge of climate change have been recognised as significant catalysts for the adoption of sustainability (UNEP, 2023; World Green Building Council, 2022). The degree to which these limitations and drivers affect the adoption of environmental sustainable indicators in privatised building projects in Malaysia is not yet fully comprehended.

A notable concern is the absence of a systematic approach for selecting and prioritising environmentally sustainable metrics pertinent to the Malaysian setting. Research conducted by Ding et al. (2021) and Wu et al. (2023) underscored the necessity for sustainability assessment frameworks to be tailored to local environmental, regulatory, and industrial contexts to guarantee effective execution. Nonetheless, research particularly investigating environmental sustainable indicators for privatised building projects in Malaysia is scarce. Consequently, building designers frequently lack explicit direction when determining energy efficiency, carbon reduction, water conservation, material selection, waste management, and interior environmental quality in the design phase.

In light of these issues, there is an evident necessity to develop a comprehensive framework for the integration of environmentally friendly indicators throughout the design phase of privatised building projects in Malaysia. This approach would aid building designers in methodically integrating environmental factors into project design, enhance sustainability performance, and bolster the national strategy for sustainable development and low-carbon growth. This research aims to bridge the knowledge gap by identifying pertinent environmental sustainable indicators, analysing the limitations and drivers influencing their implementation, and formulating a framework to facilitate their application in privatised building projects in Malaysia.

Khaderi and Aziz (2010) indicated that privatised building projects in Malaysia are linked to several challenges including cost efficiency and innovation. The absence of transparency in bidding complicates the acquisition of competitive proposals for projects, casting doubt on the effectiveness of cost-effective procurement methods. Moreover, the environmental sustainable indicators which are essential for the projects, require innovation, however, this component is missing. In comparison to other countries, such as the UK and Australia, privatisation in Malaysia is progressing slowly; Ismail and Harris (2014) along with Khaderi and Aziz (2010) believed that this may be attributed to the lack of guidelines or structured frameworks for its execution. Consequently, this affects its primary objective of achieving sustainability efficiently. Moreover, Hasan and Salleh (2018) emphasised the necessity of establishing the environmental sustainable indicators and ensuring the execution of privatisation to reach the defined environmental sustainable indicators.

To ensure the successful implementation of sustainability for privatised building projects in Malaysia, two critical factors must be considered: economic and environmental aspects. In Malaysia, the PPP guideline focuses solely on the economic aspects neglecting the environmental side. Abd Rashid, Mohamed Ghazali and Zainun (2016) emphasised that privatised building projects in Malaysia lack sustainable elements. This is particularly concerning because the nature of the long-term contracts makes them particularly ideal for integration with sustainability. Ros et al. (2011) concur that the projects lack sustainability due to insufficient knowledge and skills among building designers. Myeda and Pitt (2014) noted in their research that privatised building projects in Malaysia remain a nascent topic, allowing diverse approaches to sustainability for these projects.

The matter of innovation, as emphasised by Khaderi and Aziz (2010) is closely related to sustainability. Sustainability innovation is thought to enhance cost-effectiveness for projects (Ismail and Rashid, 2007). In 2017, the Director General of Public-Private Partnership Unit, Prime Minister's Department, underscored that privatised building projects in Malaysia necessitate innovation, particularly via the integration of sustainability and energy-efficient design. The integration will facilitate an improved atmosphere for the building occupants. Sarpin, Yang and Xia (2016) showed in their research that sustainability remains nascent in Malaysia and its adoption is obstructed among building designers. Therefore, it is essential to consider the environmental sustainable indicators to prioritise not only the environment but also the comprehensive impact across the life cycle of a building.

In a study by Steen (2005), he noted that assigning costs to environmental accounts may be challenging, although it is prudent to enhance the methodology. Furthermore, (Ristimäki et al., 2013) emphasised that economic and environmental factors are interdependent thus, guidance should be established to improve the selection of building elements. A gap in their study that requires attention, specifically concerning the optimisation of sustainability by taking sustainable indicators from the environmental aspects. Guidance or recommendation of improved environmental sustainable indicators is essential to assist building designers in assessing the possible environmental benefits of privatised building projects in Malaysia.

In a comparable manner, Rahim et al. (2014) highlighted the need to investigate how environmental sustainability might contribute to the sustainability of privatised building projects. Exploring this will undoubtedly enhance the environmental performance of the building projects. Gundes (2016) has highlighted that the necessity for a systematic and standardised methodology for environmental issues remains unfulfilled. Consequently, this research aims to implement the environmental sustainable indicators during the design phase of privatised building projects in Malaysia, providing guidance and recommendations for building designers to use these methodologies, hence enhancing the overall impact across the whole project. This aligns with the aspirations of Meng (2013) in their research, which underscores the importance of ensuring the effective execution of privatised building projects.

The establishment of comprehensive environmental sustainable indicators is crucial as it enables the evaluation of sustainability during the design phase of privatised building projects. The actual value of the projects may then be evaluated, and possibilities can be recognised to promote sustainability practices throughout the concession contract. Nonetheless, Malaysia lacks a regulated method for environmental sustainable indicators during the design phase, notably concerning privatised building projects. Ismail, Takim and Nawawi, (2012) asserted that privatised building projects in Malaysia remain underdeveloped thus, the guideline of the environmental sustainable indicators for their implementation would be beneficial. It is noteworthy that limited research has been conducted on the environmental sustainable indicators during the design phase in Malaysia. This research aims to establish a guideline for the environmental sustainable indicators during the design phase of privatised building projects in Malaysia, serving as a foundation for enhanced decision-making among building designers in selecting the optimal building elements.

This research begins by identifying the limitations and drivers of implementing the environmental sustainable indicators during the design phase of privatised building projects in Malaysia, enabling the building designers to recognise the impediments to implementing the environmental sustainable indicators during the design phase and the necessary strategies to improve their execution. The analysis of limitations and drivers is crucial since several studies have investigated the limitations and drivers, but none has focused solely on the environmental sustainable indicators during the design phase, although throughout time, other limitations and drivers have emerged.

For example, Meng and Harsha (2013) indicated that the implementation of sustainability lacks a standardised technique, but (Park, 2009) shows that it lacks in data. (Elmualim *et al.*, 2010) revealed that the implementation of sustainability is obstructed by an insufficient commitment from senior management, whilst (Asbollah, Isa and Kamaruzzaman, 2016) subsequently noted that building designers lack the requisite understanding to execute sustainability. As for the drivers, I. Ikediashi, O. Ogunlana and Boateng (2014) emphasised that legislation and regulation are crucial for the adoption of sustainability whereas Massoud et al. (2010) identified corporate image as a significant motivator. Consequently, to validate the consensus among building designers concerning the limitations and drivers of the environmental sustainable indicators for privatised building projects in Malaysia, it is important to investigate these limitations and drivers. This ensures the suggestion presented in this research is oriented towards practical use.

It is anticipated that, through this research a guideline for the environmental sustainable indicators during the design phase of privatised building projects in Malaysia, enabling building designers to enhance the efficiency of such projects in an environmental context. The guideline is intended to serve as guidance for building designers in the implementation of the environmental sustainable indicators for privatised building projects in Malaysia, ensuring the achievement of project KPIs.

1.3 Aim of Research

The aim of this research is to investigate the implementation of the environmental sustainable indicators during the design phase of privatised building projects in Malaysia.

1.4 Research Questions

The research aims to address the following research questions:

a) What are the environmental sustainable indicators during the design phase of PBPIM and its rank?

b) What are the limitations in implementing the environmental sustainable indicators during the design phase of PBPIM?

c) What are the motivations for implementing the environmental sustainable indicators during the design phase of PBPIM?

d) What are the guidance and recommendations before implementing the environmental sustainable indicators during the design phase of PBPIM?

1.5 Research Objectives

To address the research questions and fulfil the research aim, the study seeks to accomplish the following objectives:

a) To investigate and rank the environmental sustainable indicators during the design phase of PBPIM.

b) To investigate the limitations in implementing the environmental sustainable indicators during the design phase of PBPIM.

c) To investigate the motivations for implementing the environmental sustainable indicators during the design phase of PBPIM.

d) To provide guidance and recommendations for the implementation of the environmental sustainable indicators during the design of PBPIM.

1.6 Scope of Research

The research is confined to the study on the environmental sustainable indicators during the design phase exclusively within PBPIM. It is crucial that the building designers are engaged in the early stage to contribute valuable insights for the sustainability of the projects. Consequently, building designers namely architects and engineers are chosen as participants for the study. They were selected from the Board of Architects Malaysia, the Institution of Structural Engineers Malaysia and LinkedIn. Therefore, the data-collection instrument is distributed to all participants to fulfil the research aim and objectives.

The research focuses on the environmental sustainable indicators during the design phase of a privatised building project. With global environmental imbalances, which has resulted in deforestation, endangered plants and animal species, air and water pollution and greenhouse effect, among others (Dobrovolskiien and Tamo, 2016), the parties involved during the design phase namely architects and engineers need to consider the environmental sustainable indicators when designing for a project to reduce the environmental effect and energy consumption of structures to create more efficient and sustainable structures (Wong and Zhou, 2015; Liu *et al.*, 2017) as the construction sector is believed to be one of the biggest consumers of energy and natural resources (Invidiata, Lavagna and Ghisi, 2018). The selected respondents for this research would be the architects and engineers for data collection to be distributed to achieve the aim and objectives of the research.

1.7 Contribution to Knowledge

The research proposes guidance and recommendations of the environmental sustainable indicators during the design phase with a view of guiding the architects and engineers in selecting alternative building materials at the early stage of the project so that they can take into consideration not only the cost factor but also the environmental aspect of the chosen alternative. Ideally, the research is deemed capable of improving the implementation of the environmental sustainable indicators during the design phase among building designers for PBPIM since it offers standardised processes that apply to various building elements.

This research enhances knowledge by offering a contemporary and pragmatic comprehension of the implementation of environmental sustainable indicators throughout the design phase of Privatised Building Projects in Malaysia (PBPIM). Recent studies indicate that the construction industry is under mounting pressure to enhance sustainability performance due to climate change issues, carbon reduction obligations, and more stringent environmental restrictions. Nevertheless, few studies have concentrated especially on the application of sustainability in Malaysian construction projects. This research addresses this gap and offers context-specific findings pertinent to the Malaysian construction sector.

A notable contribution of the study is the identification of the principal environmental sustainable indicators prioritised by building designers during the design phase. Recent studies by UNEP (2022) and the International Energy Agency (IEA, 2023) underscore that energy efficiency, carbon reduction, resource efficiency, and sustainable material utilisation are becoming vital concerns in sustainable building development. This research discusses the perception and implementation of environmental indicators within PBPIM in Malaysia.

The research additionally identifies the motivations and limitations affecting the execution of sustainability implementation. Recent studies by Darko et al. (2022) and Jaradat et al. (2024) emphasised that the implementation of sustainability in construction projects is increasingly shaped by governmental rules, ESG commitments, market competitiveness, and organisational sustainability initiatives. This research expands on these ideas by analysing how such factors affect sustainability practices specifically in Malaysian privatised building projects. The research provides pragmatic, industry-specific insights into the practical issues of sustainability adoption. Recent research by Ershadi et al. (2021) and Ashour et al. (2022) indicated that budgetary constraints, inadequate technical proficiency, reluctance to adopt new practices, and a deficiency in sustainability awareness persist as significant limitations in sustainable construction. This study validates that similar limitations are encountered within PBPIM and illustrates how these concerns influence the application of environmentally sustainable indicators throughout the design phase.

A significant contribution is the creation of a conceptual framework that synthesises motivations, implementation limitations, environmental sustainable indicators, and sustainable design results. Recent literature frequently addresses these issues in isolation; however, this research integrates them into a cohesive framework specifically designed for the setting of Malaysian privatised building projects. The framework enhances theoretical comprehension of the interconnections among sustainability drivers, implementation limitations, and project results. The research offers ideas that can aid architects, engineers, developers, and policymakers in enhancing sustainable implementation techniques. Recent papers by CIDB Malaysia (2022) and the World Green Building Council (2021) highlighted the significance of sustainability principles, stakeholder participation, and professional training in attaining sustainable construction objectives. This study substantiates these recommendations using empirical evidence gathered directly from industry practitioners.

This research methodologically contributes by employing an interpretivist qualitative methodology to examine the application of sustainability in the construction sector. This study offers a deeper understanding through structured interviews and theme interpretation, contrasting with many contemporary sustainability studies that predominantly depend on quantitative surveys and statistical analysis. This methodology provides deeper insights into the experiences and views of professionals engaged in PBPIM. This study's contribution is grounded in its representation of genuine industrial activities and experiences, rather than solely theoretical sustainability concepts.

The results are derived from the viewpoints of architects and engineers actively engaged in building design and sustainability practices. According to Darko et al. (2022), the execution of sustainability in developing nations frequently diverges from theoretical sustainability models due to financial, organisational, and technical constraints. This research thus provides pragmatic and applicable insights into the implementation of sustainability in the Malaysian construction sector. The study enhances current sustainability knowledge by offering updated empirical evidence, practical implementation insights, and a context-specific conceptual framework for advancing environmental sustainability in privatised building projects in Malaysia.

1.8 Research Methodology

Figure 1.1 outlines the research method.

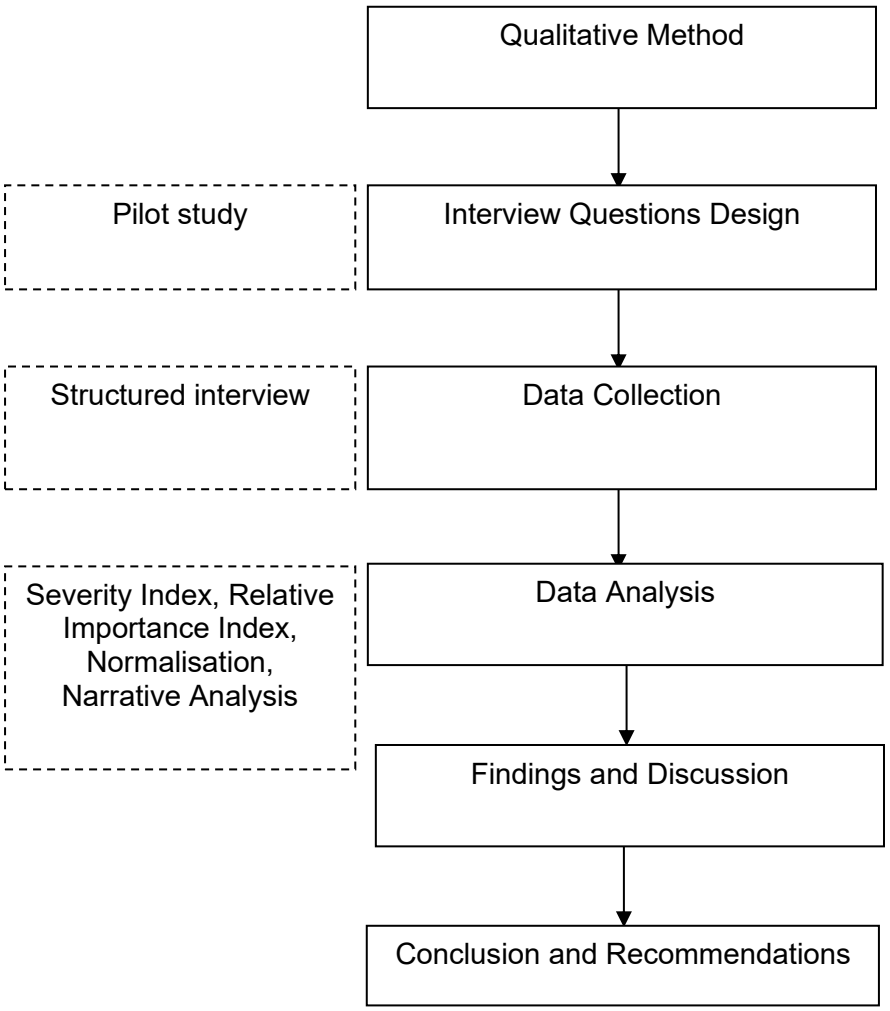

Figure 1.1 Research method flowchart

The research adopted the qualitative approach as seen in Figure 1.1. Qualitative research can also be employed to respond to research variables' interpersonal questions (Williams, 2011). The data collection consists of a structured interview. Likewise, details of the interview questions too are further explained in Chapter 3. It is noteworthy that the interview questions were piloted with five selected respondents before their formal distribution. The pilot participants were not included in the main study. They participated in the pilot study to assess the clarity, relevance and sequencing of the interview questions. Following refinement of the interview schedule, a total of 50 potential participants were invited to participate in the study. However, only eight agreed to take part in the structured interviews. Although the response rate was relatively low, the participants possessed relevant professional experience and provided rich, in-depth insights that were sufficient to address the research objectives. These responses are subsequently evaluated using the Severity Index and Relative Importance Index. Detailed explanations of the research methods are elaborated in Chapter 3 of the research.

1.9 Research Structure

The research structure is divided into two phases which are the pre-phase and post-phase. Figure 1.2 illustrates the details of the research structure.

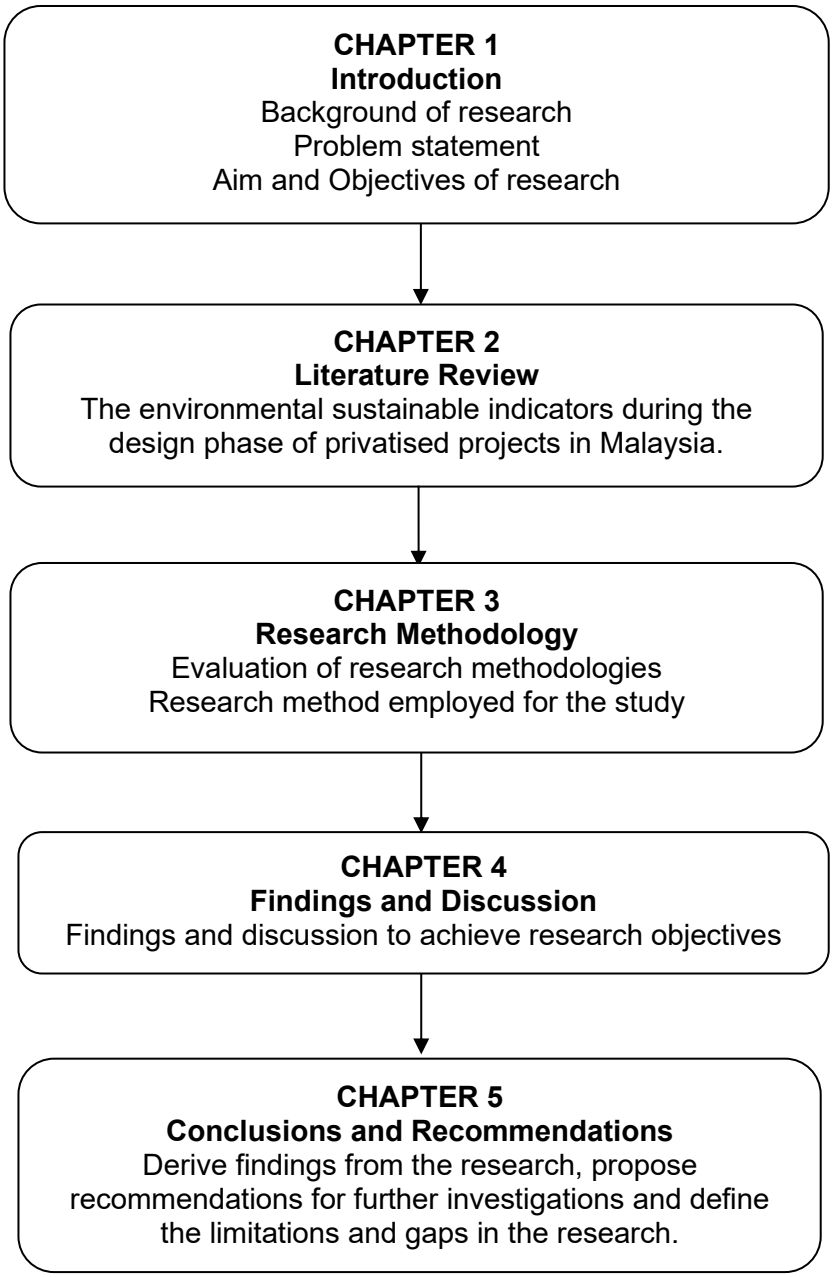

Figure 1.2 Research structure flowchart

Figure 1.2 illustrates that pre-phase activities occur prior to data collection, whereas post-phase activities take place after data collection, encompassing data analysis, discussion, research limitations, conclusion and recommendations.

(a) Chapter 1: Introduction

The chapter elucidates the foundational concept of the research via background study and problem statement. Additionally, it enumerates the research questions and substantiates the research aims and objectives to address them. Furthermore, the chapter delineates the study scope and, crucially, underscores its contribution to knowledge. The chapter finishes with a summary of the research structure and a concise explanation of the research methodology.

(b) Chapter 2: Literature Review

The chapter provides a comprehensive overview of the literature on environmental sustainable indicators throughout the design phase of privatised projects in Malaysia. The literature study addresses topics pertaining the environmental sustainable indicators primarily related to privatised building projects, focussing on their limitations and motivations. The principal objective of the literature review is to establish a basis for the formulation of a data-gathering strategy for the research.

(c) Chapter 3: Research Methodology

The chapter outlines research methods for the research and explains the research methodology used. Essentially, the chapter describes the methods used for achieving the aim and objectives of the research. It includes the research approach, sampling technique, data collection methods, and data analysis.

(d) Chapter 4: Findings and Discussion

The chapter describes the research's post-phase activities. It presents the research findings and provides a comprehensive discussion based on the findings. An appropriate analysis is carried out using the Severity Index, Relative Importance Index and narrative analysis and the results are shown numerically and graphically to achieve the objective of the research.

(f) Chapter 5: Conclusion and Recommendations

The chapter provides conclusions based on the findings and discussion and connects them to the accomplishment of the research aim and objectives. Additionally, the chapter includes essential recommendations for further research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, a thorough review of the literature on privatised building projects and environmental sustainable indicators is presented, outlining the comprehensive scope of this research. Within the scope of the environmental sustainable indicators, this section examines the limitations and motivations for its execution. Also, the structure of privatised building projects is explained and the study delves deeper into issues related to it. The study limitations are also explored in this section. This chapter lays down the groundwork for the research methodology used in the subsequent chapter.

2.2 Privatised Building Projects

This section introduces and describes the characteristics of privatised building projects.

2.2.1 Introduction to Privatised Building Projects

Privatisation has emerged as a prevalent procurement approach for the execution of public infrastructure and construction projects globally. The concept arose when governments pursued alternative methods for financing, developing, and administering public assets, aiming to alleviate the budgetary load of public expenditure. Privatisation entails the whole or partial transfer of responsibilities from the public sector to private companies, allowing governments to leverage private-sector experience, creativity, efficiency, and financial resources (Yescombe, 2018).

In the construction sector, privatised building projects are typically executed via Public–Private Partnership (PPP) agreements, in which public and private entities cooperate to fund, design, construct, operate, and maintain facilities for a designated concession duration. The World Bank (2023) indicates that Public-Private Partnerships (PPPs) have emerged as a significant method for infrastructure provision, especially in healthcare, education, transportation, housing, and governmental facilities. These agreements aim to enhance cost-effectiveness, elevate service quality, optimise risk allocation, and foster innovation throughout the project lifecycle.

Recent research indicates that the rising implementation of privatised building projects is closely linked to escalating infrastructure requirements and constrained public financial resources. The Organisation for Economic Co-operation and Development (OECD, 2023) indicated that governments globally encounter significant infrastructure investment deficits, requiring increased private-sector involvement in project execution. The World Bank (2024) emphasised that PPP investment in infrastructure is essential for attaining sustainable development goals, especially in developing nations where public funding is inadequate to satisfy increasing infrastructure demands.

Privatised building projects diverge from traditional procurement procedures by prioritising long-term performance over the mere completion of construction tasks. In contrast to conventional procurement processes, where a contractor's obligations often conclude with project completion, privatised projects frequently necessitate that private partners run and maintain facilities for prolonged durations, often spanning 20 to 30 years or longer. Thus, choices made in the design phase can profoundly affect operating efficiency, maintenance expenses, user happiness, and environmental performance during the concession period (Nguyen et al., 2022).

A primary advantage of privatised building projects is the chance for innovation. Recent research by Chen, Li, and Zhao (2023) has shown that PPP projects often promote novel design solutions, as private entities aim to enhance long-term operational efficiency and reduce life-cycle expenses. This incentive framework enables private-sector stakeholders to incorporate sustainable design methodologies, energy-efficient technologies, and environmentally conscious building practices from the first stages of project development.

Nonetheless, despite their prospective advantages, privatised building projects persist in encountering numerous limitations. Research has highlighted issues with transparency, accountability, risk distribution, contract intricacy, stakeholder collaboration, and the incorporation of sustainability (Zhang et al., 2022; OECD, 2023). In numerous developing nations, sustainability factors frequently take a backseat to financial and economic goals, leading to inadequate attention to environmental concerns in project planning and design. This circumstance is notably important as the enduring nature of PPP contracts offers a distinctive chance to incorporate sustainability concepts that can yield environmental, social, and economic advantages throughout the project life cycle.

Policymakers promote privatisation as a means to address the government's inadequate financial resources for executing substantial public works projects (Li et al., 2005; Akintoye et al., 2008) Privatisation facilitates an advantageous framework for the government, which operates with constrained resources due to the prevailing economic conditions, by using the financial assets and expertise of the private sector. The privatisation guarantees and enhances value for money in public sector resources (Ninth Malaysia Plan, 2006) Privatisation has gradually become established in Malaysia (Ismail, 2013), inspired by the successes of similar initiatives in Australia, the United Kingdom, Singapore and other nations (Ke, Wang and Chan, 2012). Privatisation creates a mutually advantageous strategic alliance between the public and private sectors (Swaffield and McDonald, 2008). The purpose of privatisation is to transfer suitable risks from the public sector to the private sector and to integrate the private sector into the administration of public assets by using its expertise and management capabilities (Li et al., 2005).

2.2.2 Privatised Building Projects in Malaysia

In response to the economic hardship in Malaysia, the private sector began providing public infrastructure and services in the 1980s. The government requires the private sector to participate in economic activities and development in Malaysia (Ismail and Rashid, 2007). In 1981, the Malaysian Incorporated Policy was implemented, followed by the Privatisation Policy in 1983. In 1985, guidelines for privatisation were established, and in 1991, the Privatisation Master Plan was developed.

Subsequently, to promote private sector participation in Malaysia's economic growth, the government implemented the Public-Private Partnership and Private Finance Initiatives (PPP / PFI) initiative under the Ninth Malaysia Plan in 2006. According to the Ninth Malaysia Plan (2006), privatisation is defined as the transfer of responsibility for financing and managing a package of capital investments and services from the public sector to the private sector. The capital investment and services encompass the construction, management, maintenance, renovation and replacement of public sector assets, establishing a self-sustaining enterprise. The private sector is accountable for producing and providing assets and services to the public sector. The public sector will compensate the private sector depending on the levels, timeliness and quality of service delivery (Ninth Malaysia Plan, 2006). Public sector assets may include buildings, infrastructure, roadways and several other forms.

In Malaysia, the phrases PPP and PFI are sometimes used interchangeably. Since PFI is a subset of PPP, and PPP is considered a kind of privatisation, the word "privatisation" will predominantly be employed in this research to denote its primary focus. Furthermore, research is limited only to buildings, although public sector assets can be in several forms. The objective of privatisation is to improve the execution of the privatisation strategy in Malaysia (Tenth Malaysia Plan, 2010). Furthermore, privatisation must account for socio-economic effects, governmental cost efficiency, project delivery timelines, service development, and increased accountability and efficiency (PPP Guidelines, 2009). Essential characteristics of privatisation encompass the obligation of concessionaires to uphold the assets over the concession period and the amalgamation of design, construction, operation, and maintenance, or, in other terms, facilities management. Figure 2.1 below depicts the framework of privatisation in Malaysia:

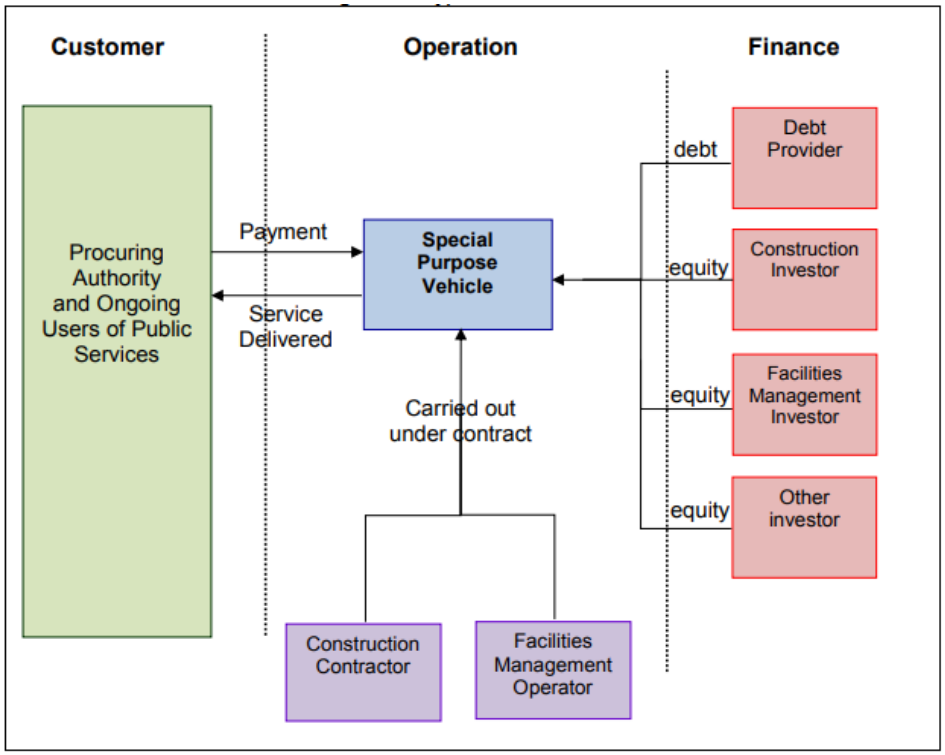

Figure 2.1 Framework of privatisation in Malaysia (derived from PPP Guidelines, 2009)

As seen in Figure 2.1, special-purpose vehicles are tasked with the construction and maintenance of PBPIM. They may be developers, contractors, or builders from the private sector with the capacity to construct and maintain projects throughout the term. Their primary responsibility is to provide services as stipulated in the contract and agreement with the public sector or government, for which they would receive compensation from the public sector appropriately. PBPIM are often founded on long-term contracts and agreements lasting up to 30 years. In addition to constructing the buildings, special-purpose vehicles are tasked with ensuring the maintenance of the buildings and their built assets. After the concession period, these buildings and assets must be transferred or returned to the public sector or government in satisfactory condition.

Investment sources may be a combination of loan and equity investors or suppliers. The public sector or government is primarily responsible for ensuring competitive bidding for projects. As previously stated, the primary characteristics of privatised building projects are the obligation to sustain the structures and their developed assets over the concession period. Consequently, the execution of the projects must be guaranteed to be precise and efficient to ensure that the initial design is adequate, particularly for future operation and maintenance. The public sector or government is responsible for establishing defined project objectives, payment mechanisms, and the Key Performance Indicators (KPIs) that must be met.

Abdullah et al. (2015) assert that the implementation of privatisation has been on the rise in Malaysia in recent years. Nevertheless, limited information exists regarding its implementation status and associated challenges. Furthermore, they highlighted the possibility of privatisation in improving the sustainability of Malaysian building projects. In terms of value for money, PBPIM prioritise the optimal life cycle cost over lower construction expenses. Moreover, the projects must improve the service efficiency offered by the concessionaire. Management for PBPIM encompasses general needs and scope of work, operational and maintenance protocols, life cycle costs, maintenance reserve funds, and Key Performance Indicators (KPIs). KPIs must be performance-oriented and adhere to the Specific, Measurable, Attainable, Realistic, and Timely (SMART) framework.

2.2.2.1 Concerns Regarding Privatised Building Projects in Malaysia

Many researchers contested the issues related to privatised building projects in Malaysia (Khaderi and Aziz, 2010; Ismail and Rashid, 2007)). The issues encompass cronyism, insufficient openness in bidding processes, a deficiency in expertise and knowledge, and inequitable monopolistic advantages. In relation to it, privatisation requires improvement in several aspects, particularly to increase its cost-effectiveness and method. According to the findings of Khaderi and Aziz (2010), economic value is a fundamental principle for privatised projects; thus, it is essential to implement early decisions efficiently for these projects. Moreover, explicit guidelines are crucial for the effective execution of privatised projects (Khaderi and Aziz, 2010).

Ismail and Harris (2014) assert that there is insufficient guidance regarding the execution of privatised projects in Malaysia. This is because privatisation is still advancing, and precise direction and processes are crucial for its proper execution. Privatisation aims for cost-effectiveness and efficient management. (Lop et al., 2016). Increased private sector involvement is thought to provide improved provision of public infrastructure and its associated assets through privatisation. Nevertheless, in Malaysia, privatisation is progressing more slowly than in other nations, such as the UK and Australia. The primary cause for this is the lack of guidelines or a framework for its execution. The guideline is essential for enhancing comprehension of its implementation and for establishing the project's KPIs accordingly (Hasan and Salleh, 2018). The implementation of KPIs will facilitate the evaluation of the project’s overall performance.

In 2017, the General Director of Public-Private Partnership Unit, Prime Minister's Department, underscored that the future of privatisation should encompass new domains, including sustainability and energy-efficient design. This is quite feasible because of the extended concession duration of privatised projects in Malaysia. The advantages of sustainable initiatives may become visible as the project advances. The presence of sustainably developed assets facilitates efficient operation and maintenance while enhancing the environment for inhabitants. Hence, the recommendation by the General Director should be taken seriously and fact that sustainability is important for privatised projects in Malaysia, hence the implementation of the environmental sustainable indicators be incorporated during the design phase of the projects. In line with the need for the guideline as discussed earlier, guidance and recommendations comprising the implementation of the environmental sustainable indicators during the design phase are developed in this research to guide the practitioners or particularly, building designers in Malaysia to achieve the KPIs of the projects.

Abdul Rashid et al. (2016) highlighted the incompleteness of privatised project contract in Malaysia, which lacks sustainable elements. This is disappointing as the nature of the projects is suitable for the consideration of sustainability. Mohd Farmi et al. (2011) added that the incompleteness might be because fundamental knowledge of sustainability is still lagging among professionals. Although privatisation has been introduced for more than a decade in Malaysia, it is still considered new and still progressing by many researchers and debate has been going on especially in terms of its guidelines and procedures that are lacking. This issue has affected the key features of the projects which are the implementation of the environmental sustainable indicators during the design phase.

The need for innovation, together with the absence of sustainability elements, has reduced the benefits of these projects and jeopardised the achievement of their primary objectives. This will also impact the achievement of the KPIs of the projects. Therefore, there is an urgent need to study the implementation of the projects in the context of the environmental sustainable indicators during the design phase to guide the building designers for its implementation so that value for money and sustainable privatised building projects in Malaysia could be achieved successfully.

2.3 Sustainability

Sustainability can be described as enhancing the quality of life and thus allowing people to live in a healthy environment and improve social, economic and environmental conditions for present and future generations (Ortiz, Castells and Sonnemann, 2009). The concept of sustainability suggests a balance between future and present needs, as well as assisting with the various issues that arise from the long-term and short-term structures, organisations, and resources (Kubba, 2010; Opoku, Agyekum and Ayarkwa, 2022). Likewise, sustainability involves environmental, economic, and social issues that transcend organisational boundaries and are highly relevant to the operations of the organisation (Ferro et al., 2017).

Though many organisations use the idea of sustainability extensively in their mission statements and strategies (Dobrovolskiien and Tamo, 2016), with the increasing international demands for more sustainable industries, the construction sector has been set to deliver the project under stricter environmental considerations with “sustainability” pillar coming into play (Al Hattab, 2021). Although progress towards sustainable buildings and construction is advancing, improvements are still not keeping up with a growing buildings sector and rising demand for energy services (Abergel, Dean and Dulac, 2022). Pre-construction and, ideally, early design phases are the best times to analyse and incorporate sustainable measures (Azhar, Brown and Sattineni, 2010; Basbagill et al., 2013; Santos et al., 2019). This is why this research is focused on the design phase as it is ideal for capturing every aspect of sustainability during this phase. Also, the basic goals of sustainability for the construction industry are to reduce energy consumption, protect the ecosystem, improve occupant health, and increase productivity (Kubba, 2010). Architects and engineers can incorporate these objectives into their roles during the planning and designing of building projects to ensure that these basic sustainable goals are met.

Sustainability should be pursued with the aid of an integrated approach capable of recognising the sustainability aspects in all choices (Sodagar and Fieldson, 2007) in this case, the Building Information Modelling could aid in illustrating the sustainability aspects in all choices. Yet again, Lapinski, Horman and Riley (2006) discuss the importance of early adoption of sustainable objectives and early selection of an experienced design and construction team and is supported by Williams and Dair (2007) who emphasise that sustainable building is hampered when designers are brought in too late in the process. It is believed that if the possibilities and appropriate design options are not considered early enough, a large portion of sustainable building potential is lost.

According to Rum and Akasah (2012), little is known about the procedures of sustainability implementation in Malaysia, and they suggested that an investigation is necessary to develop and extend the implementation of sustainability in Malaysia to contribute to a better decision-making process in construction. Similarly, Hassan et al. (2014) asserted that the implementation of sustainability in Malaysia is vague and most of the practitioners lack knowledge regarding it. This is because it is seldom being implemented by the practitioners (Mat, 2010) as clients are always concentrating on the initial costs rather than the long-term costs (Ayob and Abdul Rashid, 2011).

2.3.1 Sustainable Building

Sustainable building is about achieving the required performance with the least amount of environmental impact while also encouraging economic, social, and cultural progress at the local, regional, and global levels (ISO, 2008). Project management teams could enhance and promote sustainable building processes to increase the adoption of sustainable building processes because they are recognised as key actors in the construction industry who ensure project objectives are met and delivered successfully (Hwang and Tan, 2012). Also, throughout the construction process, project management teams could adopt basic sustainability goals (Hills et al., 2008). In this research, the project management team comprises the architects and engineers who are acting as the respondents and based on the response obtained, this research could promote the adoption of sustainable building in selecting more sustainable materials.

According to the United Nations Environment Programme's (UNEP) vision for Sustainability in the Building and Construction Sector (UNEP, 2009), sustainable building is an active process in which government policies and incentives support sustainable building and construction practices, and investors, insurance companies, property developers, and buyers/tenants of buildings are aware of sustainability considerations and play active roles in encouraging sustainable building and construction practice**.** The sustainable development of buildings (and other construction works) creates the required performance and functionality with minimum adverse environmental impact while encouraging improvements in economic and social (and cultural) aspects at local, regional and global levels. Awareness, communication, comprehension, experience, lateral thinking, leadership, negotiation, passion, and technical knowledge are required skills for managing/leading the design of a sustainable building (Mills and Glass, 2009). Other than creating guidance and recommendations, this research also creates awareness and shares its knowledge with the design team.

According to Rydin et al. (2006), while designers have confidence in their ability to access and use knowledge in general, this confidence decreases when it comes to sustainable building. (Mills and Glass, 2009) evaluate construction design managers' ability to incorporate sustainability into building design; this requires that sustainability issues be communicated in a project's brief. To design a truly sustainable building, the building designers must have access to the best available information on products and tools (Sodagar and Fieldson, 2007). These data should be transferred and analysed. This is only possible if the construction industry collaborates towards a common goal.

Because many organisations are too small to remain competent in the full range of issues involved, sustainable building knowledge should also be available as specialised service packages (Rohracher, 2001). Jonge (2005) in his research identified the lack of powerful methods in the design phase which is also supported by Tucker et al. (2003) on the problem of access to data as well as the availability of automatic calculation procedures. Sustainable building design requires integrated methods that provide product information to the process and allow for easy comparison of design options during the early stages of design (Häkkinen and Belloni, 2011). Sustainable design must be mindful, with increased effort in the early phases because decisions made during this time will have a substantial impact on the project as a whole. It is possible to argue that integrated design is a critical component in achieving sustainability (McGraw Hill Construction, 2010).

2.3.2 Sustainability for Privatised Building Projects

The growing popularity of privatised projects contributes to high demands for sustainability assessment (El-Haram et al., 2002, Takim et al., 2009). PPP Guidelines (2009) listed sustainability as one of the main features of privatised building projects whereby privatisation contract is usually awarded to the concessionaire based on the lowest bid. Under privatisation, the same special-purpose vehicle is likely involved in the design, construction, operation, and maintenance. Therefore, sustainability must be managed effectively given the involvement of significant sustainable risks for the consortium over an extended period. Consequently, with the increasing use of privatisation in the construction industry (Wang et al., 2012), the inclusion of sustainability in tenders becomes more crucial than ever. High initial cost of durable buildings considerably reduces the future cost of these buildings, which is a concern among investors. Therefore, recognising the significance of sustainability to their investments, accurate advice on the sustainability of these projects is initially procured by investors for better-informed financial planning and decision-making processes.

2.4 Approaches to Building Sustainability

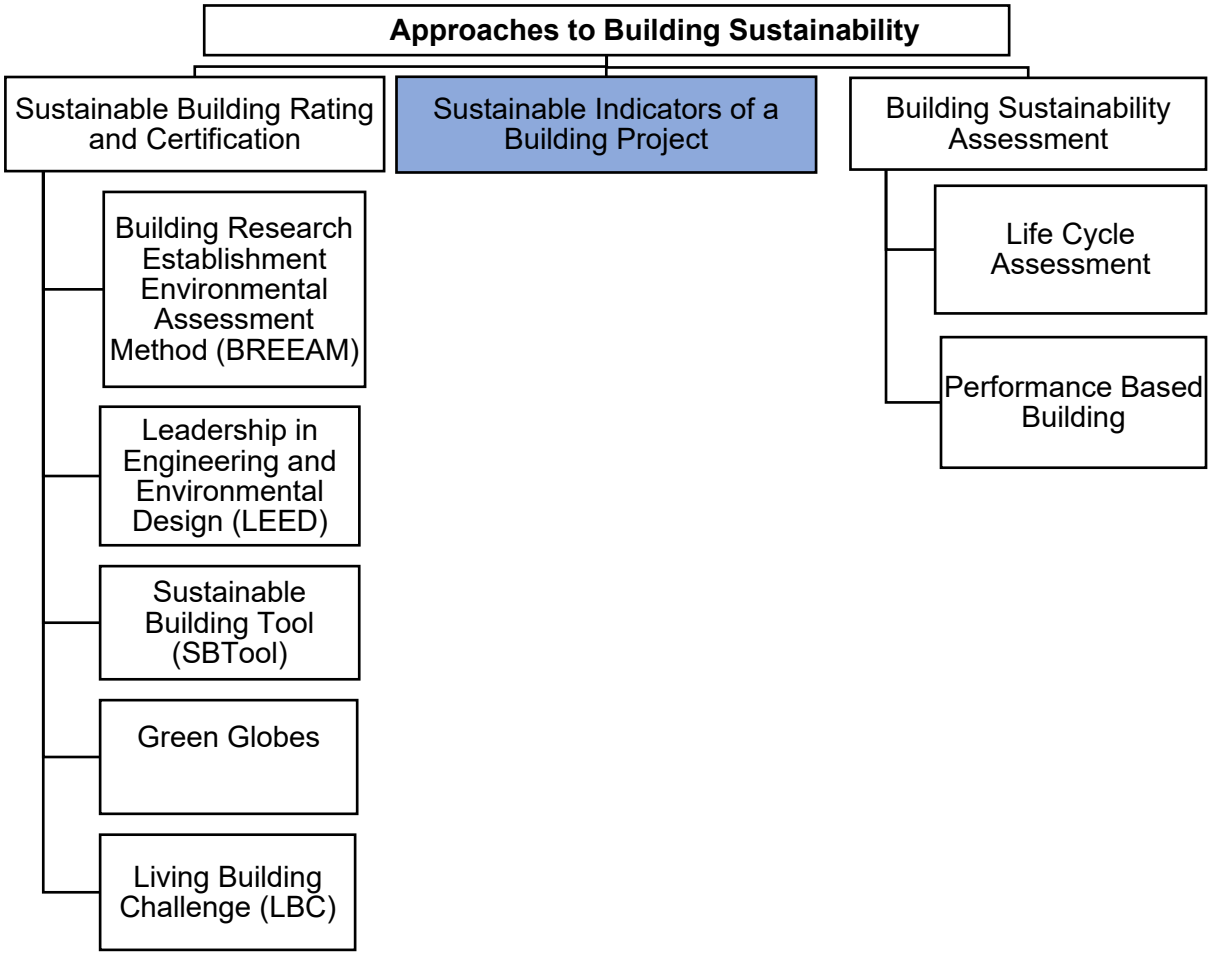

Figure 2.2 Approaches to achieving sustainability in building projects

Figure 2.2 above illustrates the approaches to achieving sustainability in building projects. There are three approaches to measure building sustainability and the approach used in this research is the sustainable indicators which focus on the environmental factors.

2.5 Sustainable Indicators of a Building Project

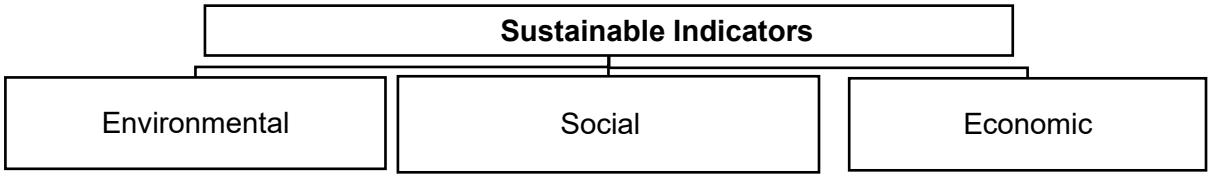

Figure 2.3 Types of sustainable indicator

Indicators are present in our daily lives, frequently without our knowledge. Time, weight, temperature, and price are all units of measurement used to describe the state of anything from a basic object to a complex system. They can also be used to generate indices, which describe data in its simplest form (see Figure 2.3). In the environmental context, indicators are defined as "measured, calculated, observable, and quantifiable key figures that form part of a targeted system used to make statements about the state and development of the environment". For example, the Organisation for Economic Co-operation and Development (OECD)'s pressure-state-reaction model distinguishes between pressure, state, and response indicators.

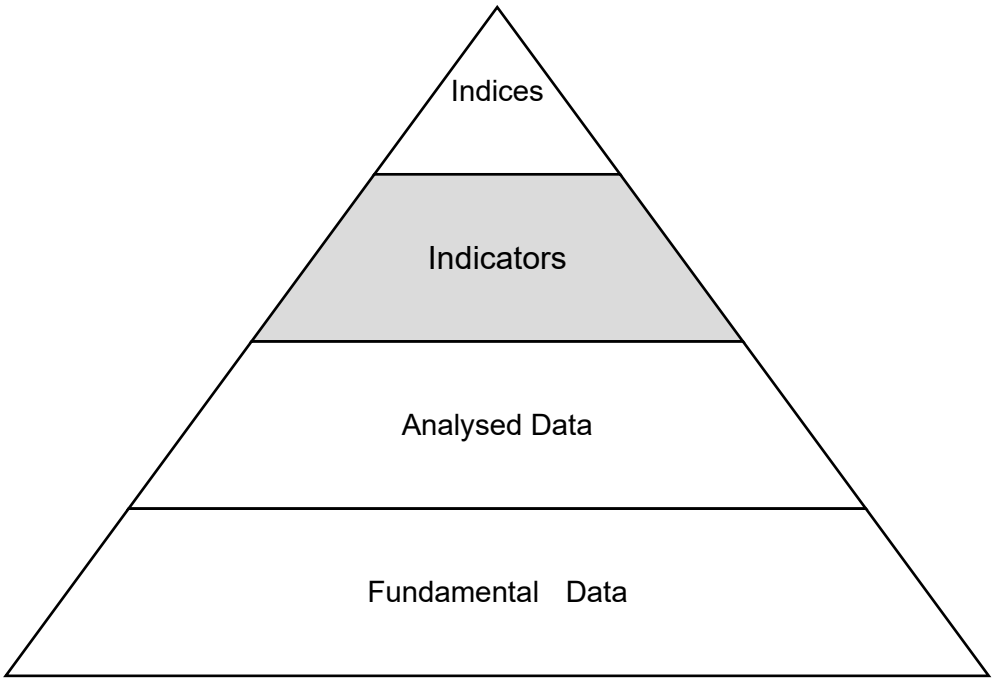

Figure 2.4 The stage model of information compression (Wallbaum, 2008)

A sustainable indicator is a metric or a group of measurements that provide information on predetermined variables (Ugwu and Haupt, 2007). To achieve sustainability, the triple bottom-line approach must be taken into consideration where a minimum performance must be attained in the environmental, social and economic dimensions (Heravi, Fathi and Faeghi, 2015). These indicators strive to quantify, evaluate and explain complex information in a simple way (Artiach *et al.*, 2010) through systematic, exact, consistent and transparent triple bottom-line aspect measurements (Tokos, Pintarič and Krajnc, 2012). As a result, selecting and identifying sustainability indicators is essential for the efficiency of their use in defining and assessing sustainability (Chen, Lin and Tseng, 2015). Sustainability indicators can be defined during the early stage, construction, operation, maintenance and demolition stages. The history of the rise of sustainable indicators is documented in Chapter 40 of Agenda 21(United Nations Conference on Environment & Development, 1992). The need for a set of sustainable indicators to monitor progress in this direction was emphasised at the first session of the United Nations Commission on Sustainable Development (UNCSD, 1993). The first such set was submitted in 1995 and adopted by the UNCSD as a foundation for evaluation (UNCSD, 1995), and the mandate was further confirmed by the Johannesburg Plan of Implementation, which required additional work on indicators of sustainable development at the national level by countries, including gender integration, voluntarily, by national conditions and priorities (World Summit on Sustainable Development, 2002). The report of the 13th session of the UNCSD on 11-12 April 2005 emphasised the importance of continuing work on sustainable indicators at the international level (UNCSD, 2015).

The construction sector has a long history of producing and employing indicators, in addition to many general initiatives to produce indicators for sustainable development (Wallbaum, 2008). Many environmental researchers have contributed to the indicators, including (Ali and Al Nsairat, 2009), (Chen et al., 2015), (Larimian *et al.*, 2012), (Shen, Wu and Zhang, 2011), (Shen et al, 2007), (O O Ugwu and Haupt, 2007). The indicators that have been produced primarily focus on major categories such as site and land usage, energy efficiency, water efficiency, materials, indoor environment quality, waste management, and pollution issues. In terms of economic sustainability indicators, life-cycle cost is a topic researched by many researchers and is regarded as the primary measure of this dimension.

However, the effects on the local economy and development (Shen et al., 2007; AlWaer, Sibley and Lewis, 2008), supply and demand (Shen et al., 2008; Shen, Wu and Zhang, 2011), productivity and performance (Alwaer and Clements-Croome, 2010; Chen et al., 2012; AlWaer, Sibley and Lewis, 2008), profitability(Chen et al., 2012), and employment (O O Ugwu and Haupt, 2007; AlWaer, Sibley and Lewis, 2008)are among the economic indicators. In order to overcome the increasing concern of today's resource depletion and to address environmental considerations in both developed and developing countries, sustainability indicators can be applied to decision-making to improve sustainability in the construction industry. As for this research, the indicators would be assessed during the early stages focusing on the design phase.

2.5.1 Fundamental Requirements of Sustainable Indicators

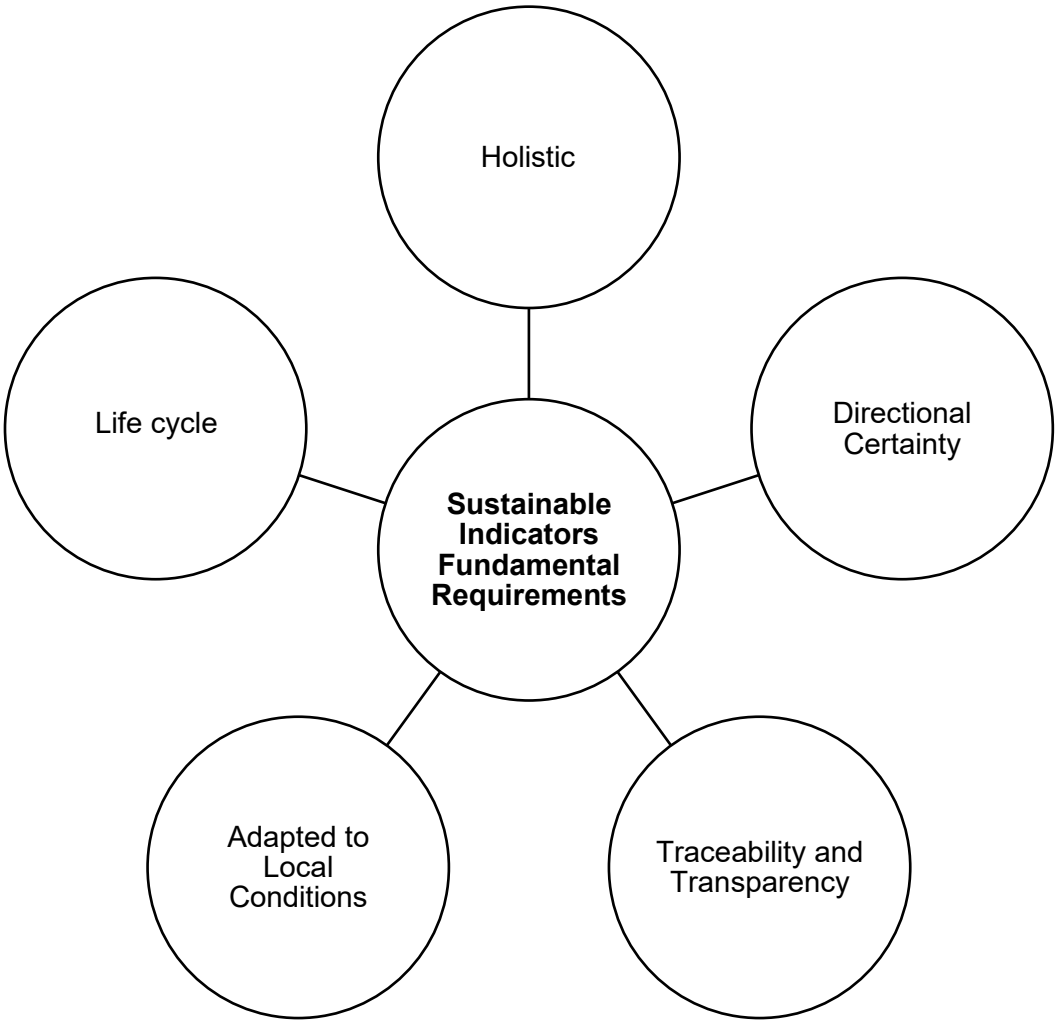

Figure 2.5 Fundamental requirements of sustainable indicators

Sustainable indicators must include all aspects of sustainable development if they are to accomplish their goal; in other words, they must be holistic. These factors differ based on the theoretical, sociological, political, or cultural perspective taken, though most employ the three-pillar model, which includes economic, environmental, and social aspects. Individual aspects can be further subdivided, and cultural and institutional aspects can be included. The problem here is in executing the chosen dimensions for the construction industry. A vision based solely on ecological criteria does not meet the prerequisites for sustainable development, even though the restricted perspective that ecology equals sustainability is still widely held.

Next, sustainable indicators must cover the entire life cycle, encompassing all operations such as raw material extraction and processing, transportation expenditures, and building construction, usage, and decommissioning. The problem here is to choose acceptable system boundaries while yet allowing the sustainable indicators set to be utilised. Depending on the level of examination, this may also involve infrastructure such as water and sewage disposal. System boundaries must be chosen so that the importance of the elements being studied is not deliberately or unconsciously limited. The observable parameters must be limited for practical reasons, but this should not come at the expense of directional certainty. If possible, sustainable indicators should be developed and used to ensure bottom-up and top-down compatibility, which can make or break the usage of statistical data.

Another criterion is traceability and transparency about the dataset used, assumptions made, and accounting and evaluation systems used. This is critical for assuring scientific accuracy and serving as the foundation for the desired communication to the target group. To maintain transparency, sustainable indicators must be adapted to local conditions, at least in terms of the evaluation procedure. In most northern European countries, for example, adequate amounts of fresh water are available, whereas in most southern European towns and cities, it is a scarce commodity that requires special attention.

2.5.2 The Environmental Sustainable Indicators

A review of several sustainability literature reveals that more emphasis has been placed on the environmental aspect, which serves as the foundation for the other aspects of sustainability (Obringer and Nateghi, 2021)**.** Environmental indicators concentrate on the environmental impacts caused by buildings throughout their life cycle. Building environmental impacts are often divided into two categories: embodied impacts (i.e., impacts embodied in the building) and operational impacts (i.e., impacts happening over the "active" service life and therefore during building use) (Anderson, Wulfhorst and Lang, 2015; Soust-Verdaguer, Llatas and García-Martínez, 2016).

The environmental sustainable indicators are affected by factors such as building design, material selection, construction quality, building location, energy supply source selection, and operations and maintenance activities (Harris, 1999; Pajchrowski et al., 2014). Reducing total environmental impacts from a building's life cycle is a difficult undertaking, due in part to the characteristics listed above, but also to the potential of burden shifting, which can transfer negative impacts from one building stage to another. To reduce operational impacts, for example, more thermal insulation or triple-glazed windows instead of double-glazed windows can be installed, however, these solutions would increase embodied impacts because more resources are utilised to construct the building. Once created and completed, it is difficult to reverse environmentally sustainable building design decisions such as building orientation, window-to-wall ratio, and Heating, Ventilation, and Air Conditioning (HVAC) systems (Russell-Smith et al., 2015).

The environmental sustainable indicators are often evaluated using Key Performance Indicators (KPIs) classified into numerous categories that allow for comparison of alternative design solutions as well as monitoring of real building performance during operation (Conte and Monno, 2012). These indicators are intended to give aggregated information about a phenomenon understandably and efficiently (Huedo, Mulet and López-Mesa, 2016). KPIs and benchmarking are essential components of any improvement plan since they represent a project's goals and provide a way for measuring and managing progress towards those goals for future learning and improvement (Kylili, Fokaides and Lopez Jimenez, 2016).

There is a continuous argument about which KPIs to use and what they actually measure. There is, for example, a heated debate over whether the United Nations Environmental Programme (UNEP) Benchmarking Think Tank Index evaluates environmental performance, sustainable performance, service performance (e.g. durability/adaptability), or energy performance (Mwasha, Williams and Iwaro, 2011). Another challenge is determining the right amount of performance indicators. Choosing a single indicator simplifies the decision, but it may also result in information loss. On the other side, a huge number of indications can limit comprehension and the relation indicator (Lasvaux *et al.*, 2016). As a result, defining the proper number of effective indicators is critical, because the list of indicators influences the quantitative performance results.

In an ideal world, there should be a limited number of indicators with standardised measures that can be easily compared to targets, benchmarks, or other relevant criteria (Alwaer and Clements-Croome, 2010; Mateus and Bragança, 2011). The environmental performance indicators are typically classified into various groups. Kylili, Fokaides and Lopez Jimenez (2016) separated the environmental category into 12 sub-categories meanwhile (Toller *et al.*, 2013) chose six indicators for environmental monitoring of the Swedish construction sector and (ALwaer and Clements-Croome, 2010) identified 16 categories relating to sustainable buildings, six of which address environmental indicators as shown below.

Table 2.1 Environmental indicator categories

Environmental Indicator	Description	Author(s)
Greenhouse Gas Emissions	Reduction of carbon emissions throughout the building life cycle.	Toller et al. (2013); IPCC (2023); UNEP (2023)
Sustainable Materials	Selection of environmentally responsible, recyclable, and low-carbon materials.	Lasvaux et al. (2016); Pajchrowski et al. (2014); UNEP (2023)
Energy Efficiency	Reduction of energy consumption through efficient design, systems, and technologies.	Alwaer and Clements-Croome (2010); UNEP (2023); Wu et al. (2023)
Waste	Minimisation, reuse, and recycling of construction and demolition waste.	Kylili et al. (2016); Aghimien et al. (2023)

Table 2.1 is crucial to this research as it presents the theoretical framework for selecting and analysing the environmentally sustainable indicators pertinent to Privatised Building Projects in Malaysia (PBPIM). The table consolidates and contrasts environmental sustainability characteristics delineated by prior researchers. Table 2.1 primarily illustrates that environmental sustainability in construction projects comprises numerous interrelated indicators rather than a solitary environmental element.

The table classifies environmental indicators into numerous principal categories, including atmosphere and greenhouse gas emissions, energy use and efficiency, waste management, reuse and recycling, pollution reduction and resource efficiency. These categories offer a systematic framework for comprehending the environmental aspects of sustainability in building projects. In this research, Table 2.1 fulfils multiple significant roles. The table underpins the literature evaluation by synthesising environmental sustainable indicators discovered in prior research. This provides an intellectual rationale for choosing environmentally sustainable indicators as the research topic. The table illustrates that environmental indicators are extensively acknowledged in sustainability assessment frameworks and literature on sustainable construction

Secondly, Table 2.1 aids in the formulation of the study framework. The indicators listed in the table serve as the foundation for comprehending the pertinent sustainability elements throughout the design phase of PBPIM. The environmental categories outlined in the table informed the development of interview questions and facilitated the identification of sustainability aspects examined with the respondents. The table aids in refining the research scope. Sustainability encompasses environmental, economic, and social factors. This research especially focuses on environmental sustainability. Consequently, Table 2.1 elucidates the rationale for the study's emphasis on environmental sustainable indicators instead of concurrently addressing all dimensions of sustainability.

The table facilitates a comparison between prior material and the results presented in Chapter 4. The variables examined by previous researchers can thereafter be contrasted with the perceptions and priorities recognised among Malaysian building designers. This enables the research to assess if the internationally highlighted environmental indicators are similarly valued within the context of Malaysian privatised building projects. Furthermore, Table 2.1 enhances the analytical rigor of the research by illustrating that the chosen environmental sustainable indicators are not random but are grounded in existing sustainability literature and acknowledged sustainability assessment frameworks. The significance of Table 2.1 is so considerable because it establishes the theoretical foundation of environmental indicators, underpins the conceptual framework, directs data collection, facilitates analysis and discourse, permits comparison with prior studies, and enhances the academic rigor of the research. Table 2.1 serves as a fundamental reference that integrates the literature evaluation, research methodology, and findings within the entire framework of the study.

2.5.3 The Environmental Sustainable Indicators for Privatised Building Projects

According to Wang et al. (2011), sustainable indicators are an appropriate tool to assess sustainability for building design. In the study on the effectiveness of sustainability in a corporate decision-making context, Gluch and Baumann (2004) emphasised the need to establish a relationship between environmental issues and corresponding financial consequences but the integration of environmental consequences through sustainability in actual scenarios remain unclear.

The significance of the environmental sustainable indicators in the decision-making process about the design and operation of building assets is recognised in privatised building projects, which implies wide acceptance and the desire for privatised building projects for sustainable design (Kirkham, 2005). It should be noted that preliminary decisions on the design of buildings have immense consequences on the life cycle of these buildings, which includes the consideration of extended environmental responsibility (Goh and Sun, 2016). The life cycle of buildings has been consistently an interest, as reflected by the numerous applications of green building characteristics in the construction industry. In fact, these green designs typically have significant operating benefits such as reduced costs in energy and water operations as well as maintenance due to their more robust design.

In privatised building projects, the environmental sustainable indicators support the decision-making process (Wong et al., 2010), which compares several available options and determines the most economic and appropriate elements or components. Hence, the inclusion of the environmental sustainable indicators as part of the decision-making process significantly contributes to the effort of establishing sustainable privatised building projects with the considerations of both costs and sustainability of an element or component. Additionally, environmental sustainable indicators assess an element or component, which determines the reduction of costs in the long term and explores options of an element or component for the building design.

The primary objective of environmental sustainable indicators is to evaluate and optimise the environmental sustainable indicators of a building as part of the decision-making processes during the design phase (Al-Hajj and Aouad, 1999; Tobin and Burnett, 2015). Typically, the environmental sustainable indicators are considered in the preliminary stage of the project development by comparing all options available, which enables better-informed decisions. Its significant role in supporting decision-making processes pertaining to the design is widely recognised in privatised building projects (Kirkham, 2005). In particular, building designers benefit from the implementation of the environmental sustainable indicators with its effective, reliable, and cost-conscious method in assessing the sustainability options of different buildings to their respective clients (Edwards et al., 2000). In return, the clients can make better-informed decisions based on the financial and environmental criteria provided.

2.5.4 Limitations to Implementing the Environmental Sustainable Indicators for Privatised Building Projects

Arguably, the lack of professional provision and scientific training for sustainability may impede the overall implementation of sustainability (Elmualim et al., 2008; Ikediashi et al., 2014). The findings were corroborated by Elmualim et al. (2010) where the lack of commitment from the senior management level deterred the implementation of sustainability. This reaffirmed the crucial need for implementing sustainability under the role of building designers at all levels with the commitment and support from the senior management level. Therefore, the lack of support from the senior management level may be identified as a significant limitation to the implementation of sustainability (Elmualim et al., 2010; Galamba and Nielsen, 2016).

Other identified limitations to a consistent and comprehensive implementation of sustainability included time constraints, lack of knowledge, and lack of commitment from the senior management level (Elmualim et al., 2010; Asbollah et al., 2016). In particular, the lack of commitment as well as understanding from the senior management level on the opportunities, threats, needs, and direction of enforcing the necessary changes are major limitations to sustainability. Limitations to the implementation of sustainability included the lack of understanding, focus on gaining the managerial leadership, ineffective funding models, reluctance to adopt new ideas, and disregard of the long-term benefits of sustainability due to other immediate priorities (Adewunmi et al., 2012). The commitment and perception of building designers, especially at the senior management level in integrating sustainability are essential (Elmualim et al., 2010).

Among the building designers at the senior management level, 60% of them recognised climate change as part of the organisation's overall strategy while 70% perceived climate change as a key branding and reputational issue (McKinsey, 2008). The majority of building designers implied its relevance across product development, investment planning, purchasing and supply management. Climate change is not majorly considered the most important global trend (30%) (Pitt and Hinks, 2001) despite being recognised as the most important policy motivation in the Stern Report.

The role of building designers at the senior management level in defending sustainability was assessed and revealed that when the size of organisation increases, the involvement of building designers at the senior management level is reduced. Building designers in smaller organisations may have an improved understanding of sustainability but they are likely to be affected by financial constraints (McKinsey, 2008). The perception of building designers influences how sustainability is implemented. The general conventional role of building designers requires transformation according to the environmental needs of climate change and evolving government on carbon emission reduction (Pitt and Hinks, 2001). The significance of transitioning a formally established project management approach to phased changes is advocated to address these industry-specific or more generic limitations towards environmental goals (Post and Altma, 1994). These phased changes should be correlated with the external and regulatory impacts, which enable the organisations to manage the fundamental changes.

The lack of knowledge and skills of building designers to sustainably manage the design are considered to obstruct the implementation of sustainability (Shah, 2008; Elmualim et al., 2010). Moreover, the needs of individual building designers widely vary across the different sectors and sizes of organisations involved. Building designers in large organisations operate more strategically than building designers in smaller organisations. This affects the development of the needed training and CPD provision for building designers. Besides that, outsourcing the services of building designers has resulted in improper management of the training and skill provision for these contracted services (Pitt and Hinks, 2004; Shah, 2008).

However, Brand and de Bruijn (1999) asserted for cooperative approach to sustainable development based on the European experience, which has introduced a new importance of shared responsibility under the Fifth Amendment Action Programme. It suggests environmental transformation and a novel method in order to stimulate the industry towards achieving sustainability. The research concludes that the critical factor in order to attain success as well as to enhance the approach of partnership, the management of the approach is essential. The development of skills at the fundamental management level is required to support this. Carpenter and Meehan (2002) advocated the need for a collaborative approach towards sustainability, and the roles of building designers should be properly established within the organisation sustainability.

Elmualim et al. (2010) reported that there was a lack of focus at the senior management level on the implementation of sustainability, where policy on sustainability was not introduced in certain organisations (31%). This study further reported that the government sector (83%) and healthcare sector (80%) were most likely to have a policy on sustainability while the non-profit organisations (63%) were likely to have no policy on sustainability. Carbon footprinting and ethical purchasing, areas key to balanced sustainability activities were less well addressed. There is a lack of understanding among building designers in the fundamentals of policy implementation, and they often perceive sustainability as a lower priority (Elmualim et al., 2010). Policies on sustainability are lacking, and sustainability-related activities are often not reported to the stakeholders and investors. This significantly affects the implementation of sustainability where the availability of information is highly required to support the responsibilities of building designers towards sustainability. The acquisition of knowledge and skills should be prioritised among the senior management level given the influence they have on establishing sustainability within the organisation.

The success of implementing sustainability within the organisation could be achieved with improved understanding at the senior management level through knowledge acquisition, which directs their commitment to achieving both aspects of sustainability as well as business profitability. The issues involved are complex, typically in social and technical aspects, thus, it is important to get support from the leadership and management of the organisation.

The roles of building designers towards the sustainability agenda within the organisation based on the contributions building designers provide concerning the established sustainability goals (Wood, 2006; Shah, 2008; Ikediashi et al., 2012). However, limitations are likely to exist considering the ever-changing roles of building designers within the organisation, which may impede the integration of sustainability into the sustainability agenda. Kato et al. (2009) asserted that there are still unaddressed challenges in the construction and management of buildings in the sustainability agenda despite the increasing trend of green buildings. Elmualim et al. (2010) researched commitment and limitations of building designers regarding sustainability. It was revealed that responsible building designers in the sustainability agenda of the organisation are not provided with adequate knowledge on sustainability due to the lack of commitment from the senior management level.

Significant limitations that challenge the implementation of an environmental management system include lack of government support and incentives, uncertainty in the outcomes and benefits of implementation and the lack of relevant environmental laws and regulations, as revealed by Massoud et al. (2010). Despite its narrow context, Massoud et al. (2010) contributed significant results that affect the implementation of sustainability in Nigeria; given the substantial number of small- and medium-scale organisations, which constituted the largest and fastest-growing sector of Nigeria's economy, are affected by infrastructure collapse. Waivers for technical and financial resources from the government as well as the monitoring of promulgated laws and regulations should be granted to effectively implement sustainability as part of the core management policy. With the low level of sustainability awareness in Nigeria, the outcomes and benefits of sustainability are likely to be doubted as well, which is certainly considered as a limitation to the implementation of sustainability.

Other common limitations to sustainability included lack of awareness, lack of training and lack of tools (Finch and Clements-Croome, 1997), financial constraints, the cost of certification, lack of in-house knowledge, customer demands and constraints, physical and historical constraints, and organisational engagements (Shah, 2008; Elmualim et al., 2008). There is also the call to identify challenges in the adoption of sustainable practices within the organisations, which emphasises the significant need to identify the limitations that significantly affect the implementation of sustainability within the organisations in Nigeria as well.

Ikediashi et al. (2012) pointed out that the only challenge though lies in the seeming lack of scientific training and professional provision across the labour industry for building designers, a state that could delay the capability of understanding the intricacies of intelligent buildings and their operations (Elmualim et al., 2008). They further corroborated that the most significant limitations to the implementation of sustainability in Nigeria are the lack of training and tools which are found to be inconsistent as time constraints, lack of commitment from the senior management level and lack of knowledge are identified as the significant limitations instead by Elmualim et al. (2010). This further implied that sustainability in Nigeria encountered a lack of skilled building designers in managing intelligent and green buildings despite the significance of sustainable development. The lack of relevant laws and regulations is also found to implicate the implementation of sustainability in Nigeria, which promptly addresses the current need to establish the necessary laws or regulatory guidelines about sustainability with the consideration of foreign investments as well.

The subsequent limitations identified, in order of significance, include uncertainty regarding outcomes and benefits, followed by a lack of government support and incentives, as well as financial constraints. The perceived uncertainty surrounding the outcomes and benefits of sustainability may be further exacerbated by insufficient government backing and limited awareness. For sustainability to gain organisational acceptance, its benefits must be clearly understood and must outweigh the associated costs; otherwise, the concept may be deemed unjustifiable. As highlighted by Ikediashi et al. (2012), the limitations to implementing sustainability can vary significantly. In summary, the challenges related to implementing environmental sustainable indicators are outlined in Table 2.2.

Table 2.2 Limitations affecting the implementation of the environmental sustainable indicators during the design phase of privatised building projects

No.	Limitations to implementing the environmental sustainable indicators
1	Lack of motivation
2	Insufficient and unavailability of data
3	Weak collaboration between stakeholders
4	Lack of training
5	Lack of tools
6	Lack of awareness
7	Financial constraints
8	Lack of well-established standards and methods
9	Time constraints
10	Lack of capabilities/ skills
11	Variety of uncertain parameters and assumptions
12	Unwillingness to implement sustainability
13	Lack of competence in managing the changing attitude process of people and institutions
14	Complicated process
15	Increasing liability
16	Lack of incentive
17	Lack of government support
18	Uncertainty of outcomes and benefits
19	Lack of relevant laws and regulation

(Source: Fathalizadeg., M. Hosseini., A. Silvius et al. (2021); M. Ashour., A. Mahdiyar., S. Haron et al. (2022); E. Ershadi., M. Jefferies., P. Davis et al. (2021); P. Akadiri. (2015); E. Ohene., A. Chan., A. Darko et al. (2023); H. Jaradat., O. Alshboul., I. Obeidat et al. (2024))

In context of privatised building projects in Malaysia, the limitations that have been explained need to be investigated based on the views of the building designers in Malaysia.

2.5.5 Motivations in Implementing the Environmental Sustainable Indicators for Privatised Building Projects

The significance of implementing sustainability is widely recognised (Pitt et al., 2005; Elmualim et al., 2009, 2010, 2012; Meng, 2014; Ikediashi et al., 2014;) but the motivations of sustainability are not sufficiently addressed (Elmualim et al., 2012; Ikediashi et al., 2014). In order to ensure an effective integration of a sustainability agenda within the organisations, the emphasis on environmental protection programmes and public participation should be introduced at the initial stage of development (Asbollah et al., 2016). For cost-effective sustainability, material durability must first be considered in the design process while the role of building designers should be initially integrated into the overall strategy of the organisation (Hodges, 2005). In short, proper planning should be distinctly conducted at the early stage of development such as considering the long-term costs and management of physical assets involved to ensure successful implementation of sustainability in the privatised building projects.

The sustainability and environmental agenda are considered the latest motivations of progress in the management of privatised building projects. In the UK, there is a commitment to reducing total carbon dioxide (CO_2) emissions by 26% by 2020 and 60% by 2050. Similarly, Malaysia aims to achieve a 40% reduction in total CO_2 emissions by 2020. To address this, specific guidelines are needed to help organisations achieve accreditation and provide formal guidance on mitigating their environmental impacts (Walker, 2007). The government is widely regarded as bearing the primary responsibility for fostering commitment within organisations and ensuring alignment with established sustainability goals (Ikediashi et al., 2012). In the UK, legislation, organisational culture, and corporate image have been identified as key motivations of sustainability efforts (Elmualim et al., 2012).

Beyond legislative requirements, Meng (2014) highlights corporate image as a major motivator, driven by market competition among organisations in the UK and Ireland. Larger organisations, in particular, face pressure from legislation, market dynamics, and evolving business environments to maintain a competitive advantage. Interestingly, internal pressures from employees and stakeholders, as well as the goal of reducing life cycle costs, are perceived as the least significant motivators, suggesting that external factors have a greater influence on organisational sustainability efforts.

In contrast, in developing nations, corporate image also emerges as a significant motivator, alongside objectives such as waste reduction, job creation for local communities, and fostering strong stakeholder relationships. However, pressures from clients and senior management, deforestation reduction, and government regulations are considered less significant in these contexts (Ikediashi et al., 2014). A classification of sustainability motivations is provided in Table 2.3.

Table 2.3 Categorisation of sustainability motivations

Category	Motivations
Environmental	Reduction in energy consumption
	Waste reduction
	Increase productivity
	Elimination of oil and air pollution
	Sustainable urbanisation
	Reduction of deforestation
	Reduction of carbon dioxide emissions
Social	Legislation
	Corporate image
	Organisation ethos
	Service management/Director's leadership
	Pressure from clients
	Pressure from employees
	Pressure from stakeholders
	Enhance relation with stakeholders
	Job creation for local communities
	Government regulation
	Pressure from senior management
	Market competition
Economic	Life cycle cost reduction
	Financial gain
	Investment drive
	Profitability
	To remain competitive
	Market expansion

Recent assessments by UNEP (2022) and the International Energy Agency (IEA, 2023) underscored the significance of energy efficiency and carbon emission reduction in sustainable architecture. These sources bolster the incorporation of energy efficiency and carbon reduction as primary motivating reasons in the revised table. The findings revealed that the construction sector substantially contributes to global greenhouse gas emissions, consequently intensifying the demand for construction firms to use sustainable design practices. Legislative pressure may serve as a stronger motivator than environmental concerns or corporate image (Casals, 2006; Elmualim et al., 2012).

Recent regulations on building energy consumption emphasise the importance of enforcing energy efficiency as a step towards sustainability, impacting both the social and business responsibilities of organisations. In addition to energy efficiency, these regulations address waste management, proper disposal, and the reduction of carbon emissions. Darko et al. (2022) determined that governmental rules and environmental policies are significant catalysts prompting organisations to embrace sustainable construction practices. This endorses the incorporation of "government regulations and legislation" as a principal motivational category in Table 2.3. The study demonstrated that more stringent environmental compliance mandates are compelling project stakeholders to incorporate sustainability factors during the design phase of construction projects.

Jaradat et al. (2024) emphasised that the adoption of sustainability is increasingly driven by organisational competitiveness, stakeholder expectations, and long-term business performance. This endorses the revised classifications for corporate image, market competitiveness, and organisational sustainability plans. The study revealed that organisations today perceive sustainability not merely as an environmental obligation but also as a strategic asset that bolsters reputation and financial value. Studies have also explored the relationship between corporate image (Loosemore and Phua, 2011), business contexts (Pitt, 2005), client and end-user demands (Nousiainen and Junnila, 2008), and various other sustainability motivations and challenges.

Organisational values and their core objectives should be assessed in light of their impact on sustainability. The diverse practices related to sustainability stem from the implementation of varying policies, which are shaped collectively by individuals across all levels of an organisation, including senior management, clients, employees, supply chain members, and even government bodies. These differing practices and policies ultimately affect the organisation's overall performance (Sioshansi, 2011).

Client, stakeholder, and employee pressures are significant motivations of sustainability, influencing understanding and implementation. Additionally, the role of senior management, particularly their leadership style and commitment, is a critical motivator (Elmualim et al., 2010). Contrasting perspectives at the senior management level regarding climate change and sustainability impact overall business strategies. For instance, 70% of senior executives view sustainability as a core aspect of organisational culture and a reputational concern, while 60% regard it as a business strategy. The integration of sustainability into core business strategies continues to evolve, shaped by various motivational factors.

The corporate image is regarded as the most significant motivation for sustainability in Nigeria (Elmualim et al., 2013). This may stem from the mismanagement of oil and other natural resources, leading to issues such as oil spills, gas flaring, and air and water pollution. These environmental challenges have heightened stakeholder awareness and pressured organisations to enhance their corporate image through sustainability practices. Additionally, job creation for local communities has emerged as another key motivation, aligning with the organisations' core values. Despite government efforts to enforce legal compliance, regulatory requirements rank among the least significant motivations for organisations (Elmualim et al., 2012).

However, in a study by Elmualim et al. (2012), legislation was identified as the most critical motivation of sustainability among 198 respondents (66%), followed by corporate image (61%), organisational culture (43%), and leadership from senior management and directors (39%). Other motivations included pressure from clients (29%), employees (21%), and shareholders (15%). Nevertheless, existing frameworks tend to prioritise environmental concerns, such as carbon emissions, carbon footprint, and energy consumption, within the context of social sustainability (Sioshansi, 2011; Elmualim et al., 2012). This approach reflects the influence of corporate image and organisational culture, which are often shaped by client demands and industrial competitiveness, both of which are considered significant motivations for organisations.

CIDB Malaysia (2022) emphasised that sustainable construction and green infrastructure are gaining prominence in the Malaysian construction sector due to national sustainability initiatives and environmental obligations. This indicates that the incentives outlined in Table 2.3 possess both theoretical significance and practical relevance for privatised building projects in Malaysia. The use of recent references enhances the academic quality of the research by aligning the discourse on sustainability objectives with prevailing global trends, recent policy advancements, and modern practices within the construction industry.

Another significant motivation is legislation (Elmualim et al., 2012), where legislation compels organisations to strictly comply with the established regulations in their sustainability practices. In brief, the motivations could be summarised as shown in Table 2.4.

Table 2.4 Motivations for implementing the environmental sustainable indicators

No.	Motivations of the implementation of the environmental sustainable indicators
1	Reduction in energy consumption
2	Waste reduction
3	Increase productivity
4	Elimination of pollutions
5	Sustainable urbanisation
6	Reduction of deforestation
7	Reduction of carbon dioxide emissions
8	Corporate image
9	Pressure from clients
10	Pressure from senior management and stakeholders
11	Market competition
12	Life cycle cost reduction

(Source: E. Ohene., A. Chan., A. Darko et al. (2023); A. Darko., A. Chan., D. Owusu-Manu et al. (2017); R. Lakys., A. Saad., T. Ahmed et al. (2022); I. Amarasinghe., Y. Hong., R. Stewart. (2024); S. Abdulai., G. Nani., R. Taiwo et al. (2024))

Table 2.4 outlines the correlation between the specified motives and the environmental sustainable indicators employed throughout the design phase of Privatised Building Projects in Malaysia (PBPIM). The table is significant as it illustrates the impact of certain motivational factors on the adoption and prioritisation of particular environmentally friendly indicators in construction projects. The objectives serve as catalysts that motivate building designers and project stakeholders to adopt sustainability measures, including energy efficiency, water efficiency, waste management, sustainable material selection, and carbon emission reduction.

Table 2.4 illustrates that governmental laws and legislation significantly affect the execution of environmental indicators pertaining to energy efficiency, carbon reduction, and pollution management. Darko et al. (2022) assert that environmental rules and sustainability policies are significant motivators prompting organisations to embrace sustainable construction practices. Jaradat et al. (2024) indicated that escalating regulatory demands necessitate construction stakeholders to incorporate sustainability factors in the initial design phase. This illustrates that regulatory pressure compels organisations to adopt environmental indicators to ensure adherence to sustainability standards and environmental policies.

Long-term operational cost savings are directly associated with metrics such as energy efficiency, water efficiency, and the selection of durable materials. Ashour et al. (2022) indicated that organisations are progressively implementing sustainable design techniques due to their capacity to diminish operational and maintenance expenses across the building's life cycle. Hwang et al. (2020) similarly discovered that energy-efficient systems and resource-efficient technologies enhance long-term financial performance. Within the framework of PBPIM, this connection is crucial as concessionaires are tasked with the operation and maintenance of the facility for prolonged concession durations.

The correlation between business image and environmental sustainability metrics is also illustrated in Table 2.4. Organisations are driven to adopt sustainability metrics to improve their reputation, public image, and market standing. Ohene et al. (2023) asserted that sustainable practices enhance organisational credibility and stakeholder trust. Zhang et al. (2021) elucidated that organisations are progressively implementing green construction techniques to enhance corporate branding and competitiveness. Thus, measures like sustainable materials, energy-efficient systems, and carbon reduction initiatives are frequently employed to exhibit environmental commitment.

Client demand and market competitiveness are also associated with the adoption of environmentally sustainable measures. Darko and Chan (2021) discovered that heightened client expectations for environmentally friendly and sustainable structures compel organisations to incorporate sustainability elements into project designs. This relationship is evident in the incorporation of metrics like interior environmental quality, sustainable materials, and efficient resource management, which enhance building performance and market value.

Environmental responsibility is closely linked to metrics such as carbon emission reduction, waste management, and pollution control. UNEP (2022) highlighted that the construction sector exerts considerable environmental impacts, therefore amplifying the necessity for sustainable building methods. The IPCC (2023) emphasised the necessity of mitigating greenhouse gas emissions using sustainable design and construction methodologies. These environmental issues compel organisations and designers to adopt metrics that reduce adverse ecological effects. Moreover, the enhancement of occupant welfare is associated with indices pertaining to indoor environmental quality, ventilation, illumination, and thermal comfort. The World Green Building Council (2021) asserts that sustainable buildings enhance occupant health, comfort, and productivity. Allen et al. (2020) similarly elucidated that enhanced indoor settings augment user contentment and wellbeing. This encourages designers to integrate sustainability metrics that improve the quality of interior environments. Innovation and technical progress also affect the application of environmentally sustainable indicators. Mahmud et al. (2022) observed that sustainable construction promotes the utilisation of novel technology, including smart energy systems, renewable energy integration, and advanced construction techniques. This link illustrates that technical innovation facilitates the attainment of environmental sustainability goals in construction projects.

Table 2.4 illustrates that the adoption of environmentally sustainable indicators is significantly affected by many interrelated motivational factors. The table is important as it delineates a conceptual connection between the reasons described in the literature and the sustainability indicators analysed in the research. This relationship further substantiates the analytical discourse in Chapter 4 by offering a framework for comprehending the prioritisation of specific environmental sustainable indicators by building designers in privatised building projects in Malaysia.

In context of privatised building projects in Malaysia, the motivations that have been explained need to be investigated based on the views of the building designers in Malaysia. In conclusion, Table 2.5 sum up the environmentally sustainable indicators examined in the literature study and to illustrate their correspondence with the research questions. The table establishes a distinct link between the theoretical discourse in Chapter 2 and the data collection methodology outlined in Chapter 3. This alignment guarantees uniformity across the research and verifies that the interview questions were constructed based on the environmental sustainability themes described in the literature.

Table 2.5 Categorisation of Environmental Sustainable Indicators and Research Questions

Environmental Sustainable Indicators	**Description from Literature**	**Related Research Question**	**References**
Carbon Emission	Strategies to minimise greenhouse gas emissions and environmental impacts	How can sustainability implementation be improved in PBPIM	WGBC (2021); Alllen et al. (2020)
Embodied Energy	Reduction in energy consumption through passive design, efficient systems and renewable energy integration	How can sustainability implementation be improved in PBPIM	Kylili et al. (2016); UNEP (2022); IEEA (2023)
Renewable and environmentally preferable products	Use of environmental friendly, recyclable and low-carbon materials.	What motivates implementation of environmental sustainable indicators	Soust-Verdaguer et al. (2016); Anderson (2015)
Less Waste	Reduction, reuse and recycling of construction and operational waste	What limitations affect sustainability implementation.	Toller et al. (2013); Shen et al. (2007)

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter examines the research methodology and proposes the research methodology framework that provides an overview of the whole research strategy. It starts with a discussion of the qualitative approach. In addition, to provide more insights into the research instrument used for the research, the interview questions design is thoroughly explained. In relation to that, analytical techniques used to analyse the collected data are also presented in this chapter which include Severity Index, Relative Importance Index and Narrative Analysis. Lastly, this chapter concludes with a summary.

3.2 Research Philosophy

The study used an interpretivist research philosophy to comprehend the perspectives, experiences, motivations, and limitations faced by building designers in the application of sustainability. The research inquiries concentrate on comprehending human experiences and professional assessments rather than quantifying objective numerical correlations. The study questions examine what environmental sustainable indicators are utilised, what motivates them, what constraints hinder their execution, and how may sustainability practices be enhanced. These inquiries necessitate the examination of subjective experiences and contextual comprehension. Consequently, the interpretivist philosophy is suitable since it facilitates a comprehensive knowledge of social and organisational reality within PBPIM. The philosophy consequently fits with the research objective by establishing a basis for examining how industry practitioners comprehend and experience sustainability implementation.

The qualitative study approach was used to study sustainability implementation challenges that cannot be adequately explained through quantitative analysis alone. The qualitative methodology facilitates an in-depth examination of sustainable practices, implementation challenges, organisational behaviours and professional experiences This methodology directly addresses the research objectives as the study aims for explanatory and interpretive insights rather than statistical forecasting. For instance, questions concerning motivations necessitate that respondents explain the rationale for the adoption of sustainability strategies. Questions regarding limitations necessitate an in-depth examination of the practical limitations encountered during implementation. The qualitative approach thus facilitates the examination of sustainability implementation within its actual context.

Structured interviews were utilised as the principal research method because of their capacity to gather comprehensive information from architects, engineers, and building designers engaged in PBPIM. The interviews directly engage with the study questions by allowing respondents to articulate indicators of environmental sustainability applied in projects, factors motivating the implementation, limitations hindering sustainability practices, and suggestions for enhancing the implementation. The interview technique thus guarantees that the data gathered are directly pertinent to the research aim and objectives. Moreover, interviews provide the clarification and exploration of responses, so enhancing the depth and quality of information gathered concerning sustainability implementation techniques.

Purposive sampling was chosen as the research necessitates participants with expertise and professional experience in sustainable building design and PBPIM. The sample technique corresponds with the research objectives, as only seasoned specialists may offer pertinent views regarding implementation of sustainability, decision-making throughout the design phase, environmental indicators, and challenges specific to the project. Choosing architects and engineers for privatised building projects guarantees that the results directly respond to the research inquiries and aims of the study. The structured interview questions were created in accordance with the research objectives and literature review. Every section of the interview instrument aligns precisely with the research questions.

Table 3.1 Connections between research questions and data collected

Research Questions	Data Collected
What environmental sustainable indicators are implemented?	Information regarding sustainability practices and indicators
What motivates the implementations?	Respondents' views on motivation and incentive
What limitations affect the implementation?	Experience relating to limitations and challenges
How can implementation be improved?	Recommendations and professional advice

This illustrates that the data collecting procedure was meticulously crafted to get the information necessary to address the research questions and fulfil the objectives. Narrative interpretation, Relative Importance Index (RII), and Severity Index were employed to analyse the gathered data. These analytical methods correspond with the research questions as they facilitate the research to rank the environmental indicators, motivations and constraints, analyse respondents' experiences, and compare findings with existing literature. The analysis therefore converts the gathered data into significant insights that directly pertain to the research objectives. The application of RII and Severity Index facilitates the interpretation process by determining the relative importance of sustainability variables, whilst thematic analysis offers a more profound comprehension of respondents' viewpoints.

The conceptual framework establishes connections on motivating factors, implementation limitations, environmentally sustainable indicators, and sustainable design results. The framework corresponds with the research questions since it visually illustrates the linkages examined in the study. It also directs the comprehensive framework of the research by interconnecting the literature review, methodology, findings, and discussion. Each element of the study design was meticulously chosen to facilitate the attainment of the research objectives and to address the research questions proficiently. The interpretivist philosophy, qualitative methodology, structured interviews, purposive sampling, and analytical techniques combined establish a cohesive framework for examining the implementation of environmentally sustainable indicators in PBPIM.

3.3 Research Design

Research design is considered a systematic framework for data collection in a study. It seeks to address the research questions or evaluate the research hypotheses through three distinct processes: data collecting, development of the research instrument, and sampling. Yin (2009) identified four problems in research design: formulating research questions, identifying relevant data, determining data to acquire, and analysing data. Generally, research design encompasses the identification of the research population, the selection of a sampling technique, data collecting, and the formulation of a questions. This research employed interpretivism as its philosophical frameworks and adopted a qualitative approach. In the context of research methodologies, this research included interviews to gather the necessary data.

Interviews are utilised for data gathering in this research due to their statistical framework, enabling generalisations to be drawn for the full population represented by the research sample (Fellows and Liu, 2015). Furthermore, the qualitative methods are deemed highly suitable for this research due to their cost-effectiveness and significant time efficiency. With ease, the researcher can acquire the necessary data for further study. Interviews were conducted both online and in person, based on their convenience. The respondents for this research are located all around Malaysia and with the help of the technology researchers need not spend high costs of administration.

3.3.1 Population of Research

In line with Eisenhardt (1989), the population of the research is crucial as the sample will be derived from the entities defined by the population. Before a study sample can be drawn, it is essential to first define the research population. The research population comprises building designers in Malaysia. The building designers are identified using a list sourced from the Board of Architects Malaysia, LinkedIn, prior connections, past colleagues, the Institution of Structural Engineers Malaysia, and acquaintances. The lists provide the complete names of each member along with their organisation, position, and contact information.

3.3.2 Research Instrument

A research instrument is described as a tool for measuring or documenting study data (Creswell, 2012). Primarily, the research instrument consists of questions created during the preliminary phases of the study, concerning the literature review. Akogun (2000) said that a research instrument is employed to gather data from a designated population to fulfil the aims and goals of the research. This research uses an interview as the research tool to accomplish its aims and goals. Creswell (2009) asserts that interviews generate qualitative data concerning participants' experiences, perceptions, and professional judgements.

Blaxter et al. (2001) noted that the administration and distribution of an interview may be conducted in many methods. For example, an interview can be conducted and disseminated over the internet and online platforms, in person through face-to-face interactions or over the phone. Each method presented possesses distinct benefits and limitations; nonetheless, based on the study requirements, each facilitates convenient and successful data collection.

As already stated, in this research, interviews are employed as the research tool. This is due to its significant affordability and convenience for respondents to submit their answers (Idrus, 2001). The questions are designed based on the literature study. The interviews are conducted via an online platform and in person. Conversely, a pilot study is undertaken prior to administering the interview to the research population. The objective of the pilot study is to ascertain that the interview questions are pertinent, coherent, and comprehensible. The participants for the pilot study are purposively selected to test clarity and relevance of the interview questions, representing 30% of the overall population. Following the feedback from the respondents, small adjustments are made to the interview questions before to the administration of the interviews.

3.3.2.1 Design of the Interview Questions

Following the literature study in Chapter 2, a series of interview questions have been designed to assess the limitations and motivations of implementing the environmental sustainable indicators for privatised building projects in Malaysia. The interview questions consist of five sections: Section A: Profile and background of participants; Section B: Environmental sustainable indicators; Section C: Limitations to implementing the environmental sustainable indicators during the design phase of PBPIM; Section D: Motivations for implementing the environmental sustainable indicators during the design phase of PBPIM; and Section E: The implementation of sustainable environmental indicators. Table 3.2 delineates the specifics of each part included in the interview questions.

Table 3.2 Details of interview questions

Section A	Profile and background of participants
Section B	Environmental sustainable indicators
Section C	Limitations to implementing the environmentally sustainable indicators during the design phase of privatised building projects in Malaysia
Section D	Motivations in implementing the environmental sustainable indicators during the design phase of privatised building projects in Malaysia
Section E	The implementation of sustainable environmental indicators

In Section A, participants must disclose their profession, years of experience in designing building projects and engagement in privatised building projects.

1. Which of the following best describes you?

	An Architect
	An Engineer (Please specify: Civil / Structural / etc):
	Others (Please specify):

2. What are your years of experience in designing building projects?

	Less than 1 year
	1 to 5 years
	6 to 10 years
	More than 10 years

3. Have you been involved / are you currently involve in private building projects?

	Yes
	No

Figure 3.1 Structured interview questions in Section A

In Section B, the participants are asked to rank the environmental sustainable indicators.

4. Please rank (from 1 – 4) the following environmental sustainable indicators one would considered when selecting for materials during design process with 1 being the highest and 4 the lowest.

1.	Greenhouse gas emission	
2.	Renewable and environmentally preferable products (using material that maximize renewable and environmental friendly)	
3.	Embodied energy (energy consumed by the material).	
4.	Less waste (using recycled materials)	

5. During design process, would you consider sustainable indicators for decision making?

	Yes
	No

Figure 3.2 Structured interview questions in Section B

Meanwhile, in Section C the participants must assess the severity of limitations implementing the environmental sustainable indicators during the building phase in PBPIM. They are to utilise the following Likert scale for their evaluations: 1 –Least severe; 2 – Mild; 3 – Moderate; 4 –severe; and 5 – Most Severe, as illustrated below.

		Least Severe	Mild	Moderate	Severe	Most Severe
1.	Lack of motivation					
2.	Insufficient and unavailability of data					
3.	Weak collaboration between stakeholders					
4.	Lack of training					

Figure 3.3 Structured interview questions in Section C

Section D of the structured interview questions request participants to indicate the significance degree of implementing sustainable environmental indicators during the design phase of PBPIM. The participants must specify the degree of significance utilising the below Likert scale: 1 – Least Important; 2 – Unimportant; 3 – Moderate; 4 – Important; and 5 – Very Important, as illustrated in below.

		Least Important	Unimportant	Moderate	Important	Very Important
1.	Establish standard and guideline					
2.	Develop framework					
3.	Define parameters and assumptions					
4.	Develop model based on case studies					

Figure 3.4 Structured interview questions in Section D

Finally, in Section E, participants are afforded the chance to provide their opinions and ideas about the implementation of environmental sustainable indicators during the design process for PBPIM. Seemingly, the five-point Likert scale is utilised for the majority of the questions. The Likert scale is a widely recognised instrument utilised in research (Leming, 1997). This is due to its several advantages, including seamless development and management

In terms of data collection, the researcher interviewed face-to-face and via an online meeting. It is discovered that this approach is suitable, convenient and fast for both the researcher and participants when answering questions. Their identity is hidden and remain anonymous to encourage their involvement. The participation information sheet was given upfront before the interview was conducted stating that the answers will be used only for academic purposes. Furthermore, the researcher alerted the participants that, should they express interest in the study, they would receive a summary report following the completion of the study.

3.4 Research Methodology

Research, according to Creswell (2017), is the process of gathering and analysing information to improve an understanding of a topic. To put it differently, the research examines a problem employing diverse systematic methodologies. Research can be characterised as a "voyage of discovery" (Fellows and Liu, 2015), irrespective of whether the researcher made a significant finding. A research endeavour often has three tasks: formulating a topic, collecting data to address it, and presenting the results. Additionally, Fellows and Liu (2015) define research as a collection of tactics employed to achieve the specified aims and objectives of a study. Kreuger and Neuman (2006) characterised methodology as linked to philosophical deduction and the ethical criteria that a researcher must consider. Fikri Mohamed (2006) identified four essential principles inherent to research, which include:

a) Bias; is described as any situation that distorts data, whether collectively or individually. Two origins of bias are personal prejudice and cultural factors (Neuman, 2005). Therefore, it is imperative for a researcher to meticulously identify sources of bias and subsequently mitigate them. Fellows and Liu (2015) elucidated that bias can insidiously influence research across various stages, including data collection and analysis.

(b) Validity; As stated by Fellows and Liu (2015), validity pertains to the capacity of an instrument to accurately evaluate the idea it is designed to assess. To generate superior empirical research, Rowley (2002) proposed that three types of validity must be considered: construct validity, internal validity, and external validity. The former can be accomplished by developing a suitable technique to evaluate the study proposal. Internal validity, as defined by Leedy and Ormrod (2001), pertains to the capacity of the research design and data to enable the researcher to infer causal linkages and effects within the study. Finally, Kreuger and Neuman (2006) defined external validity as the capacity to extrapolate and generalise results from a specific sample to the broader population.

(c) Reliability; In the context of reliability, Yin (2003) clarified that a test must yield comparable results under consistent conditions. To put it differently, Reliability signifies that if the identical test is conducted under comparable conditions, analogous results must be achieved. Utilising a dependable instrument in research is crucial to ensure that situational influences do not compromise the study's integrity.

Finally, (d) Generalisability; This idea pertains to the extrapolation of study findings or conclusions to a broader population. Fikri Mohamed (2006) elucidated that the notion of generalisability pertains to the extent to which a study sample accurately represents the overall population under investigation.

3.5 Research Framework

The research employed interpretivism philosophy through qualitative research methodology selected as the research design. Primary data is gathered by interviews. Thereafter, interpreted data is analysed, and conclusions are derived from the interpretation. Figure 3.5 depicts the research methodology framework employed for the study.

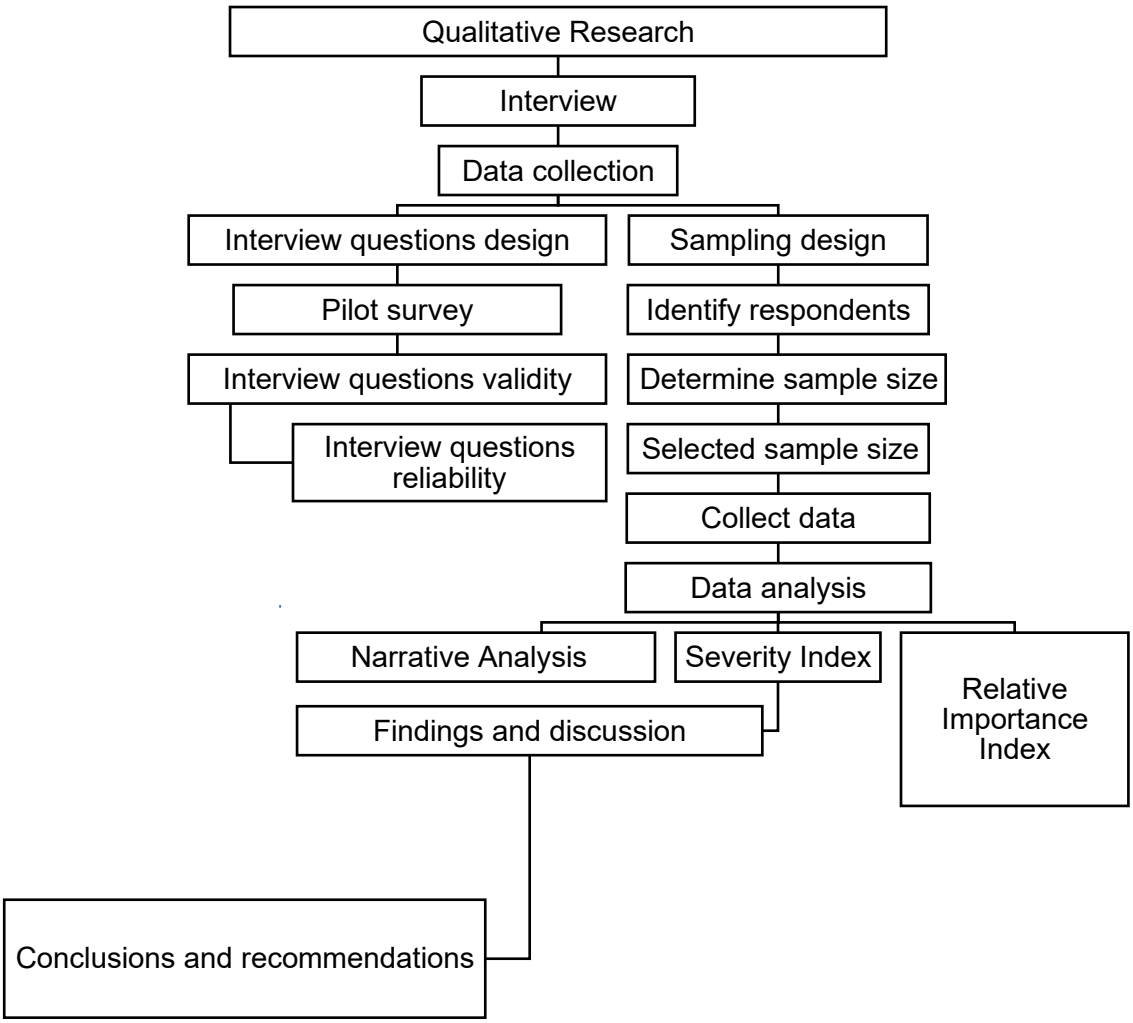

Figure 3.5 Research methodology flowchart

Figure 3.5 shows the comprehensive research methodology framework utilised in this study. The flowchart illustrates the sequential procedure employed to fulfil the research aim and objectives for the integration of environmentally friendly indicators throughout the design phase of Privatised Building Projects in Malaysia (PBPIM). The study employs a qualitative research methodology based on interpretivism philosophy. Primary data were obtained via interviews with chosen architects engaged in privatised building projects.

The initial phase of the framework entails the formulation of interview questions. Before the actual interviews, a pilot survey was administered to assess the validity and reliability of the interview questions. This method guaranteed that the questions were appropriate, comprehensible, and able to elicit precise and pertinent responses from the participants. The second step pertains to the sampling design, encompassing the identification of respondents, the determination of sample size, and the selection of appropriate participants for the study. The participants mostly comprised architects and engineers with pertinent expertise and experience in the implementation of sustainability in privatised building projects.

Subsequent to the sampling process, the following phase is data collecting, during which interviews were executed to acquire qualitative information from the respondents. The gathered data were subsequently analysed through various methods, specifically Narrative Analysis, Severity Index (SI), and Relative Importance Index (RII). Narrative analysis was employed to elucidate and analyse respondents' perspectives and experiences with the implementation of environmental sustainability. Simultaneously, the Severity Index and Relative Importance Index were utilised to rank and assess the significance of identified constraints and incentives related to the implementation of environmentally sustainable indicators in PBPIM

The analysed findings were thoroughly discussed prior to the formulation of conclusions and recommendations. The concluding phase of the framework aids in formulating advice and recommendations to enhance the application of environmentally sustainable indicators during the design phase of privatised building projects in Malaysia.

3.6 Research Method

This study employed a qualitative research method consistent with the interpretivist research philosophy outlined in Section 3.2. Data were collected through structured interviews with architects and engineers who had experience of privatised building projects in Malaysia (PBPIM). The interviews explored participants' perceptions of environmental sustainable indicators, the motivations for their implementation, the limitations encountered during the design phase, and recommendations for improving current practice. Interview data were analysed primarily through narrative interpretation. The Severity Index (SI) and Relative Importance Index (RII) were used only as descriptive ranking tools to summarise participants' assessments and were not used for statistical inference or hypothesis testing.

This research aims to investigate the implementation of the environmental sustainable indicators during the design phase of privatised building projects in Malaysia. It is crucial to choose the most suitable research philosophy and approach, which will subsequently inform the appropriate research strategy necessary to fulfil the research aim and objectives (Creswell, 2017).

Research methodologies connect philosophical perspectives, research frameworks, and research approaches. Despite being largely implicit in research, philosophical perspectives must be recognised since they can impact the research method (Fellows and Liu, 2015). Figure 3.6 below illustrates research method.

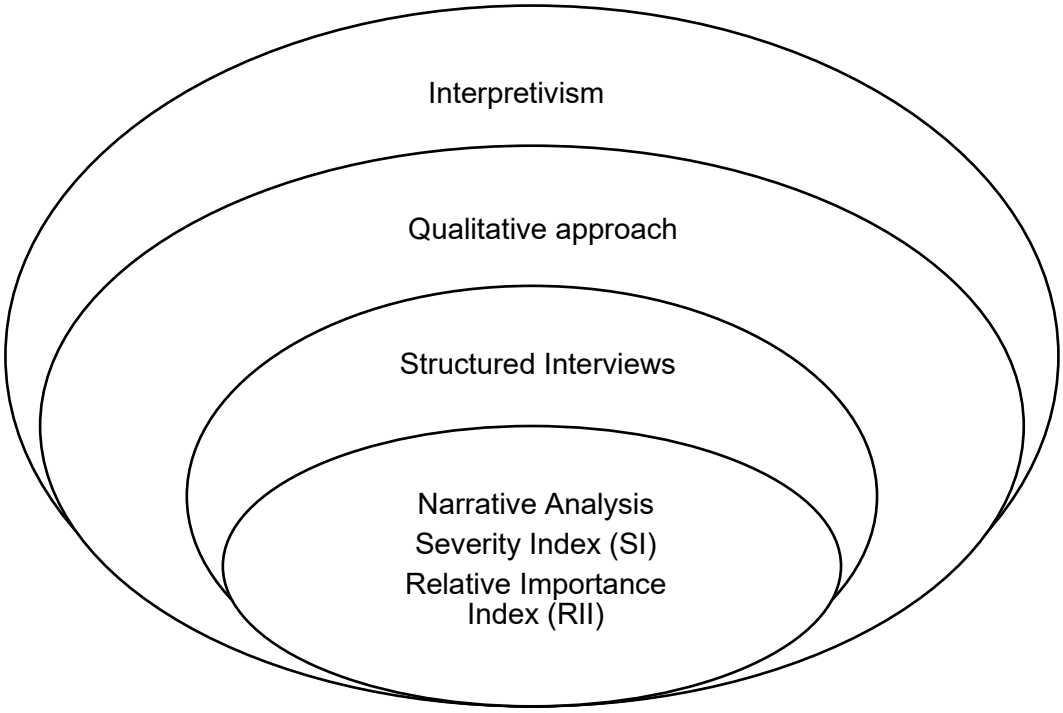

Figure 3.6 Research philosophy and methodology

According to Figure 3.6, research philosophy is the fundamental premise of research. The presence of research philosophy enables researchers to formulate and choose the most suitable research methodologies and approaches. The research methodology encompasses the several methodologies previously outlined, including quantitative, qualitative, and mixed methods approaches. This method can be suitably chosen about the overarching research philosophy. Subsequent, research procedures encompass all accessible data collection methods, including self-administered surveys, interviews, focus groups, and others. Regarding research methodologies, researchers typically employ multiple techniques to get adequate and accurate data for their studies. The presence of multiple techniques enables them to enhance one another.

To accomplish the aims and objectives of this research, a qualitative approach was employed, grounded interpretivist philosophy. Interviews are employed as research instruments to gather data from building designers. Thereafter, the gathered data is analysed using Severity Index (SI), Relative Importance Index (RII) and narrative analysis. Consequently, a qualitative approach is employed in this research, involving interviews with all building designers to fulfil the research aim and objectives.

Figure 3.6 demonstrates the importance of research philosophy in directing the entire research process. The image illustrates that research philosophy constitutes the foundational ground for the selection and development of research methodologies, approaches, and procedures. The figure indicates that research philosophy affects the choice of suitable research methodology, encompassing quantitative, qualitative, and mixed methods approaches. The graphic highlights that the researcher's philosophical perspective influences the interpretation of information, the collection of data, and the analysis of findings.

The picture additionally illustrates that research methodologies, including interviews, surveys, focus groups, and observations, are formulated according to the chosen study approach. This suggests that the research philosophy indirectly influences the methodologies employed for data gathering and analysis This research employed interpretivist philosophy utilising a qualitative research methodology. The statistic thus substantiates the rationale for choosing interviews as the principal research method for gathering data from architectural designers engaged in Privatised architectural Projects in Malaysia (PBPIM).

Furthermore, the figure underscores that the selected philosophy guarantees coherence among the study aims, objectives, methodology, and analytical tools. This study employed the Severity Index (SI), Relative Importance Index (RII) and narrative analysis to properly analyse the obtained data and fulfil the research objectives. Figure 3.6 illustrates that research philosophy is crucial as it establishes the conceptual framework that directs the entire research design, encompassing methodological selection, data interpretation, and conclusion formulation.

3.6.1 Qualitative Approach

Creswell (2017) characterised the qualitative approach as a process of investigation aimed at comprehending human or societal experiences through various methodologies of inquiry. In contrast to the quantitative approach, this approach assumes that reality cannot be measured. This strategy entails researchers developing their comprehension of the research concerns, typically involving intricate situations and contexts in the investigation. Data gathered using qualitative methods are frequently abundant in substance. The questions formulated are typically broad and generic, allowing respondents to formulate their interpretations and perceptions when providing answers for the research. Crotty (1998) concurs that the qualitative approach is predominantly inductive, with researchers generally deriving meaning and understanding from the data gathered from respondents.

3.7 Data Analysis

As mentioned earlier, this research employed a qualitative approach and utilised an interview as the instrument to get the necessary data from the research population. Usually, the gathered data is classified as ordinal due to the ambiguity of the ranks assigned via the five-point Likert scale. The rankings solely represent the relative severity, importance, and significance of particular factors, rather than disclosing their overall magnitude or relevance to one another. The data gathered in this research is examined using both non-parametric and parametric methods.

Data collected from Section A: Profile and background of participants is examined using percentages, as per the interview questions design outlined in 3.5.3.1. As for Section B, the analysis is done using median. Next, regarding the limitations to implementing the environmental sustainable indicators during the design phase of PBPIM, the limitations are prioritised according to the International System of Unit (SI) calculations. SI calculations have been employed in numerous prior studies; for example, Assaf and Al-Hejji (2006) utilised SI to prioritise the reasons of delays in large building projects according to the severity rankings provided by participants. Likewise, Le-Hoai et al. (2008) assessed the factors contributing to cost overruns in Vietnam through SI calculation.

Furthermore, the Relative Importance Index (RII) is computed for the motivations for implementing the environmental sustainable indicators for PBPIM. Numerous studies employ RII calculations; for instance, Enshassi et al. (2009) utilised RII to assess the perceptions of diverse respondents regarding the performance characteristics of construction projects in Gaza. Also, Odusami (2002) computed the RII to prioritise the essential talents that construction project directors should possess, as shown by the rankings provided by the research participants.

Besides, before the calculation of SI and RII for the limitations and motivations for implementing the environmental sustainable indicators during the design phase in PBPIM, the normalisation of the obtained data is examined. Driscoll et al. (2000) assert that statistical analyses rely on the presumption that the gathered data follow a normal distribution. Field (2009) affirmed that the normality of acquired data must be regarded with seriousness; otherwise, accurate and reliable conclusions cannot be attained. Field (2009) asserted that the normality of acquired data must be regarded with seriousness; else, accurate and reliable conclusions cannot be attained.

Therefore, the normality of the gathered data for both limitations and motivations for implementing the environmental sustainable indicators during the design phase of PBPIM is assessed using Skewness, Kurtosis, and Shapiro-Wilk tests. Chua (2014) indicated that data is considered regularly distributed if the values of Skewness and Kurtosis fall between -1.96 and +1.96. Furthermore, he stated that according to the Shapiro-Wilk test, the p-value (significance) of the collected data must exceed 0.05. This research used the Shapiro-Wilk test to assess data normality, as it is deemed suitable for small sample sizes according to Shapiro and Wilk (1965). Royston concurred that the test is appropriate for study samples above 3 but not surpassing 5000. Table 3.2 succinctly presents the specifics of the research analysis methodologies.

In Section E. the analysis is done using the narrative analysis method. Narrative analysis is a research methodology that emphasises the interpretation of human experiences and motivations via the examination of the narrative's individuals convey within particular contexts (Saraf, 2023; Luminoso, 2024). This methodology examines extensive participant answers or narratives as data to identify themes and meanings, utilising sources such as interviews, monologues, written accounts, or recordings. Through the analysis of narrative structure, content, and performance, researchers can acquire insights into participants' experiences, beliefs, and values, thus enhancing the comprehension of how individuals interpret their lives and the surrounding world (McLeod, 2024).

Table 3.3 Research analysis methodologies

No.	Section	Research Instrument	Research Analysis Methodologies
A.	To provide profile and background of participants	Interview	Percentage
B.	To rank the environmental sustainable indicators during the design phase of privatised building projects in Malaysia.	Literature review and interview	Median
C&D	To investigate the limitations and motivations for implementing the environmental sustainable indicators during the design phase of privatised building projects in Malaysia.	Literature review and interview	Normalisation, Severity Index and Relative Importance Index
E.	To provide guidance and recommendations in implementing the environmental sustainable indicators during the design phase of privatised building projects in Malaysia.	Literature review and interview	Narrative analysis

To attain the initial objective, the normality of the data is assessed using Skewness, Kurtosis, and Shapiro-Wilk tests, as indicated in Table 3.3 above. Subsequently, SI and RII are computed for the respective limitations and motivations for implementing the environmental sustainable indicators during the design phase of PBPIM. In reference to previous studies that employed SI as an analytical technique, SI can be computed using the following equation (3.1) (Assaf and Al-Hejji, 2006; Le-Hoai et al., 2008):

$$\mathrm{SI} = \sum \frac{a\left(\frac{n}{N} x 100\right)}{5} \tag{3.1}$$

here a = a fixed weight assigned to each response (ranging from 1 to 5), n = the frequency of the responses, N = the total number of responses. The SI allows the researcher to prioritise the limitations to implementing the environmental sustainable indicators during the design phase PBPIM based on their severity. Furthermore, regarding the motivations for implementing the environmental sustainable indicators during the design phase of PBPIM, the RII is computed, and according to previous studies, it may be determined using the following equation (3.2) (Enshassi et al., 2009; Odusami, 2002):

$$RII = \sum \quad \frac{W}{A * N} \tag{3.2}$$

where W represents the weight assigned to each response (ranging from 1 to 5), A denotes the maximum response integer (5), and N signifies the total number of responses. The RII enables the researcher to assign a priority ranking to the environmental sustainable indicators as well as the motivations for implementing the environmental sustainable indicators during the design phase of Malaysian privatised building projects.

3.8 Research Limitations

Each research study possesses specific limitations that may influence the breadth, interpretation, and generalizability of the results. Recognising these limits is crucial as it reflects transparency, academic integrity, and an understanding of the constraints faced during the research process. This study highlighted various constraints with the investigation of the implementation of environmentally sustainable indicators during the design phase of Privatised Building Projects in Malaysia (PBPIM). The study concentrated exclusively on the design phase of privatised building projects in Malaysia. Consequently, the findings may not comprehensively reflect sustainability implementation techniques in other project phases, including building, operation, or maintenance.

The research primarily focused on the viewpoints of building designers, specifically architects and engineers, due to their significant involvement in the design phase. As a result, the perspectives of additional stakeholders, including contractors, facility managers, policymakers, and end users, were not thoroughly analysed. The study employed a qualitative research methodology utilising structured interviews with a restricted number of participants. While qualitative approaches offer comprehensive insights into sustainability implementation challenges, the limited sample size may restrict the generalizability of the results to the broader Malaysian construction sector.

The findings thus represent the experiences and perspectives of the chosen participants, rather than encompassing all experts engaged in privatised building projects in Malaysia. The research depended on respondents' professional insights, experiences, and self-reported data. Consequently, there exists a potential for subjective bias in the responses elicited during the interviews. Certain respondents may have perceived the implementation of sustainability variably, influenced by their distinct professional backgrounds, organisational contexts, and project experiences.

The study largely concentrated on environmental sustainable indicators and did not thoroughly examine the economic and social aspects of sustainability. The research deliberately restricted its attention to environmental sustainability, despite the broader concept encompassing environmental, economic, and social dimensions, to ensure depth of analysis. Consequently, the results may not offer a comprehensive evaluation of sustainability implementation from a wider triple-bottom-line viewpoint.

The restricted availability of documented information and case-specific sustainability statistics for privatised building projects in Malaysia presented limitations during the research. Certain organisations may impose limitations on access to project information owing to confidentiality issues, organisational policies, or commercial sensitivities. This constraint may have influenced the accessibility of comprehensive sustainability performance data for analysis. Moreover, time and resource constraints affected the extent of the investigation. The investigation was conducted within a defined of time and geographical framework due to time constraints. A comprehensive inquiry with an increased number of participants, diverse project categories, or comparative international analysis could yield more extensive data and profound insights into sustainability implementation strategies.

Notwithstanding these constraints, the study offers significant insights into the application of environmentally sustainable indicators during the design phase of PBPIM. The results enhance the comprehension of sustainability practices, motivations, and implementation limitations encountered by building designers in Malaysia. The limitations revealed in this study present potential for future research to broaden the examination by incorporating additional stakeholders, greater sample sizes, quantitative methodologies, and comparative analyses across other project kinds and nations.

3.9 Pilot Study

A pilot study was performed before the primary data collection to assess the appropriateness, clarity, and efficacy of the research instrument used in this study. The pilot study is a crucial preliminary phase in research as it identifies any shortcomings, ambiguities, or practical concerns related to the interview questions and research techniques prior to the actual study. This research conducted a pilot study to evaluate the structured interview questions created for examining the implementation of environmental sustainable indicators during the design phase of Privatised Building Projects in Malaysia (PBPIM). The pilot study confirmed that the interview questions were pertinent to the research aim, comprehensible to the respondents, and capable of producing significant and dependable data concerning sustainability implementation strategies.

The pilot study included a small number of participants comprising participants with similar characteristics those of the real respondents chosen for the primary study. The pilot study facilitated the assessment of the appropriateness of the questions within the PBPIM context, and the clarity and professional relevance of the terminology employed in the interviews. In the pilot study, participants were requested to evaluate and answer the interview questions. Feedback was obtained concerning clarity of the questions, appropriateness of the terminology, relevance of the sustainability indicators, structure of the interview, and general appropriateness of the research instrument.

Based on the input obtained, numerous improvements were implemented to optimise the interview questions and strengthen the efficacy of the data collection process. Ambiguous or redundant inquiries were modified to enhance clarity and coherence. Certain technical terminology was reduced to enhance comprehension among responders, and the order of questions was modified to facilitate the flow of the interview sessions.

The pilot study facilitated the estimation of the approximate duration for each interview and identified potential practical issues that may occur during the primary data gathering procedure. This facilitated the researcher in enhancing interview management and ensuring more effective communication with respondents during the study. Moreover, the pilot study enhanced the validity and reliability of the research instrument. Through pre-testing the interview questions before to the primary study, the researcher validated that the questions could elicit information pertinent to the research aim, objectives, and inquiries. The pilot study consequently enhanced the overall quality and reliability of the research approach.

The pilot study ensured coherence among the interview questions design, conceptual framework, and environmental sustainable indicators examined in the literature review. This was crucial in guaranteeing that the gathered data would adequately facilitate the examination of sustainability implementation inside PBPIM. The pilot study significantly contributed to refining the research instrument, augmenting data collection quality, minimising potential errors, and confirming the methodology's appropriateness for examining the implementation of environmentally sustainable indicators during the design phase of Privatised Building Projects in Malaysia.

3.10 Research Ethics

Research ethics describes the ethical principles and professional standards that govern the conduct of research involving human subjects. Ethical concerns are crucial for doing research responsibly, honestly, and respectfully, while safeguarding the rights, privacy, and well-being of the people involved in the study. This research meticulously adhered to ethical considerations while examining the integration of environmentally friendly indicators during the design phase of Privatised Building Projects in Malaysia (PBPIM). The study entailed gathering data from architects, engineers, and building designers via structured interviews, necessitating the use of many ethical criteria to uphold the integrity and credibility of the research process.

Initially, informed consent was secured from all participants prior to the interviews being conducted. The participants were explicitly explained of the research aim, objectives, and scope. They were told of the nature of their involvement, the anticipated duration of the interview sessions, and the intended utilisation of the gathered material in the study. Participation in the research was wholly optional, and respondents retained the right to withdraw from the study at any point without incurring any adverse repercussions.

Secondly, confidentiality and anonymity were rigorously upheld during the research procedure. The identity of the respondents and their organisations were not revealed in the thesis or any associated publications. Personal information and interview replies were regarded as confidential and utilised exclusively for academic reasons. To safeguard participant anonymity, replies were designated by codes or broad descriptions instead of personal names or firm information. Third, the study guaranteed that volunteers experienced no damage, pain, or professional jeopardy. The interview questions aimed to concentrate on professional experiences and sustainable practices while avoiding emotional distress or reputational risks. The study refrained from gathering extraneous personal or sensitive information not pertinent to the research aim.

The research upheld integrity and transparency in data gathering, analysis, and reporting. The study's findings were derived from the genuine responses of the participants, with no data modified, faked, or misrepresented. All information sources utilised in the literature review and discussion were duly acknowledged through suitable reference and citation methods to prevent plagiarism and uphold academic honesty. The research adhered to institutional ethical standards and academic research protocols. Ethical approval was secured from the appropriate university or faculty research ethics committee before performing the interviews, when necessary. This guaranteed that the study adhered to recognised academic and professional ethical norms. The study also guaranteed the secure management and storage of the data acquired. Interview data, transcripts, and associated materials were securely held and accessible solely by the researcher for scholarly purposes. The data were safeguarded to avert unauthorised access, disclosure, or exploitation.

Ethical considerations significantly contributed to the study's credibility, trustworthiness, and professional integrity. The implementation of ethical principles during the study process safeguarded the rights and interests of participants while ensuring the research was conducted responsibly and in an academically acceptable manner.

3.11 Summary

In summary, this chapter has presented the methodological framework adopted for the study. The research was guided by an interpretivist philosophy and employed a qualitative methodology. Purposive sampling was used to recruit architects and engineers with experience of privatised building projects in Malaysia. A pilot study involving five participants was undertaken to refine the interview schedule; these participants were not included in the main study. Subsequently, eight structured interviews were conducted for the main study. Data were analysed primarily through narrative interpretation, while the Severity Index (SI) and Relative Importance Index (RII) were used to provide descriptive rankings of participants' assessments. Ethical procedures (attached in Appendix), participant confidentiality, informed consent, and secure data management were also described. The following chapter presents the findings and discussion arising from the interview data.

CHAPTER 4

DATA ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter provides an analysis and discussion derived from the research data collected. As described in Chapter 3, a qualitative technique is employed for the research, utilising an interview as the tool for data gathering. This chapter presents the statistical findings of the gathered qualitative data. This chapter portrays the ranking of the environmental sustainable indicators, the limitations and motivations for implementing the environmental sustainable indicators during the design phase in PBPIM, and the implementation of the environmental sustainable indicators. The normality of data distribution is assessed using Skewness, Kurtosis, and Shapiro-Wilk tests for limitations and motivations. Thereafter, the limitations are displayed and prioritised according to the Severity Index (SI) values and mean scores, while the motivations are exhibited and ranked based on the Relative Importance Index (RII) values and mean scores, respectively. The primary aim of this chapter is to guarantee the attainment of the objectives.

4.2 Administration of the Interviews

As previously discussed, the interview questions consisted of five distinct components as outlined in Table 3.3. Besides Section A: Profile and Background of Participants, Section B: Environmental Sustainable Indicators and Section E: The Implementation of the Environmental Sustainable Indicators, all questions in the other sections utilise a five-point Likert scale allowing respondents to express the degree of severity and importance.
Eight participants were interviewed face to face and via Teams meeting. According to (Dworkin, 2012), recommends and suggests anywhere between 5 to 50 participants as adequate.

4.3 Profile and Background of Participants

Table 4.1 illustrates the background of the participants.

Table 4.1 Background of the participants

Profile and background	Frequency	Percentage
Profession		
Architect	4	50%
Engineer	4	50%
Others		
Years of Experience		
1 – 5 years		
6 - 10 years		
More than 10 years	8	100%
Involvement in Privatised Building Projects		
Yes	8	100%
No		

From Table 4.1, a total of 8 participants have been interviewed where 4 of them were architects and the other 4 were engineers (2 structural and 2 electricals). All of them have more than 10 years' experience and have been involved in a privatised building project.

4.4 Environmental Sustainable Indicators

Table 4.2 The environmental sustainable indicators ranking

Item	The environmental sustainable indicators	Rank
1.	Greenhouse gas emission	3
2.	Renewable and environmentally preferable products (using material that maximise renewable and environmental friendly)	1
3.	Embodied energy (energy consumed by the material).	2
4.	Less waste (using recycled materials)	4

Based on Table 4.2, renewable and environmentally preferable products have been ranked as the first indicator the participants would consider during the design process followed by embodied energy, greenhouse gas emission and less waste.

4.4.1 Renewable and Environmentally Preferable Products

The selection of materials was recognised as a significant indicator of environmental sustainability due to its impact on embodied carbon, resource depletion, and the long-term performance of buildings. The respondents recognised that choosing environmentally friendly materials in the design phase can significantly enhance overall life-cycle sustainability performance. Durable and recyclable materials were regarded as essential for minimising maintenance expenses throughout the concession period.

The results corroborate the assertions of Anderson, Wulfhorst, and Lang (2015), who highlighted that material selection profoundly influences embodied environmental impacts. Soust-Verdaguer, Llatas, and García-Martínez (2016) also emphasised the significance of assessing material impacts across the building life cycle. Instances from GreenRE-certified projects in Malaysia illustrate how sustainable materials enhance building environmental performance and facilitate green construction goals.

Nonetheless, respondents said that sustainable materials are frequently regarded as costly and challenging to procure locally. This corresponds with Massoud et al. (2010), who identified that financial constraints and market accessibility often hinder the adoption of sustainability. The findings demonstrate that the selection of sustainable materials is crucial for enhancing environmental sustainability in PBPIM.

4.4.2 Embodied Energy

The results indicated that embodied energy was considered as one of the critical environmental sustainability factor throughout the design phase of privatised building projects in Malaysia. The responders highlighted that energy-efficient design solutions substantially reduce operational expenses during the project's concession period. Given that privatised building projects typically entail long-term operations and maintenance obligations lasting 20 to 30 years, embodied energy is crucial for maintaining cost-effective building performance.

The results demonstrate that building designers are becoming more aware of the correlation between energy usage and total life-cycle costs. This is especially significant for PBPIM, as concessionaires are accountable for sustaining building performance during the concession period. Thus, decreasing energy consumption with appropriate orientation, natural ventilation, daylighting techniques, and efficient HVAC systems can significantly reduce operational costs. The results align with the work of Kylili, Fokaides, and Lopez Jimenez (2016), who recognised energy consumption as a significant category of environmental sustainability in buildings. Wang et al. (2011) underscored that sustainable indicators are vital instruments for enhancing sustainability performance in the building design phase. Russell-Smith et al. (2015) emphasised that initial choices concerning HVAC systems, glazing systems, and building orientation have enduring environmental consequences that are challenging to amend post-project completion.

The results align with Kubba (2010), who asserted that a primary aim of sustainable buildings is to diminish energy use while enhancing occupant comfort and productivity. The participants in this study equally acknowledged that energy-efficient designs enhance sustainability and increase indoor environmental quality for occupants.

A relevant Malaysian example is the Diamond Building in Putrajaya, which incorporates passive design principles, efficient lighting systems, and renewable energy technologies. The structure exemplifies how energy-efficient attributes can diminish operational expenses while improving environmental efficacy. This corroborates the respondents' perspectives that sustainable energy techniques are feasible and attainable in Malaysian construction projects.

Notwithstanding the significance of energy efficiency, the respondents identified numerous hurdles in its implementation. These encompass budgetary constraints, inadequate technical proficiency, insufficient knowledge of sustainability, and opposition to progressive technologies. This conclusion corroborates Elmualim et al. (2010), who highlighted insufficient knowledge and organisational commitment as major limitations to the implementation of sustainability.

4.4.3 Greenhouse Gas Emissions

Respondents acknowledged carbon emission reduction as a crucial sustainability indicator, driven by escalating global environmental concerns and Malaysia's climate obligations. The respondents said that prioritising the reduction of carbon emissions during the design process is essential, as buildings substantially contribute to greenhouse gas emissions. The use of low-carbon design solutions was deemed crucial for facilitating sustainable urban development. The results align with Obringer and Nateghi (2021), who contended that environmental sustainability is fundamental to sustainable development strategies. The results also endorse global sustainability goals advocated by the Paris Agreement and UNEP sustainability frameworks.

Respondents noted that the lack of explicit legislative frameworks and sustainability incentives persists in hindering the development of low-carbon building techniques. This finding aligns with Ikediashi et al. (2012), who identified inadequate government assistance as an impediment to sustainability implementation. The findings indicate that carbon emission reduction must be a fundamental aspect of environmental sustainability in privatised building projects in Malaysia.

4.4.4 Less Waste

Waste management was recognised as a crucial measure of environmental sustainability. The respondents emphasised that construction and demolition debris continue to be significant environmental issues in Malaysia, attributed to escalating urban expansion and insufficient recycling methods. The results demonstrate that participants regarded waste reduction measures as crucial for enhancing environmental sustainability in building development. The participants asserted that efficient waste management strategies might diminish reliance on landfills, enhance resource efficiency, and mitigate environmental contamination. Toller et al. (2013) corroborate the findings, recognising waste management as a critical environmental indicator in the evaluation of sustainable building. Shen et al. (2007) also emphasised that waste minimisation plays a crucial role in sustainable construction techniques. The Industrialised Building System (IBS) projects of CIDB Malaysia exemplify how prefabrication techniques diminish material waste and enhance building efficiency. The use of IBS illustrates the capacity of sustainable construction methods to mitigate waste in Malaysian construction projects.

Notwithstanding these advantages, respondents said that inadequate stakeholder participation and the absence of clear sustainability standards persist in obstructing the effective implementation of waste management. This corroborates the findings of Adewunmi et al. (2012), who found organisational opposition and insufficient coordination as impediments to sustainability practices. The findings indicate that waste management measures must be incorporated at the design phase to enhance the environmental performance of privatised building projects in Malaysia.

4.4.5 Summary

Table 4.3 Comparison of each environmental sustainable indicators to literature and case studies

Environmental Sustainable Indicators	Rank	Comparison with literature	Case Study
Renewable and environmentally preferable products	1	The selection of materials profoundly influences environmental impacts (Pajchrowski et al., 2014) Material indicators are essential in building assessments (Lasvaux et al., 2016)	One Angel Square, UK The project utilised sustainable materials with low embodied carbon and achieved excellent environmental performance.
Embodied energy	2	Energy performance serves as a primary indication of sustainability (Alwaer and Clements-Croome, 2010) Energy indicators dominate sustainability frameworks (Kylili et al.,2016) Energy-efficient design reduces long-term operational costs (Goh and Sun, 2016)	BedZED, UK The Beddington Zero Energy Development (BedZED) project accomplished significant decreases in energy use via passive solar architecture, insulation, and renewable energy sources. The success of BedZED illustrates how decisions made during the design phase can markedly enhance environmental performance. Comparable strategies may be integrated into privatised building projects in Malaysia.
Greenhouse gas emission	3	Buildings contribute significantly to global emissions (IPCC, 2023) The construction sector is accountable for significant carbon emissions (UNEP, 2022) Carbon indicators are crucial for the assessment of sustainability (Toller et al.,2013)	The Edge Building, Netherlands The Edge Building reduced carbon emissions with advanced energy systems, renewable energy production, and intelligent building management technologies. The project illustrates the implementation of carbon-reduction methods that could be integrated into Malaysian PPP projects.
Less waste	4	Waste management constitutes a significant aspect of sustainability (Kylili et al., 2016) Construction waste remains a challenge in Malaysia (Ros et al., 2011)	Hong Kong Public Housing Projects Public housing developments in Hong Kong achieved significant reductions in construction waste through prefabrication and recycling initiatives.

		Waste reduction improves environmental performance (Sarpin et al.,2016)	

4.5 Limitations to Implementing the Environmental Sustainable Indicators during the Design Phase of Privatised Building Projects in Malaysia.

This section delineates the research conclusions derived from the acquired qualitative data.

4.5.1 Analysis Technique for Limitations to Implementing the Environmental Sustainable Indicators during the Design Phase of Privatised Building Projects in Malaysia.

The limitations to implementing the environmental sustainable indicators during the design phase of PBPIM are evaluated using the Severity Index (SI) and mean scores. As described in the preceding chapter of the research, SI has been extensively utilised across various studies, irrespective of their character. SI offers indexes for each limitation, enabling their ranking based on severity levels. The specifics of SI are outlined in section 3.6.

4.5.2 Severity of Limitations to Implementing the Environmental Sustainable Indicators during the Design Phase of Privatised Building Projects in Malaysia.

Subsequently, SI calculations and mean scores are determined for each limitation to implementing the environmental sustainable indicators during the design phase of PBPIM with the findings presented in Table 4.4.

Table 4.4 Severity index and mean score for limitations to implementing the sustainable indicators during the design phase of privatised building projects in Malaysia.

No.	Limitations to Implementing the Environmental Sustainable Indicators during the Design Phase of Privatised Building Projects in Malaysia	SI	Rank
1	Lack of motivation	57.5	10
2	Insufficient and unavailability of data	72.5	6
3	Weak collaboration between stakeholders	80.0	5
4	Lack of training	97.5	2
5	Lack of tools	87.5	4
6	Lack of awareness	87.5	4
7	Financial constraints	70.0	7
8	Lack of well-established standards and methods	100.0	1
9	Time constraints	52.5	11
10	Lack of capabilities/ skills	90.0	3
11	Variety of uncertain parameters and assumptions	67.5	8
12	Unwillingness to implement sustainability	25.0	14
13	Lack of competence in managing the changing attitude process of people and institutions	50.0	12
14	Complicated process	50.0	12
15	Increasing liability	65.0	9
16	Lack of incentive	97.5	2
17	Lack of government support	70.0	7
18	Uncertainty of outcomes and benefits	47.5	13
19	Lack of relevant laws and regulation	67.5	8

4.5.3 Discussion of Limitations to Implementing the Environmental Sustainable Indicators during the Design Phase of Privatised Building Projects in Malaysia

Table 4.4 exhibits a lack of well-established standards and methods, as evidenced by the top ranking with an SI value of 100%. In the absence of standardisation, building designers employ individualised methods for adopting the environmental sustainable indicators leading to inconsistency. Consequently, various tools, such as software and databases, are employed for implementation, resulting in inconsistencies in the implementation of the environmental sustainable indicators. Numerous developing and developed nations have formulated and instituted standards and guidelines for environmental sustainability. In the UK, the Building Research Establishment Environmental Assessment Method (BREEAM) is developed to give guidelines for the implementation of environmental sustainability in buildings and constructed assets. Regrettably, Malaysia lacks a definitive standard or guideline for environmental sustainability that building designers can reference for its implementation. Consequently, building designers are likely to use distinct methodologies for implementation, resulting in inconsistency.

Lack of incentive and lack of training have been ranked second with an SI value of 97.5%. In the absence of incentives, building designers find it difficult to implement the environmental sustainable indicators. Although conceivable, the precision of the implementation of the environmental sustainable indicators cannot be assured. Incentives can manifest as either monetary rewards or motivational factors. Building designers in Malaysia identified the lack of incentive as the second most significant limitation to implementing the environmental sustainable indicators for privatised building projects, potentially attributable to the client's motive. Clients are unable to perceive the short-term advantages of the implementation of the environmental sustainable indicators and can only acknowledge the heightened initial expenditure required. Consequently, building designers experienced diminished motivation from clients to implement the environmental sustainable indicators, resulting in reduced incentives as well. Lack of training constitutes another limitation to the implementation of the environmental sustainable indicators, indicating that extensive training is essential for effective environmental sustainable indicators execution.

Lack of tools and lack of awareness ranked fourth with an SI value of 87.5%. This indicates their unwillingness to implement the environmental sustainable indicators and a deficiency in awareness regarding its implementation. Weak collaboration among stakeholders constitutes an additional limitation to the implementation of the environmental sustainable indicators with an SI value of 80%. This indicates that collaboration among stakeholders enhances the implementation of the environmental sustainable indicators for the projects.

Insufficient and unavailability of data ranked sixth with an SI of 72.5%. The implementation of the environmental sustainable indicators necessitates a substantial quantity of data and supportive technologies, encompassing computational databases, and external collaboration with suppliers and providers. Sufficient data is essential for the implementation of the environmental sustainable indicators. For instance, data regarding energy consumption, water consumption, and other variables. Nevertheless, in Malaysia, the data is scarce and restricted. Consequently, the majority of participants concurred that insufficient data constitutes a significant limitation to the implementation of the environmental sustainable indicators. In the absence of the necessary data, building designers will find it challenging to execute the environmental sustainable indicators for PBPIM. Given that projects are awarded for extended concession periods, the environmental sustainable indicators would be unfeasible due to insufficient data.

Financial constraints and lack of government support ranked seventh with an SI value of 70.0%. This indicates that a significant financial investment is essential for the implementation of the environmental sustainable indicators. Generally, there is a prevailing inclination to minimise initial investments. Consequently, it prompts the government to make decisions on privatised building projects in Malaysia based on short-term considerations rather than evaluating the entire project life cycle. Consequently, building designers for the projects lack motivation from the government to implement the environmental sustainable indicators.

Lack of relevant laws and regulations ranked eighth with an SI value of 67.5%. Furthermore, regarding laws and regulations, participants concurred that it is a principal catalyst for the implementation of the environmental sustainable indicators in PBPIM. One reason may be that laws compel organisations to adhere to regulations, thereby promoting the adoption and implementation of sustainable practices. Compliance by building designers depends on stringent laws and regulations imposed by the government. Therefore, the presence of laws and regulations can improve the implementation of the environmental sustainable indicators for PBPIM. A variety of uncertain parameters and assumptions also ranked eighth with the same SI value.

The implementation of the environmental sustainable indicators is a procedure that consists of a series of parameters. It is a forecasting strategy that necessitates building designers to formulate practical and pertinent assumptions for an extended duration. In PBPIM, building designers must predict and hypothesise for a period of up to 30 years. Consequently, this results in inconsistencies within the foundational concept and methodology of the implementation of the environmental sustainable indicators. The absence of clearly defined parameters and assumptions about the environmental sustainable indicators complicates the successful implementation of the environmental sustainable indicators by building designers in PBPIM.

Increasing liability ranked ninth with an SI value of 65.0%. This suggests that building designers perceive the implementation of the environmental sustainable indicators as an additional burden for themselves. Lack of motivation ranked tenth with an SI value of 57.5%. The absence of motivation frequently results in related issues, such as insufficient incentives provided by the government. Additionally, the government must recognise the advantages that could be derived from implementing the environmental sustainable indicators, or, more succinctly, acknowledge that a greater capital expenditure is justified. For instance, by increasing their investment, they must acquire an energy-efficient structure that will result in long-term cost-effectiveness. The absence of desire to implement the environmental sustainable indicators is justifiably attributed to the fact that long-term advantages may not accrue to the decision maker, or, in other words, lie outside the decision maker's purview. Consequently, building designers in Malaysia concurred that insufficient motivation is a significant limitation impeding the adoption of the environmental sustainable indicators in privatised building projects.

4.6 Motivations in Implementing the Environmental Sustainable Indicators during the Design Phase of Privatised Building Projects in Malaysia.

This section delineates the research conclusions derived from the acquired qualitative data.

4.6.1 Analysis Technique for Motivations for Implementing the Environmental Sustainable Indicators during the Design Phase of Privatised Building Projects in Malaysia.

The motivations for implementing the environmental sustainable indicators during the design phase of PBPIM are evaluated using the Relative Importance Index (RII). As described in the preceding chapter of the research, RII has been extensively utilised across various studies, irrespective of their character. RII offers indexes for each motivation, enabling their ranking based on the level of importance. The specifics of SI are outlined in section 3.6.

4.6.2 Importance of Motivations for Implementing the Environmental Sustainable Indicators during the Design Phase of Privatised Building Projects in Malaysia.

Subsequently, RII calculations are conducted for each motivation in implementing the environmental sustainable indicators during the design phase of PBPIM, with the findings presented in Table 4.5.

Table 4.5 Relative importance index for motivations for implementing the sustainable indicators during the design phase of privatised building projects in Malaysia

No.	Motivations in Implementing the Environmental Sustainable Indicators during the Design Phase of Privatised Building Projects in Malaysia	RII	Rank
1	Reduction in energy consumption	1.000	1
2	Waste reduction	0.800	4
3	Increase productivity	0.750	6
4	Elimination of pollution	1.000	1
5	Sustainable urbanisation	0.850	3
6	Reduction of deforestation	0.675	7
7	Reduction of carbon dioxide emissions	0.975	2
8	Corporate image	0.625	8
9	Pressure from clients	0.450	10
10	Pressure from senior management and stakeholders	0.425	11
11	Market competition	0.600	9
12	Life cycle cost reduction	0.775	5

Table 4.5 presents the analysis of the motivations affecting the adoption of environmentally sustainable indicators throughout the design phase of Privatised Building Projects in Malaysia (PBPIM). The table employs the Relative Importance Index (RII) to prioritise the significance of each motivational component according to the respondents' perceptions. The Relative Importance Index is frequently utilised in construction and sustainability research to assess the relative significance of issues by transforming respondents' assessments into numerical values.

A higher RII score indicates a greater perceived significance of the motivational element. Factors with elevated RII values indicate that building designers significantly acknowledge their role in promoting sustainable practices in privatised building projects. If, for example, legislation and regulations had one of the highest RII values, it signifies that respondents perceive government policies and regulatory enforcement as crucial in promoting the implementation of sustainability. This conclusion corroborates the assertions of Ikediashi, Ogunlana, and Boateng (2014), who underscored that law is a pivotal catalyst for the adoption of sustainability in building projects.

Likewise, motives like long-term operational cost reductions are particularly pertinent to PBPIM, as concessionaires are accountable for the management and maintenance of the structures for prolonged concession durations. Sustainable design solutions can consequently diminish maintenance and operational costs throughout the project lifecycle. This substantiates the assertion by Wang et al. (2011) that the implementation of sustainability enhances overall life-cycle performance. Table 4.5 is essential as it offers practical insights into the characteristics that promote sustainability implementation among building designers in Malaysia. Comprehending these reasons is crucial for enhancing sustainable practices and formulating successful implementation methods for PBPIM.

Moreover, the table contributes in fulfilling the research objectives by delineating the principal motivational elements that affect the adoption of environmentally sustainable indicators. The results can aid policymakers, governmental bodies, and industry professionals in formulating regulations, incentives, and sustainability frameworks that promote the broader use of sustainable practices in privatised building projects The table is pertinent in facilitating the formulation of guidelines and recommendations put forth in this research. Also, table 4.7 is significant as it offers empirical evidence concerning the incentives driving sustainability implementation in PBPIM and lays the groundwork for enhancing environmental sustainability practices in the Malaysian construction sector.

4.6.3 Discussion of Motivations for Implementing the Environmental Sustainable Indicators during the Design Phase of Privatised Building Projects in Malaysia.

Table 4.5 indicates that reduction in energy consumption and elimination of pollution rank first, with a Relative Importance Index (RII) value of 1.000. The decrease in energy usage is regarded as a significant factor that could facilitate the adoption of the implementation of the environmental sustainable indicators in PBPIM. Energy is a critical resource in any building, and the implementation of the environmental sustainable indicators could significantly reduce energy consumption over the extended concession periods of PBPIM. The environmental sustainable indicators are instruments employed to evaluate, quantify, and oversee the effects of human activities on the environment. They furnish essential data that can pinpoint areas for enhancing environmental performance and aid in making decisions that mitigate pollution and foster sustainability. The implementation of these indicators during the design phase can substantially mitigate pollution through numerous means.

Reduction of carbon dioxide emissions ranked second with an RII value of 0.975. The implementation of the environmental sustainable indicators entails measuring, monitoring, and mitigating greenhouse gas emissions to assess and enhance the environmental effect of activities. This is a detailed explanation of the implementation of carbon emissions as a measure of environmental sustainability. Sustainable urbanisation ranked third with an RI value of 0.850. The implementation of the environmental sustainable indicators in sustainable urbanisation enables cities to assess their environmental impacts and monitor advancements towards more sustainable, resilient urban systems. By employing a series of environmental sustainable indicators in domains such as energy, waste, water, air quality, and transportation, municipalities may synchronise their development with environmental objectives, mitigate resource depletion, and enhance citizens' quality of life.

Waste reduction ranked fourth with an RII value of 0.800. Implementing the environmental sustainable indicators in the design phase promotes a proactive strategy for waste reduction. By emphasising material efficiency, utilising digital tools, and engaging with stakeholders, building projects can substantially reduce waste, thereby advancing overarching sustainability objectives. Implementing these techniques mitigates environmental impacts and complies with global sustainable development goals.

Life cycle cost reduction ranked fifth with an RII value of 0.775. Early consideration of implementing the environmental sustainable indicators ensures a decrease in life cycle costs. Consequently, the building designers concurred that communicating the life cycle cost reduction to the government or the client might improve the implementation of the environmental sustainable indicators. While the government or client generally lacks interest in increased investment during the initial phase, proper education or awareness regarding the benefits particularly concerning the potential reduction in life cycle costs through the implementation of the environmental sustainable indicators could effectively persuade them. Consequently, the lowering of life cycle costs is regarded as a crucial factor that could improve the implementation of the environmental sustainable indicators in PBPIM. Moreover, privatised building projects involve long-term contracts; therefore, it is improper to concentrate solely on startup costs, since a significant amount of the total expenses is incurred at subsequent stages. According to Hodges (2005), meticulous planning must be undertaken at the initial phase of development, taking into account the long-term expenses and management of physical assets to guarantee the successful execution of the environmental sustainable indicators.

Increase productivity ranked sixth with an RII value of 0.750. Incorporating sustainability indicators during the design phase enables organisations to develop environmentally friendly products and processes, hence improving productivity and competitiveness. Reduction of deforestation ranked seventh with an RII of 0.675. Implementing the environmental sustainable indicators throughout the design phase is essential for mitigating deforestation. These indicators facilitate the early incorporation of environmental factors in the planning process, guaranteeing sustainable outcomes. Incorporating these indicators during the planning phase enables projects to proactively tackle deforestation issues, thereby maintaining a balance between development and environmental conservation.

Corporate image ranked eighth with an RII value of 0.625. Incorporating environmental sustainable indicators into the design process of a corporate image entails embedding ecological concepts into the creation of branding, marketing materials, and other visual and operational components that characterise a company's identity. By incorporating environmental sustainable indicators into the design phase, a corporation illustrates its commitment to responsible practices while cultivating a corporate image that appeals to environmentally conscious stakeholders.

The market competition ranked ninth with an RII value of 0.600. Incorporating environmental sustainable indicators throughout the design phase for market competition entails integrating measurements that evaluate and improve the ecological impact of a product, process, or service. This strategy guarantees that development is consistent with sustainability objectives and attracts environmentally aware consumers, investors, and regulatory authorities. Through the application of these metrics, organisations can develop competitive, sustainable designs that fulfil customer expectations and regulatory standards, so achieving enduring market success.

Pressure from clients ranked tenth with an RII value of 0.450. Incorporating environmental sustainable indicators throughout the design phase, in response to customer demands, entails integrating precise measurable metrics that correspond with both environmental objectives and client expectations. These metrics facilitate the achievement of sustainability objectives while evidencing a commitment to environmentally responsible actions. Effectively implementing sustainability indicators necessitates a balance of fulfiling customer expectations, complying with environmental standards, and ensuring project practicality. Incorporating these indicators throughout the design process enables firms to proactively address client demands while fostering environmental accountability.

Lastly, pressure from senior management and stakeholders ranked eleventh with an RII value of 0.425. Incorporating environmental sustainable indicators into the design phase, influenced by senior management and stakeholders, necessitates a systematic method to reconcile conflicting priorities while achieving sustainability objectives. By integrating environmental sustainable indicators into the design phase and proactively addressing stakeholder concerns, organisations can guarantee that projects align with environmental objectives while managing pressures from senior management and stakeholders. This methodology necessitates explicit communication, systematic preparation, and ongoing oversight.

4.7 The Implementation of the Environmental Sustainable Indicators

The subsequent findings are derived from the following questions.

4.7.1 Is there any specific software as to how you leverage technology to enhance environmental sustainability in your building design?

Based on the answers obtained during the interview, the use of software tools includes Building Information Modelling like Autodesk Revit, energy modelling software such as the EnergyPlus, and eQuest as well as specialised tools like Ecotech for solar analysis. These tools will allow the designers to stimulate and optimise energy consumption or thermal performance for daylighting and other sustainability metrics before the construction begins.

4.7.2 How do you monitor and evaluate the effectiveness of sustainable practices during the design process?

Based on the interview, some suggested they monitored the effectiveness via a regular check on site while others commented the effectiveness of sustainable practices is monitored through a combination of simulation software, performance metrics tracking and regular design. These typically involve energy modelling tools to predict the building performance, conduct the life cycle assessment, setting the key performance indicators for sustainability goals and implementing the alternative design with sustainability consultants to ensure the targets are met throughout the design process.

4.7.3 Is it necessary to have a framework in place before the building design process take place? Please explain your reasoning.

All eight participants agreed that it is necessary to have a framework in place because a very defined framework provides a structured approach to incomplete sustainability measures, ensures consistency in decision making, to establish clear objectives and performance targets and helps align all the stakeholders' expectations. Without such framework, sustainability initiatives may become fragmented, inconsistent or overlooked during the complex design process.

4.7.4 Is it important for the environmental sustainable indicators that have been mentioned in Section B to be further investigated in order to determine their significance towards the current practice for privatised building projects in Malaysia?

All participants agreed that it is crucial to investigate the environmental sustainable indicators for privatised projects in Malaysia to be further investigated because the local climate, cultural context and regulatory environment will present unique challenges and opportunities. Understanding these indicators' significance will help to develop more effective locally relevant sustainable design strategies which will ensure compliance with Malaysia's green building standard and promote more efficient resources in building tropical climate.

4.7.5 What are the benefits that can be expected by having a framework for the environmental sustainable indicators during the building design process for privatised building projects in Malaysia?

The expected benefits of having a framework concluded from the interview include improved project outcomes to standardise sustainability assessment methods, better risk management, enhanced cost control through early identification of sustainable solutions, improved stakeholder communication, easier compliance with green building certification, easier decision-making processes during the design phase.

4.7.6 How can the framework act as the basis of the development of the current practice?

The suggestions made by the participants were to incorporate more local climate-sustainable solutions and develop stronger integration with traditional Malaysia's building designers' principles, also, to establish a clearer connection between the environmental sustainable indicators and economic benefits and to create a more robust mechanism of pre/post-occupancy evaluation. In addition to that, the framework should be flexible enough to accommodate technological advancement while maintaining its core sustainability principles.

4.8 Conceptual Framework

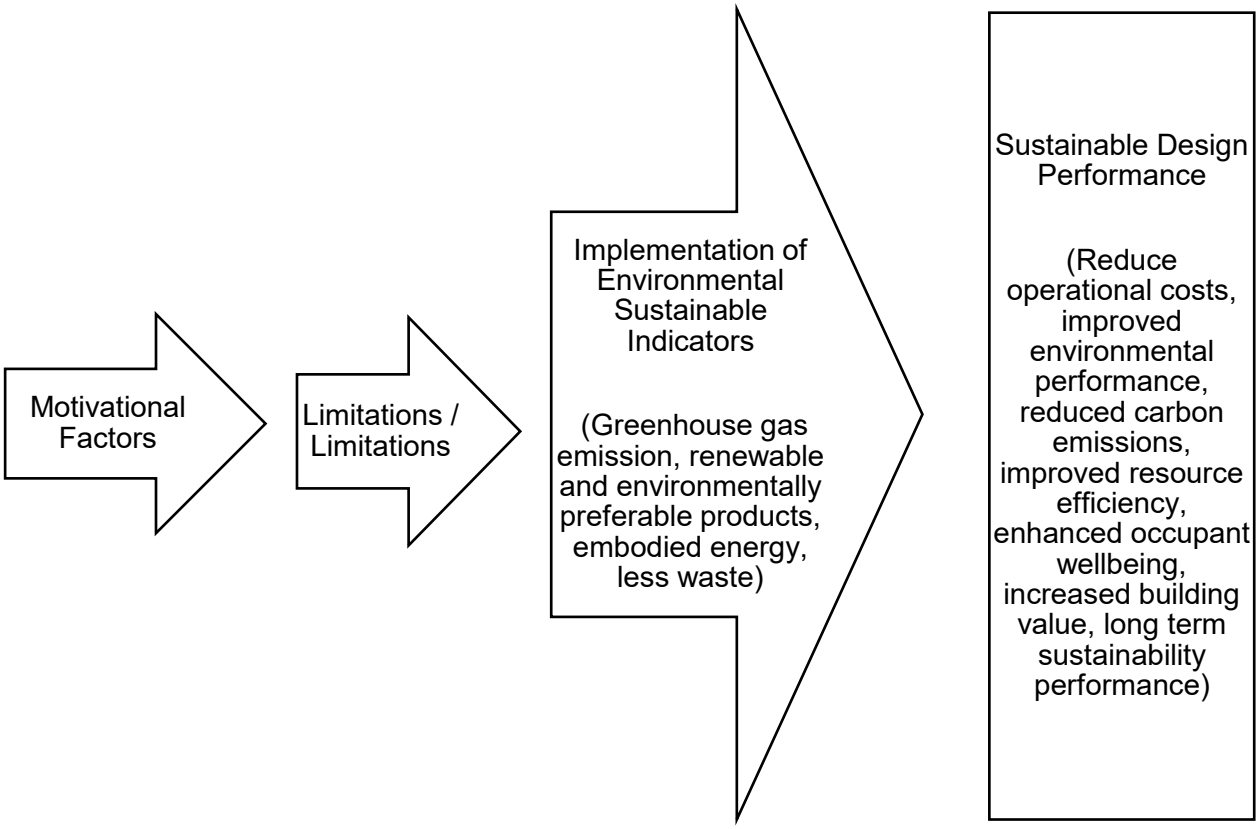

Figure 4.1 Conceptual framework flowchart

This research's conceptual framework highlights the interconnections among motivating variables, implementation constraints, environmental sustainable indicators, and sustainable design performance within Privatised Building Projects in Malaysia (PBPIM). The framework was constructed from the integration of sustainability literature, environmental sustainability theories, and prior empirical research about sustainable construction techniques.

The initial component of the framework comprises the motivational elements that promote the integration of environmentally friendly indicators during the design phase. The objectives encompass government restrictions, client demand, environmental accountability, long-term operational cost reduction, organisational sustainability initiatives, development of business image, and technical advancement. Prior research conducted by Darko et al. (2022), Jaradat et al. (2024), and UNEP (2022) highlighted these characteristics as critical determinants affecting the adoption of sustainability in the construction sector.

The second component of the framework comprises the constraints or limitations influencing the implementation of sustainability. The challenges encompass financial limitations, inadequate sustainability knowledge, insufficient awareness, reluctance to change, absence of sustainability protocols, weak stakeholder collaboration, and restricted access to sustainable resources. The literature suggests that these hurdles frequently diminish the efficacy of sustainability implementation during the design and development phases of projects.

The third component signifies the execution of environmentally sustainable indicators, which constitutes the primary emphasis of the research. The KPIs encompass energy efficiency, water efficiency, waste management, sustainable material selection, carbon emission reduction, and indoor environmental quality. These indicators originate from sustainability assessment frameworks and prior sustainability research, including Kylili et al. (2016), Toller et al. (2013), and Alwaer and Clements-Croome (2010).

The final element of the framework signifies the anticipated sustainable design performance results derived from the effective execution of environmental sustainable indicators. These results encompass higher environmental performance, decreased operational expenses, diminished carbon emissions, increased resource efficiency, improved occupant well-being, and sustained building longevity. The approach illustrates that the adoption of environmentally sustainable indicators in PBPIM is affected by both facilitating motivations and implementation limitations. The interplay among these aspects ultimately dictates the efficacy of sustainability implementation and the attainment of sustainable building performance goals.

4.9 Summary

This chapter examines the study and results on the limitations and motivations of implementing the environmental sustainable indicators in PBPIM through the use of SI and RII. Four primary impediments to the adoption of environmental sustainable indicators have been identified: lack of well-established standards and methods, lack of training, lack of capabilities/ skills, lack of tools and lack of awareness. To enhance the implementation of the environmental sustainable indicators for PBPIM, the factors identified in this chapter include reduction in energy consumption, elimination of pollution, reduction of carbon dioxide emissions, sustainable urbanisation, and waste reduction.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the research conclusions and offers significant recommendations for future studies. The primary aim of this research, as outlined in the first chapter, is to establish guidance and recommendations on the implementation of the environmental sustainable indicators during the design phase of PBPIM, aimed at assisting building designers in the implementation of a sustainable design within these projects.

5.2 Achievement of the Research Objectives

The subsequent findings are derived from the objectives.

To investigate and rank the environmental sustainable indicators during the design phase of PBPIM.

The first research objective was to investigate and rank the environmental sustainable indicators during the design phase of privatised building projects in Malaysia (PBPIM). This objective was successfully accomplished through structured interviews with architects and engineers who possessed professional experience in the design and implementation of privatised building projects. Participants were asked to evaluate the importance of the identified environmental sustainable indicators based on their knowledge and practical experience. The responses were analysed using the Severity Index (SI) and Relative Importance Index (RII) to determine the relative importance of each indicator.

The findings revealed that renewable and environmentally preferable products were ranked as the most important environmental sustainable indicator during the design phase, followed by embodied energy, greenhouse gas emissions, and less waste through the use of recycled materials. These findings indicate that material selection and the adoption of environmentally preferable products are considered by industry practitioners to have the greatest influence on improving environmental sustainable during the design stage of privatised building projects.

The ranking further demonstrates that participants recognised the importance of incorporating life-cycle thinking into design decisions by considering the embodied energy of construction materials, reducing greenhouse gas emissions through improved building performance, and minimising construction waste through the use of recycled materials and efficient resource management. Collectively, these indicators represent the key environmental considerations that should be integrated into the design process to enhance the sustainability performance of privatised building projects.

The accomplishment of this objective provides empirical evidence of the relative importance of environmental sustainable indicators within the Malaysian construction context. The ranking established a clear basis for prioritising sustainability considerations during the design phase and formed the foundation for the proposed implementation framework developed in this study. Consequently, the achievement of this objective contributes to improving understanding of how environmental sustainable can be systematically incorporated into the design process of privatised building projects in Malaysia.

To investigate the limitations in implementing the environmental sustainable indicators during the design phase of privatised building projects in Malaysia

The second research objective was to investigate the limitations to implementing environmental sustainable indicators during the design phase of privatised building projects in Malaysia. This objective was successfully accomplished through structured interviews with architects and engineers who possessed extensive experience in the planning and design of privatised building projects. The participants provided valuable insights into the practical challenges encountered when incorporating environmental sustainable considerations into the design process.

The findings revealed that the implementation of environmental sustainable indicators is constrained by several interconnected technical, economic, organisational and regulatory limitations. The participants consistently identified the high initial cost of sustainable design and environmentally preferable materials as one of the most significant barriers. Although sustainable design can generate long-term economic and environmental benefits, the higher upfront investment required during the design and procurement stages often discourages clients and developers from adopting sustainable solutions, particularly where project budgets and financial returns are prioritised.

Another major limitation identified by the participants was the limited awareness, understanding and commitment among clients and project stakeholders regarding environmental sustainable. The findings indicated that some clients continue to prioritise project cost, construction duration and immediate financial returns over long-term environmental performance. Consequently, sustainability objectives are often not incorporated into the project brief or are given lower priority during design decision-making.

The study also found that insufficient government support, inconsistent policy implementation and limited regulatory enforcement reduce the effectiveness of sustainability initiatives within privatised building projects. Although Malaysia has introduced several sustainability policies, guidelines and green building initiatives, participants perceived that stronger regulatory enforcement, clearer implementation guidelines and additional government incentives are required to encourage wider adoption of environmental sustainable practices throughout the construction industry.

Furthermore, participants identified the lack of technical knowledge, professional expertise and sustainability training among some industry practitioners as an important limitation. Implementing environmental sustainable indicators requires specialised knowledge of sustainable design principles, life-cycle assessment, energy modelling and environmental assessment tools. The absence of adequate training and continuous professional development may therefore limit the ability of project teams to integrate sustainability effectively during the design phase.

The participants also highlighted limited availability of environmentally preferable materials, sustainable technologies and reliable environmental information as practical barriers to implementation. Difficulties in sourcing suitable sustainable materials, together with uncertainty regarding their performance, cost and availability, were reported to influence design decisions and reduce opportunities for adopting environmentally sustainable solutions.

In addition, the findings demonstrated that insufficient collaboration and communication among project stakeholders can hinder the successful integration of sustainability into the design process. Effective implementation requires close cooperation between clients, architects, engineers, quantity surveyors, contractors and regulatory authorities from the earliest stages of project development. Where stakeholder engagement is limited, sustainability considerations are less likely to be fully integrated into project planning and design.

Overall, the accomplishment of this research objective provides a comprehensive understanding of the principal limitations affecting the implementation of environmental sustainable indicators during the design phase of privatised building projects in Malaysia. The findings demonstrate that these limitations are multidimensional, encompassing financial, organisational, technical and regulatory challenges that collectively influence sustainable design practices. Identifying these limitations enabled the study to propose practical implementation strategies within the proposed framework, aimed at assisting industry practitioners and policymakers in overcoming existing barriers and improving the integration of environmental sustainability into future privatised building projects.

To investigate the motivations for implementing the environmental sustainable indicators during the design phase of privatised building projects in Malaysia

The third research objective was to investigate the motivations for implementing environmental sustainable indicators during the design phase of privatised building projects in Malaysia. This objective was successfully accomplished through structured interviews with architects and engineers involved in the design and delivery of privatised building projects. The participants shared their professional experiences and perspectives regarding the factors that encourage the integration of environmental sustainability into the design process.

The findings revealed that the implementation of environmental sustainable indicators is driven by several interrelated motivations. Participants identified environmental protection and the reduction of adverse environmental impacts as the primary motivation, reflecting the increasing recognition of the construction industry's responsibility to minimise resource consumption, greenhouse gas emissions and environmental degradation. The findings also demonstrated that sustainability implementation is motivated by the need to improve the long-term environmental performance of buildings through environmentally responsible design decisions.

In addition, participants highlighted that client requirements and organisational commitment play an important role in promoting the adoption of environmental sustainable indicators. Increasing awareness among clients and developers regarding sustainable development has encouraged project teams to incorporate sustainability objectives during the early stages of project design. Organisational commitment, supported by corporate environmental policies and management support, was also recognised as an important factor influencing the successful implementation of sustainable design practices.

The study further found that government regulations, environmental policies and green building assessment systems provide significant motivation for implementing environmental sustainable indicators. Participants acknowledged that compliance with national sustainability policies, environmental regulations and green building certification requirements encourages design professionals to consider sustainability throughout the design phase. These findings demonstrate the importance of an effective regulatory framework in supporting the wider adoption of sustainable construction practices within the Malaysian construction industry.

Economic considerations also emerged as an important motivational factor. Although sustainable design may require greater attention during the early design stages, participants recognised that incorporating environmental sustainable indicators can contribute to reduced operating costs, improved energy efficiency, lower maintenance requirements and enhanced long-term asset value. Consequently, sustainability was viewed not only as an environmental responsibility but also as a means of improving the overall performance and value of privatised building projects.

Overall, the accomplishment of this research objective provides a comprehensive understanding of the factors motivating the implementation of environmental sustainable indicators during the design phase of privatised building projects in Malaysia. The findings demonstrate that sustainability implementation is influenced by environmental, organisational, regulatory and economic considerations, which collectively encourage design professionals to integrate sustainability principles into project decision-making. These findings also informed the development of the proposed implementation framework by identifying the key drivers that support the successful adoption of environmental sustainable indicators within the Malaysian construction industry.

To provide guidance and recommendations on the implementation of the environmental sustainable indicators during the design phase of privatised building projects in Malaysia.

The fourth research objective was to provide guidance and recommendations for the implementation of environmental sustainable indicators during the design phase of privatised building projects in Malaysia. This objective was successfully accomplished through the integration and synthesis of the empirical findings obtained from the structured interviews with architects and engineers. The guidance and recommendations were developed based on the identified environmental sustainable indicators, the motivations that encourage their implementation, and the limitations that hinder their adoption during the design phase.

The findings from the preceding research objectives demonstrated that environmental sustainable can be more effectively incorporated into privatised building projects when sustainability considerations are integrated systematically throughout the design process. Consequently, the study developed a proposed implementation framework that translates the empirical findings into practical guidance for industry practitioners. The framework provides a structured approach for integrating the identified environmental sustainable indicators into the various stages of the design process, while identifying the corresponding design actions, responsible stakeholders, relevant Malaysian policies and standards, and the expected project outputs.

The proposed implementation framework prioritises the environmental sustainable indicators according to their importance, as determined by the study findings. Renewable and environmentally preferable products, which emerged as the highest-ranked indicator, are recommended for consideration at the project initiation stage to ensure that sustainability objectives are incorporated into the project brief and material selection strategy from the outset. Embodied energy is addressed during the concept design stage through the application of life-cycle assessment and the evaluation of alternative design solutions. Greenhouse gas emissions are considered during the detailed design stage through the application of building performance assessment tools and energy modelling techniques, while waste reduction is incorporated during the final design stage through efficient material utilisation, recycling strategies and resource-efficient design practices.

In addition to providing practical guidance for the implementation of environmental sustainable indicators, the framework also recognises the importance of stakeholder collaboration throughout the design process. The findings indicated that successful implementation requires active participation from clients, architects, engineers, quantity surveyors, contractors and relevant government agencies. Clear allocation of roles and responsibilities, together with effective communication among project stakeholders, facilitates informed decision-making and strengthens the integration of sustainability objectives throughout project development.

The framework further recommends that environmental sustainable implementation should be supported by existing Malaysian policies, regulations and green building initiatives, including the Green Building Index (GBI), MS 1525, the National Green Technology Policy and relevant Construction Industry Development Board (CIDB) guidelines. Aligning project design with these national initiatives enhances regulatory compliance and promotes greater consistency in sustainable construction practices within the Malaysian construction industry.

Overall, this research objective has been successfully achieved through the development of a practical implementation framework that is grounded in the empirical findings of the study. Unlike the conceptual framework presented in Chapter 2, which explains the theoretical relationships between the research variables, the proposed implementation framework provides practical guidance for industry practitioners by translating the research findings into a structured implementation process. The framework therefore contributes to both academic knowledge and professional practice by supporting architects, engineers, clients and other project stakeholders in integrating environmental sustainable indicators more effectively during the design phase of privatised building projects in Malaysia. It also provides a foundation for future refinement and application in similar construction projects, thereby contributing to the advancement of sustainable development within the Malaysian construction industry.

5.3 Proposed Implementation Framework for Environmental Sustainable Indicators During the Design Phase of Privatised Building Projects in Malaysia

Table 5.1 Proposed implementation framework for environmental sustainable indicators during the design phase of privatised building projects in Malaysia

Implementation Stage	Environmental Sustainable Indicators	Importance Rank (Findings)	Key Design Action	Responsible Party	Malaysian Policy / Standard	Expected Output
Project Initiation	Renewable and Environmentally Preferable Products	1	Establish sustainability objectives and identify environmentally friendly, recyclable and low-carbon materials during project planning	Client, design team	Green Building Index; National Green Technology Policy	Sustainable material selection strategy
Concept Design	Embodied Energy	2	Undertake life-cycle assessment, compare design alternative and optimise passive design strategies to reduce embodied energy.	Design Team	Malaysian Standard 1525; Green Building Index	Life-cycle assessment report and embodied energy strategy.

Detailed Design	Greenhouse Gas Emissions	3	Apply Building Information Modelling (BIM), EnergyPlus, eQuest and Ecotect to establish sustainability targets and reduce carbon emissions before construction.	Design Team	Government Environmental Regulations; Green Building Index	Carbon reduction strategy and environmental performance targets.
Design Completion	Less Waste	4	Incorporate waste minimisation measures, recycled materials, resource-efficient design solutions and design optimisation before construction.	Design Team	CIDB; Industrialised Building System; Malaysian waste management regulations	Waste management and resource efficiency strategy.

The proposed implementation framework presented in Table 5.1 was developed from the findings of this study to provide a practical guide for implementing environmental sustainable indicators during the design phase of privatised building projects in Malaysia. The framework was formulated based on the perceptions and experiences of architects and engineers obtained through the structured interviews and reflects the environmental sustainable indicators identified as being most important for sustainable building design.

The framework organises the four environmental sustainable indicators according to their importance ranking derived from the interview findings. Renewable and environmentally preferable products were identified as the highest priority indicator, followed by embodied energy, greenhouse gas emissions and less waste through the use of recycled materials. The ranking reflects the collective judgement of the participants regarding the relative importance of each indicator in improving environmental sustainability during the design stage of privatised building projects.

The implementation framework is structured according to the main stages of the design process. At each stage, a specific environmental sustainable indicator is integrated with appropriate design actions, responsible stakeholders, relevant Malaysian policies or standards, and the expected project outputs. This structure demonstrates how sustainability considerations can be incorporated systematically throughout the design process rather than being treated as isolated activities.

During the project initiation stage, the framework emphasises the selection of renewable and environmentally preferable products. Establishing sustainability objectives at the beginning of a project enables clients and design professionals to incorporate environmental considerations into the project brief and material selection strategy from the outset. Early integration of sustainability objectives provides a clear direction for subsequent design decisions and supports the achievement of long-term environmental performance.

The concept design stage focuses on reducing embodied energy through life-cycle assessment and the evaluation of alternative design solutions. The findings indicated that considering embodied energy during the early stages of design enables architects and engineers to select construction materials and building systems that minimise environmental impacts throughout the building life cycle. Integrating life-cycle thinking during concept development also supports more informed design decision-making.

During the detailed design stage, the framework recommends addressing greenhouse gas emissions by incorporating sustainability assessment tools such as Building Information Modelling (BIM), EnergyPlus, eQuest and Ecotect, as identified by the interview participants. These tools assist the design team in evaluating building performance, estimating energy consumption and identifying opportunities to reduce carbon emissions before construction commences.

The final stage of the framework addresses waste reduction through the use of recycled materials and resource-efficient design strategies. Participants highlighted the importance of incorporating waste minimisation measures during design to reduce material consumption, improve construction efficiency and minimise environmental impacts. The framework therefore recommends the preparation of waste management strategies and the consideration of recyclable materials before construction begins.

The implementation of each indicator is supported by relevant Malaysian policies and standards, including the Green Building Index (GBI), the National Green Technology Policy, MS 1525 and relevant CIDB guidelines. Linking the proposed actions to existing national policies demonstrates that the framework is consistent with current sustainability initiatives within the Malaysian construction industry and facilitates its practical application by project stakeholders.

Overall, the proposed implementation framework provides a structured approach for integrating environmental sustainability considerations into the design phase of privatised building projects in Malaysia. Unlike the conceptual framework presented in Chapter 2, which illustrates the relationships between the research variables, this implementation framework translates the empirical findings of the study into practical guidance for industry practitioners. The framework is intended to assist architects, engineers, clients and other project stakeholders in incorporating environmental sustainable indicators systematically during project design, thereby supporting more sustainable decision-making and improving environmental performance in privatised building projects.

5.4 Recommendations

In light of the aforementioned conclusions of this research, the following solutions are proposed to improve the efficacy of PBPIM regarding value for money and sustainability:

- Malaysia lacks guidelines and references for environmental sustainable indicators, notably concerning privatised building projects. Therefore, the government must assume a crucial role in advocating a systematic methodology for building designers to improve the integration of environmental sustainable indicators during the design phase of PBPIM. This would greatly enhance the projects' efficacy regarding cost-efficiency and sustainability.
- The environmental sustainable indicators are very novel and continue to evolve in Malaysia. Indeed, it is not a fundamental concept of PBPIM. This is imperative and requires immediate attention. Given the nature of the projects, it is essential to incorporate environmental sustainable indicators to ensure that the outcomes are delivered to the government and end users sustainably.
- The advancement of the suggested guideline should incorporate additional sub-parameters to offer more detailed direction to building designers. The guideline can be further elaborated based on the varying degrees of projects.

5.5 Proposed Areas for Further Research

The study offers potential avenues for further research in the subsequent areas:

- Future research may utilise the same methodology to establish a framework of environmentally sustainable indicators throughout the design phase of privatised building projects in additional developing nations. This is to guarantee the successful completion of the projects.
- This research focused exclusively on PBPIM; however, future investigations could expand the scope to encompass more project types, including traditionally procured and design-and-build projects, among others.
- Future research may utilise the findings of this study in a practical case analysis to validate its relevance and assist building designers in implementing the environmental sustainable indicators during the design phase of PBPIM.

5.6 Contribution of Research

This research develops a guideline for implementing the environmental sustainable indicators during the design phase of PBPIM. The guideline is deemed relevant, realistic, and implementable for building designers to utilise as guidance in efficiently executing the environmental sustainable indicators for the projects. It permits the achievement of the KPI of the projects and gives standardisation of the execution. Furthermore, the guideline's standardisation and methodical procedures address prevalent difficulties discussed in previous studies. The integration of the environmental sustainable indicators during the design phase allows for the assessment of the environmental issues for the projects. Consequently, tangible advantages for humanity may be obtained. This research has provided practical guidance that addresses the existing research gap. Finally, a systematic and methodological technique is employed and may be applied to similar studies.

5.7 Limitation of Research

A significant limitation of this research is that the proposed conceptual framework has been formulated based on the identification of environmentally sustainable indicators, limitations, motivations, and expert opinions concerning their implementation during the design phase of privatised building projects in Malaysia. The framework offers a systematic and theoretically sound method for incorporating environmental sustainability into project design; however, its practical efficacy has not been empirically assessed through actual project execution.

The present study focused on the creation and validation of the framework both conceptually and through stakeholder input. Thus, the research does not encompass the implementation of the framework in finished or continuing privatised building projects to evaluate its impact on environmental performance, decision-making efficacy, project results, or sustainability achievements. The degree to which the framework can enhance project sustainability in practice has yet to be validated.

Furthermore, the implementation of environmentally sustainable indicators is affected by various project-specific elements, such as organisational culture, stakeholder commitment, regulatory requirements, project scale, budgetary limitations, and technology capabilities. The contextual variables may influence the framework's efficacy and could not be thoroughly analysed within the constraints of this study's duration and scope.

Assessing the framework's efficacy necessitates a comprehensive inquiry that includes pilot implementation, longitudinal observation, performance assessment, and comparison analysis across various projects. This endeavour would require the gathering of primary data over a prolonged duration and the evaluation of environmental, operational, and economic impacts stemming from the implementation of the framework. Due to the complexity and magnitude of this process, a thorough assessment exceeds the parameters of the present study.

Consequently, it is advisable that forthcoming research, possibly at the doctoral (PhD) level, concentrate on the actual use and evaluation of the suggested framework. This may entail implementing the framework in specific privatised building projects in Malaysia, formulating quantifiable performance metrics, and assessing its efficacy in attaining sustainable goals across the project life cycle. This research would yield significant empirical evidence concerning the framework's applicability, robustness, and contribution to sustainable development in the Malaysian construction sector.

5.8 Concluding Remarks

Privatised building projects are implemented in Malaysia to guarantee the effective provision of services to society while maintaining cost-effectiveness. Contributing to society encompasses not only financial aspects but also necessitates a balanced integration of economic, social, and environmental factors. Consequently, given the long-term nature of the projects, which necessitates the Special Purpose Vehicle (SPV) to not only construct but also maintain the projects over an extended concession period, it presents a favourable opportunity to integrate the environmental sustainable indicators into the projects Nonetheless, despite the implementation of the environmental sustainable indicators during the design phase of PBPIM being recognised for its benefits among numerous practitioners, the country still lacks adequate guidance and references for its implementation.

Thus, this research aims to assist practitioners, particularly building designers, in incorporating the environmental sustainable indicators during the design phase of PBPIM. It involves examining the limitations and motivations for the implementation, investigating the ranking of the environmental sustainable indicators, and assessing the implementation of these indicators. This research confirms that it may assist building designers in incorporating the environmental sustainable indicators during the design phase of PBPIM, ensuring successful outcomes in both financial and sustainability aspects.

The established study incorporates environmental sustainable indicators throughout the design phase of PBPIM by integrating all pertinent indicators that have been qualitatively examined. The lack of uniformity in the implementation of PBPIM results in variations in techniques and processes among building designers, hence compromising the accuracy of the environmental sustainable indicators for these projects. The guideline is vital for achieving the project's KPIs, as numerous other factors must be evaluated and accomplished beyond cost-effectiveness. Sustainability and genuine benefit for humanity are essential for the projects because of their extended concession period. Consequently, the guideline established in this research incorporates environmental sustainable indicators during the design phase, ensuring that, in addition to cost, sustainability is also taken into account by building designers when applying these indicators to their projects.

APPENDIX

SECTION A: PROFILE AND BACKGROUND OF PARTICIPANTS

Please tick (√) the appropriate box to answer the following questions.

1. Which of the following best describes you?

	An Architect
	An Engineer (Please specify: Civil / Structural / etc):
	Others (Please specify):

2. What are your years of experience in designing building projects?

	Less than 1 year
	1 to 5 years
	6 to 10 years
	More than 10 years

3. Have you been involved / are you currently involve in private building projects?

	Yes
	No

SECTION B: ENVIRONMENTAL SUSTAINABLE INDICATORS

4. Please rank (from 1 – 4) the following environmental sustainable indicators one would consider when selecting for materials during design process with 1 being the highest and 4 the lowest.

1.	Greenhouse gas emission	
2.	Renewable and environmentally preferable products (using material that maximise renewable and environmental friendly)	
3.	Embodied energy (energy consumed by the material).	
4.	Less waste (using recycled materials)	

5. During design process, would you consider sustainable indicators for decision making?

	Yes
	No

SECTION C: LIMITATIONS TO IMPLEMENTATING ENVIRONMENTAL SUSTAINABLE BUILDING DESIGN FOR PRIVATISED BUILDING PROJECTS IN MALAYSIA.

6. Please tick (√) the appropriate scale to indicate the level of severity of limitations to implementing sustainable building design for PBPIM.

		Least Severe	Mild	Moderate	Severe	Most Severe
1.	Lack of motivation					
2.	Insufficient and unavailability of data					
3.	Weak collaboration between stakeholders					
4.	Lack of training					
5.	Lack of tools					
6.	Lack of awareness					
7.	Financial constraints					
8.	Lack of well-established standards and methods					
9.	Time constraints					
10.	Lack of capabilities/ skills					
11.	Variety of uncertain parameters and assumptions					
12.	Unwillingness to implement sustainability					
13.	Lack of competence in managing the changing attitude process of people and institutions					
14.	Complicated process					
15.	Increasing liability					
16.	Lack of incentive					
17.	Lack of government support					
18.	Uncertainty of outcomes and benefits					
19.	Lack of relevant laws and regulation					

SECTION D: MOTIVATIONS FOR IMPLEMENTATING ENVIRONMENTAL SUSTAINABLE BUILDING DESIGN FOR PRIVATISED BUILDING PROJECTS IN MALAYSIA.

7. Please tick (√) the appropriate scale to indicate the level of importance of motivations for implementing sustainable building design for PBPIM.

		Least Important	Unimportant	Moderate	Important	Very Important
1.	Establish standard and guideline					
2.	Develop framework					
3.	Define parameters and assumptions					
4.	Develop model based on case studies					
5.	Form database to compile data					
6.	Communicate its benefits					
7.	Provision of incentive					
8.	Formal education					
9.	Provision of training					
10.	IT and tools support					
11.	Establish standard and guideline					
12.	Develop framework					

SECTION E: THE IMPLEMENTATION OF SUSTAINABLE ENVIRONMENTAL INDICATORS

8. Is there any specific software as to how you leverage technology to enhance environmental sustainability in your building design?

9. How do you monitor and evaluate the effectiveness of sustainable practices during the design process?

10. Is it necessary to have a framework in place before the building design process take place? Please explain your reasoning.
    Note: A framework is a supporting structure around which something can be built; a system of rules, ideas, or beliefs that is used to plan or decide something.

11. Is it important for the environmental sustainable indicators that have been mentioned Section B to be further investigated in order to determine their significance towards the current practice for PBPIM?

12. What are the benefits that can be expected by having a framework for the environmental sustainable indicators during the building design process for PBPIM.

13. How can the framework act as the basis of the development of the current practice?

14. Please make general comments or suggestions on any questions put forward or any other relevant points not mentioned anywhere in this interview questions in relation to the development of a design framework for the environmental sustainable indicators during building design process for PBPIM (if any).

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5 September 2024

LETTER OF APPROVAL

APPROVAL HAS BEEN GRANTED FOR THIS STUDY TO BE CARRIED OUT BETWEEN 05/09/2024 AND 30/09/2024

Applicant (s): Mrs Nur Ellyana Binti Mohd Ariff

Project Title: The Implementation of Environmental Sustainable Indicators During the Building Design Process for Private Building Projects in Malaysia

Reference: 47737-LR-Aug/2024- 52766-1

Dear Mrs Nur Ellyana Binti Mohd Ariff

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- **The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.**

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
- Approval to proceed with the study is granted subject to any conditions that may appear above.
- The Research Ethics Committee reserves the right to sample and review documentation, including raw data, relevant to the study.
- If your project has been approved to run for a duration longer than 12 months, you will be required to submit an annual progress report to the Research Ethics Committee. You will be contacted about submission of this report before it becomes due.
- You may not undertake any research activity if you are not a registered student of Brunel University or if you cease to become registered, including abeyance or temporary withdrawal. As a deregistered student you would not be insured to undertake research activity. Research activity includes the recruitment of participants, undertaking consent procedures and collection of data. Breach of this requirement constitutes research misconduct and is a disciplinary offence.

Professor Simon Taylor

Chair of the College of Engineering, Design and Physical Sciences Research Ethics Committee

Brunel University London

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