ENVIRONMENTAL, SOCIAL AND GOVERNANCE (ESG) COMPLIANCE ON CONSTRUCTION PROJECTS

WONG YAU YII

A project report submitted in partial fulfilment of the requirements for the award of Master of/in Project Management

Lee Kong Chian Faculty of Engineering and Science
Universiti Tunku Abdul Rahman

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DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

Signature : 

Name : WONG YAU YII

ID No. : 2401674

Date : 03.04.2025

APPROVAL FOR SUBMISSION

I certify that this project report entitled **“ENVIRONMENTAL, SOCIAL, AND GOVERNANCE (ESG) COMPLIANCE ON CONSTRUCTION PROJECTS”** was prepared by **WONG YAU YII** has met the required standard for submission in partial fulfilment of the requirements for the award of Master of Project Management at Universiti Tunku Abdul Rahman.

Approved by,

Signature : _________________________

Supervisor : _________________________

Date : _________________________

Signature : _________________________

Co-Supervisor : _________________________

Date : _________________________

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ABSTRACT

In Malaysia, the construction industry is a key driver of economic growth but also contributes significantly to environmental degradation, social inequalities, and governance-related challenges. Although Environmental, Social, and Governance (ESG) principles are gaining attention globally, the Malaysian construction sector still faces inconsistencies in ESG compliance due to varying levels of regulatory enforcement, limited stakeholder awareness, and the absence of a structured framework for implementation and reporting. This gap underscores the need for a systematic investigation into ESG practices within local construction projects. This study aims to examine the ESG criteria relevant to Malaysian construction projects, evaluate the extent of compliance, and propose practical strategies to improve ESG integration in future developments. A quantitative research approach was employed through the use of a structured questionnaire survey distributed to professionals across the construction industry. A total of 101 valid responses were collected from respondents comprising project managers, engineers, architects, quantity surveyors, contractors, and consultants, predominantly based in the Klang Valley region. The diversity in professional roles allowed for a comprehensive assessment of stakeholder perceptions and ESG awareness levels. Statistical analyses were conducted using Cronbach's Alpha reliability test, Shapiro-Wilk test for normality, arithmetic mean ranking, Spearman's rank-order correlation, and the Kruskal-Wallis H test to identify key compliance levels and inter-group differences. The findings reveal that Occupational Health and Safety, Standards and Regulations, Socio-Economic Development, Board Composition, and Workplace Well-Being are among the most prioritised ESG compliance criteria. The study also identifies actionable strategies for improving ESG compliance, such as the popularisation of Building Information Modelling, enhancement of ethical leadership, and adoption of advanced technologies. These findings contribute to the broader understanding of ESG implementation in Malaysian construction projects and provide valuable recommendations for policymakers, regulatory bodies, and industry practitioners. Ultimately, this study supports national sustainability objectives and serves as a foundation for further studies on ESG integration in the built environment.

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LIST OF SYMBOLS / ABBREVIATIONS

e	margin of error
k	the number of scale items
n	sample size / the total number of observations
p	the estimated proportion of the population with the characteristics in study
z	the z-scores of the desired confidence level
ρ	Coefficient for Spearman's rank-order correlation
$\overline{c}$	the average of all covariances between items
$\overline{v}$	the average variance of each item
$\overline{x}$	the arithmetic mean
x_i	each individual data point
d_1^2	difference between the two ranks of each observation
$\sigma_{y_i}^2$	the variance associated with item i
σ_z^2	the variance associated with the observed total scores

3D	three-dimensional
BOD	board of directors
C&D	construction and demolition
CE	circular economy
CG	corporate governance
CO_2	carbon dioxide
ETS	Emissions Trading Systems
GBI	Green Building Index
GHG	greenhouse gas
GPC	geopolymer concrete
GSCM	green supply chain management
HVAC	Heating, Ventilation, and Air Conditioning
IBS	Industrialised Building System
IoT	Internet of Things

LCA	Life Cycle Assessment
OHS	Occupational Health and Safety
PPE	personal protective equipment
PV	photovoltaic
PWD	Public Works Department
RCA	recycled concrete aggregates
RMK-12	Rancangan Malaysia Ke-12
RMP	risk management plan
SBMs	Sustainable building materials
SCM	supply chain management
SCMs	sustainable construction materials
SPSS	Statistical Package for the Social Sciences

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CHAPTER 1
INTRODUCTION

1.1 General Introduction

One of the world's most resource-intensive, wasteful, and energy-intensive industries, the construction industry has far-reaching impacts on various aspects (Murtagh, Scott, and Fan, 2020; Hossain *et al.*, 2020; Chuai *et al.*, 2021). The construction industry faces several key environmental challenges, including high energy consumption in construction activities (Santamouris and Vasilakopoulou, 2021) and difficulties in managing greenhouse gas (GHG) emissions during the building operation stage (Chen *et al.*, 2024). Apart from that, one of the social issues in the construction industry revolves around human rights concerns, such as preventing forced labour and safeguarding migrant workers' rights (Kordi, Belayutham, and Che Ibrahim, 2021; LeBaron, 2021; ElDidi *et al.*, 2023). Similarly, the prevalent governance issues in the construction industry include inefficient transparency due to information asymmetry, notably uneven sharing of project information can further aggravate conflicts (Ivić and Cerić, 2023; Obonadhuze *et al.*, 2021). These global concerns have driven the construction industry towards an urgent need for sustainability initiatives.

Sustainability generally refers to utilising natural resources in a balanced manner, ensuring they are not exhausted, depleted, or pushed beyond the point of renewal while enhancing them for future generations (Yilmaz and Bakis, 2015). From an environmental perspective, sustainable construction practices aim to improve resource efficiency (land, water, materials) use and eventually reduce the overall environmental impact (Labaran *et al.*, 2022; Almusaed *et al.*, 2024). This aligns with global efforts to combat climate change, as construction activities significantly contribute to GHG emissions and energy consumption (Musarat *et al.*, 2024). According to Eizenberg and Jabareen (2017), social sustainability in the construction industry refers to treating people and communities impacted by building projects fairly and equally, guaranteeing their involvement and access to resources, and protecting their rights. Research highlights the importance of workplace safety, access to personal protection, and community protection during construction phases as key criteria for attaining social sustainability (Bashir *et al.*, 2024). It is a multi-level phenomenon that pertains to the governance of the project, the parent company, any supplier or contractors, and their interactions with one another (Turner and Müller, 2017). In order to create an ethical framework that favours decision-making on transparency, accountability, and other topics, governance as a control system consists of processes, policies, and authority (Derakhshan, Mancini, and Fernandes, 2020; OECD, 2023). In response to the growing severity of sustainable development concerns, sustainable development action plans such as the Environmental, Social, and Governance (ESG) initiative were proposed to create a comprehensive and sustainable development framework for the construction practitioners to comply with (Li *et al.*, 2021).

Globally, due to the use of carbon and energy-intensive materials like steel and cement (Sbahieh, Zaher Serdar, and Al-Ghamdi, 2023), the construction industry is responsible for 40% of energy consumption (Luo *et al.*, 2022) and a quarter of GHG emissions (Bahramian and Yetilmezsoy, 2020). Compared to other industries in Malaysia, the construction industry accounts for nearly a quarter of carbon emissions (Rahim *et al.*, 2023). In response, Malaysia has committed to lowering its gross domestic product's GHG emissions intensity by 45% by 2050 compared to 2005 levels under the United Nations Framework Convention on Climate Change (Rasiah *et al.*, 2017). Moreover, Malaysia has launched green finance programs to support green development (Solla *et al.*, 2020) and created the Green Building Index (GBI) (Wan Yusoff Wan Zahari, 2014) to encourage green construction in Malaysia.

Therefore, sustainability within the construction industry must be viewed through the lens of the ESG framework, where ESG criteria are interrelated and equally essential. Together, these criteria drive the construction industry towards long-term resilience, improved stakeholder relationships, and a sustainable future for both the industry and society at large.

1.2 Importance of the Study

Construction projects in Malaysia play a central role in driving infrastructure growth and economic progress. However, they are also major contributors to environmental degradation, social disparities, and governance-related risks. Given the resource-intensive and high-impact nature of construction activities, it is increasingly important to evaluate these projects through the lens of ESG compliance. This study is significant as it delves into how ESG criteria are currently understood, implemented, and managed within the context of Malaysian construction projects, where structured compliance remains inconsistent, and stakeholder awareness is still developing.

In recent years, Malaysia has intensified its efforts to promote sustainable development, such as committing to reduce GHG emissions and introducing initiatives like the GBI and various green financing mechanisms. Despite these policy measures, the actual integration of ESG principles at the project level, during planning, execution, and post-completion stages, remains fragmented. By examining and ranking ESG criteria, the study enhances the industry's understanding of which aspects are most significant and where improvements are most needed. It also contributes to raising awareness among industry professionals about the value of ESG as a tool not only for environmental protection but also for strengthening social responsibility and governance transparency.

This study also provides practical insights for project managers, developers, consultants, and contractors who are directly involved in construction delivery. By identifying and ranking ESG criteria based on their relevance and compliance levels, the research offers a valuable reference for improving project planning, procurement strategies, risk management, and stakeholder communications. It helps construction professionals understand which ESG criteria carry the greatest impact on project outcomes, both in terms of sustainability performance and long-term viability.

Moreover, the findings are poised to assist government bodies and regulatory agencies in developing clearer, more enforceable ESG frameworks that target the operational realities of construction projects. The study's recommendations can contribute to the standardisation of compliance approaches, enhance ESG reporting mechanisms, and strengthen the credibility of Malaysia's construction sector in the eyes of both domestic and international investors.

In essence, this study underscores the importance of embedding ESG considerations into the lifecycle of construction projects to support sustainable development, reduce project-level risks, and enhance the overall quality and accountability of infrastructure delivery across the country.

1.3 Problem Statement

Malaysia is not an exception to the fact that the construction industry significantly contributes to environmental degradation (Mbala, Aigbavboa, and Aliu, 2019), social inequities (Nelson *et al.*, 2024), and ethical governance challenges (Paul *et al.*, 2021). While previous studies on ESG compliance in the construction industry have provided constructive evaluations of the integration of sustainability practices, several gaps remain that justify the need for further research, particularly in the Malaysian project context.

Studies show that many countries have strongly focused on or started to look into ESG disclosures and reporting instruments (Singhania and Saini, 2022), especially by comparing the regulatory frameworks in developed and developing countries (Lozano, and Martínez-Ferrero, 2022; Singhania *et al.*, 2024). Cruz *et al.* (2023) discovered that the emphasis often remains on integral innovative methods to advance ESG goals rather than structured frameworks for compliance that ensure these practices are adopted consistently across construction projects. Bezerra, Martins, and Macedo (2024) examined the common obstacles to effective ESG implementation and challenges in adopting ESG practices in the construction industry, particularly in an emerging economy like Brazil, and they emphasised the difficulty in establishing a consistent compliance framework.

In the Malaysian context, Ojetunde *et al.* (2023) reviewed global regulatory approaches and suggested that Malaysia could enhance its ESG frameworks by incorporating holistic elements like circular economy principles and dual materiality, highlighting the need for standardised metrics and targets to facilitate performance comparisons, which could support more consistent and transparent ESG reporting. Sulaiman *et al.* (2024) evaluated the ESG practices of 55 construction companies listed on Bursa Malaysia, using a structured approach based on the Financial Times Stock Exchange Russell rating model, to showcase the current state of ESG disclosure and underlined the need for better compliance mechanisms and structured frameworks to enhance ESG compliance within the industry. Through the analysis of the top 100 Malaysian companies, Adzrin *et al.* (2023) identified a positive relationship between ESG disclosure and improved business outcomes and the need for robust compliance measures to mitigate risks and maintain investor confidence, a critical aspect of ensuring successful ESG integration in any industry. This was also agreed upon by Wan Masliza Wan Mohammad and Shaista Wasiuzzaman (2021), who explored the direct impact of ESG disclosure on company performance, finding that enhanced ESG reporting correlated with better company performance, particularly when competitive advantage was factored in. Yaman and Ghadas (2024) concluded that Malaysia's existing standard contract forms were inadequate for addressing the specific needs of green building projects, which was a crucial aspect of advancing ESG practices in the construction industry. Zahid, Rehman, and Khan (2019) concentrated on the Malaysian Code of Corporate Governance 2012 and its impact on the ESG practices of Malaysian publicly listed companies, emphasising the importance of regulatory reforms in fostering sustainable corporate behaviour and further strengthening the regulatory framework, which could significantly improve ESG compliance in Malaysia's corporate sector.

Given these gaps, this study aims to resolve the lack of comprehensive research on the full integration of ESG compliance in Malaysian construction projects. It seeks to evaluate how ESG compliance impacts the delivery of successful construction projects and to propose actionable recommendations for improving compliance levels in construction projects. The study's findings are advantageous in minimising the existing knowledge gap and offer valuable insights for policymakers, construction companies, and stakeholders aiming to align their operations with global sustainability goals.

1.4 Aims and Objectives

The aim of this study is to investigate the extent of ESG compliance within the Malaysian construction projects by examining the relevant ESG criteria, assessing current levels of implementation in construction projects, and proposing actionable recommendations to strengthen ESG integration and performance in future construction projects. While this study's main objective is to uncover ESG practices on construction projects in Malaysia, which include:

1. To examine the ESG criteria relevant to Malaysian construction projects.
2. To evaluate the compliance of ESG practices on construction projects.
3. To suggest recommendations for improving ESG compliance in future construction projects in Malaysia.

1.5 Scope of the Study

This research will focus on construction practitioners who have experience in handling all kinds of construction projects, including residential, commercial, infrastructure, industrial, and others, in Klang Valley, Selangor, Malaysia.

1.6 Outline of the Report

Chapter 1 provides an overview of the research framework, beginning with a general introduction to the construction industry's ESG challenges, including environmental impact, social issues, and governance concerns. The chapter also highlights the research gap within this context, as stated in the problem statement, and outlines the importance of the study, research aim, objectives, and scope of the study.

Chapter 2 presents the literature review. The information was collected from both primary and secondary literature sources, such as journals, articles, and other published public resources. This chapter provides the ESG compliance criteria and the strategies for improving compliance levels in future Malaysian construction projects.

Chapter 3 covers the research methodology, focusing on the data and information collected from targeted respondents. It also offers a detailed explanation of the research method, including the Shapiro-Wilk test, arithmetic mean, Cronbach's alpha reliability test, Kruskal-Wallis H test, and Spearman's correlation test.

Chapter 4 shows the results of the questionnaire survey. The data obtained from the questionnaire was subjected to a variety of statistical analyses. The study's objectives were attained once the data was analysed and the findings were displayed in tables.

Chapter 5 provides a conclusion summarising the research findings, covering the research aim and objectives. This chapter also outlines the limitations encountered and offers reasonable recommendations for improving future studies on relevant topics.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The United Nations (UN) initially presented the concept of ESG in 2004 with the "Who Cares Wins" report (Billio *et al.*, 2021) and further advanced it in 2006 with the establishment of the Principles for Responsible Investment (Dutta, C., 2023). It is used in different contexts and has no specific definition. However, according to several research, ESG can be defined as a comprehensive framework used to evaluate and promote the environmental sustainability, social responsibility, and ethical governance of an organisation or business, that can impact its financial performance and potentially enhance its value by attracting investors who prioritise sustainable development (Li *et al.*, 2021; Ure *et al.*, 2024; Bezerra, Macedo, and Martins, 2024).

The rise of ESG considerations in recent years represents a fundamental shift in how industries across the globe operate (Dwimayanti *et al.*, 2023; Hoang, Nguyen, and Tran, 2024; Behl *et al.*, 2022). Traditionally, companies focused on financial performance, but for now, stakeholders are increasingly pressuring companies to act responsibly and incorporate sustainability and ethical practices into their core operations in addition to pursuing financial objectives (Melinda and Wardhani, 2020; Burke, Hoitash, and Hoitash, 2019). Therefore, ESG has emerged as a key framework that outlines specific criteria for companies to achieve a more sustainable and responsible business environment (Alsayegh, Rahman, and Homayoun, 2020). Thus, investors embraced these guidelines to help them incorporate ESG considerations into their decision-making (Martha & Khomsiyah, 2023). Globally, the ESG framework is becoming increasingly vital in the construction industry due to its substantial impact on the environment, communities, and governance practices.

The integration of ESG principles in construction projects offers a pathway to tackle these complications by promoting responsible use of resources, enhancing worker safety, and ensuring transparency and accountability. By adopting an ESG framework, construction companies can not only minimise environmental and social risks but also secure long-term profitability, attract ethical investments, and improve their reputations. As governments and regulatory bodies around the world introduce stricter environmental and social regulations, ESG compliance is no longer optional but a necessity for companies aiming to remain competitive and sustainable.

2.2 ESG Criteria

This section will list a total of 21 ESG criteria, where each category has 7 criteria. This section will be broken down into 3 subtopics, which are Environmental Criteria, Social Criteria, and Governance Criteria. Then, another specific 7 criteria will be listed out under each category with detailed elaboration.

2.2.1 Environmental Criteria

As stakeholders call for increased accountability and environmental stewardship, the necessity of sustainable and responsible construction practices has become critical (Wang and Xue, 2023). Therefore, the environmental criteria focus on reducing the adverse effects that construction activities have on natural resources and ecosystems. This aspect of ESG emphasises sustainable resource use, minimising emissions, and preserving biodiversity to mitigate climate change effects and environmental degradation. In construction, it means adopting practices that decrease the ecological footprint of projects, making them more sustainable and less harmful to the planet.

2.2.1.1 Carbon Footprint

Xu and MacAskill (2024) described carbon footprint as the total quantity of carbon emissions that are created by an activity or that have accumulated throughout a product’s life stages and supply chain. It is still the primary measure for determining the carbon emission level (Fang *et al.*, 2023). Therefore, a good measurement with a suitable amount of granularity and precision is necessary to manage precisely where reduction efforts should be prioritised. The idea of carbon footprint considers the environmental effects of carbon dioxide (CO_2) and other GHGs produced during different construction activities (Labaran, Mathur, and Farouq, 2021).

The Life Cycle Assessment (LCA) method was developed in the late 1960s to measure a product's environmental impact throughout its whole lifespan. It seeks to determine the potential environmental impact of any products or services from the point of origin (cradle) to the point of disposal (grave) (EvandroFenner *et al.*, 2018). Design, eco-labelling, material optimisation, and performance analysis are just a few of the many processes and procedures that LCA facilitates.

2.2.1.2 Energy Efficiency

Shove (2018) defined energy efficiency as the ability to provide more services for the same amount of energy input or the same services for less energy input. It is a critical component of the environmental criterion within the ESG framework, as reducing energy usage directly contributes to lower carbon emissions and mitigates climate change impacts.

Energy efficiency in construction projects can be achieved through various methods, including using renewable energy facilities like rooftop solar panels, and employing light-emitting diode lighting, which can save up to 75% of energy compared to traditional lighting options (Jia *et al.*, 2021; Kayode Olajiga *et al.*, 2024). Additionally, adopting building energy management systems and integrating smart technologies enhance overall energy performance, while renewable energy solutions like photovoltaic (PV) systems further reduce reliance on conventional energy sources, thus decreasing CO_2 emissions and promoting sustainability (Wang and Xue, 2023; Chen, *et al.*, 2024). Incorporating these practices not only meets regulatory demands but also improves building operational efficiency and attracts environmentally conscious investors, aligning the construction industry with global sustainability goals (Yoon *et al.*, 2023; Zhao *et al.*, 2023).

2.2.1.3 Waste Management

Although resource waste is a critical problem in many industries, the construction industry is among the most wasteful, accounting for around 40% of the solid waste produced annually from construction and demolition (C&D) operations. Debris produced during construction, maintenance, restoration, demolition, and natural calamities is referred to as construction trash (Qiao *et al.*, 2020). According to Barbir and Dabić (2024), construction waste is usually inert, which means it does not alter physically, chemically, or biologically. Besides that, the construction process produces liquid waste onsite, such as groundwater, rainwater runoff, and wash water used for trades (Karunasena *et al.*, 2024). Consequently, construction companies must implement comprehensive construction waste management strategies to mitigate the harmful effects of building operations.

To protect the environment, animals, and public health, construction waste must be managed properly. Construction managers are guided by a waste hierarchy that prioritises waste prevention, recycling, disposal, and other recovery activities. This hierarchy is in line with the principles of sustainable construction (Barbir and Dabić, 2024). Portable concrete crushers can be used to break down concrete into coarse and fine aggregates, which can then be recycled immediately (Rumambi *et al.*, 2023). Managing construction waste materials through recycling, source sorting, and prefabrication not only minimises environmental impact and conserves resources but also aligns with ESG compliance and improves sustainability in construction projects (Wu *et al.*, 2019).

2.2.1.4 Water Consumption

Water consumption is a critical aspect of construction projects, involving various activities like concrete mixing, dust suppression, and equipment cleaning. Approximately 16% of the world's water use is attributed to the construction industry, underscoring its influence on environmental sustainability (Khoo *et al.*, 2024).

As part of the environmental criteria of ESG, efficient water management in construction reduces the environmental footprint by minimising water wastage and adopting sustainable practices (Nový, Nováková, and Waldhans, 2019). To comply with ESG criteria, construction projects can implement several measures by using recycled water, installing rainwater harvesting systems, and optimising processes that require water, such as concrete curing and cleaning, to reduce overall water usage (Peng, Wu, and Wang, 2020). These practices not only align with regulatory requirements but also support broader sustainability goals, helping mitigate the environmental impact associated with high water consumption in the construction industry (Heravi and Abdolvand, 2019).

2.2.1.5 Biodiversity

The range of species, habitats, and genetic material found in an environment is referred to as biodiversity (Kopnina *et al.*, 2024). It is essential in maintaining the balance of natural ecosystems by supporting functions such as nutrient cycling, soil formation, and pollination. However, there are major detrimental effects on biodiversity from the construction industry, which uses about half of the non-renewable resources on the globe (Opoku, 2019). Activities like land clearing, urbanisation, and resource extraction lead to habitat destruction and fragmentation, contributing to the loss of species and ecosystem degradation.

As an environmental criterion of ESG compliance, biodiversity focuses on reducing these adverse effects by incorporating conservation strategies into project planning and execution. Compliance with biodiversity considerations in construction projects can be achieved by implementing green infrastructure solutions like green walls (Iligan and Irga, 2021). A well-studied form of green infrastructure, green walls are being utilised more and more in urban areas to integrate sustainability principles and green design into new construction projects (Lu *et al.*, 2020). This is because of their suggested advantages for urban areas, such as the reduction of urban heat, enhanced air quality, and the provision of biodiversity (Castiglia Feitosa and Wilkinson, 2020; Paull *et al.*, 2020; Huo, Yu, and Wu, 2018).

2.2.1.6 Standards and Regulations

Regulatory compliance ensures that construction projects reduce their environmental footprint by enforcing standards that promote sustainable practices, such as minimising carbon emissions and adopting cleaner technologies. It acts as a driver for companies to implement environmental management plans, which help manage the project's impact on the environment effectively (Esa, Halog, and Rigamonti, 2017).

To comply with regulatory requirements, construction projects can incorporate strategies like using sustainable materials, adhering to energy-efficient building designs, and implementing carbon accounting systems. Frameworks like the European Union’s zero-energy requirements and Australia’s National House Energy Rating Scheme 5-star standard push designers to adopt energy-efficient designs and low-carbon materials, aligning projects with global climate goals (Sizirici *et al.*, 2021). ISO 14031 offers guidelines for Environmental Performance Evaluations, helping companies assess their environmental impacts using various performance indicators, such as operational, management, and environmental condition indicators (Falqi, Alsulamy, and Mansour, 2020). Effective regulations and standards not only ensure sustainability but also encourage innovation in cleaner technologies, ultimately helping to improve the competitiveness of construction companies while contributing to environmental protection and achieving broader ESG objectives (Alsayegh, Abdul Rahman, and Homayoun, 2020).

2.2.1.7 Sustainable Construction Materials

To reduce the environmental impact induced by construction projects, which accounts for half of the global carbon emissions due to its high energy and raw material consumption, the concept of sustainable construction materials (SCMs) was proposed (Sadar Din and Ishak, 2024). With ongoing advancements in renewable materials, smart technologies, and sustainable supply chain management, SCMs help enhance resource efficiency and lower GHG emissions throughout the project lifecycle (Huo *et al.*, 2020; Huo *et al.*, 2018).

SCMs help to accomplish the UN's Sustainable Development Goals (SDGs) by minimising the depletion of natural resources, cutting waste, and lowering carbon emissions during production and consumption (Yap, Leow, and Goh, 2024). Complying with ESG compliance in construction projects involves integrating SCMs like recycled aggregates, eco-friendly building components like green roofs, rainwater harvesting systems, and advanced technologies like energy-efficient materials and LCA (Hossain *et al.*, 2020; Huo *et al.*, 2018). These practices support the shift towards a circular economy by prioritising sustainable material management and reducing reliance on non-renewable resources over the project's lifespan (Chan, Masrom, and Yasin, 2022). By adopting SCMs, construction projects can not only mitigate environmental impacts but also achieve financial benefits, such as reduced maintenance expenses and possible tax credits and incentive savings (Shurrab, Hussain, and Khan, 2019).

2.2.2 Social Criteria

Social criteria in ESG address the human-centered elements of construction projects, focusing on fair labor practices, community impact, and workplace conditions. These criteria are designed to ensure that projects are conducted ethically and positively influence the communities in which they operate. Social responsibility in construction encompasses promoting worker rights, fostering inclusivity, and creating safer, more equitable environments, which contribute to long-term project success and social welfare.

2.2.2.1 Workplace Well-Being

Workplace well-being is the state of being happy in one's workplace. It encompasses all facets of working life, according to the International Labour Organisation, from the components of the working environment to the feelings that employees have about their workplace (ILO, 2018). Many people believe that construction sites are among the most dangerous locations to work, and each year, labour-related illnesses and accidents claim millions of lives (Alhammadi *et al.*, 2024). Additionally, countless individuals experience non-fatal injuries, including psychological risks and stress.

A healthy workplace well-being is essential since it boosts employee performance and productivity. Carvajal-Arango, Vásquez-Hernández, and Botero-Botero (2021) found that development and projection, honours and acknowledgment, activity performed, physical workspace, and mental and bodily well-being were the most significant factors affecting workplace well-being in construction projects. Furthermore, a healthy psychological condition is a part of well-being. Newaz, Giggins, and Ranasinghe (2022) identified mental health prevention strategies at the individual, workgroup, and organisational levels in construction workplaces, such as seeking instrumental support from senior colleagues, offering recognition and resilience-building, and offering career development opportunities.

2.2.2.2 Occupational Health and Safety

The construction industry, which is recognised as one of the most dangerous industries globally, frequently experiences high rates of fatalities and injuries due to numerous occupational risks (Alejo, Aigbavboa, and Aghimien, 2024). Construction sites are rife with dangers, including heavy machinery, sharp tools, elevated platforms, flying debris, and sparks, making them inherently risky. Construction workers must wear personal protective equipment (PPE) to reduce these dangers (Obaju *et al.*, 2020). However, the effectiveness of PPE can sometimes be hindered by workers' resistance due to perceptions of the equipment as burdensome or bulky (Consunji *et al.*, 2020).

Occupational Health and Safety (OHS) is increasingly recognised as a critical aspect of social sustainability in the construction industry (Bashir *et al.*, 2024). Developing a formal OHS policy is essential for establishing a robust management system (Rahmi and Ramdhan, 2021). Standards such as OHSAS 18001:1999, which has transitioned to ISO 45001:2018, provide comprehensive frameworks for implementing OHS systems that meet international standards (Abdi, Hareru, and Umar, 2024). Construction project managers are responsible for creating and enforcing OHS plans that address diverse workplace hazards, including fall risks, electrical dangers, and exposure to hazardous materials (Bourahla, Fernandes, and Ferreira, 2024).

2.2.2.3 Workforce Diversity

Workforce diversity forms the basis for understanding workforce management (Nayeem, 2020) and the characteristics of workforce sustainability (Karakhan and Simmons, 2020). The similarity-attraction theory states that perceived differences between team members, including surface-level characteristics like age and ethnicity, and deep-level characteristics such as personality traits and work attitudes (Wang *et al.*, 2024).

In the construction industry, high workforce diversity offers significant potential for improving productivity and fostering sustainable practices. By leveraging the skills, experiences, and cultural backgrounds of diverse workers across sectors, construction companies can enhance knowledge transfer and promote innovation in construction projects (Won, Hwang, and Chng, 2021). Metro, Harper, and Bogus (2021) examined workforce recruitment issues in public transportation, emphasising that salary and promotional opportunities are key motivators. Similarly, Maurer, Choi, and Hur (2021) highlighted challenges for women in construction, such as limited gender diversity within engineering teams and fewer promotion opportunities. A study conducted by Metro, Harper, and Bogus (2021) utilised sensor data to assess workforce knowledge and skills, revealing that targeted training in key knowledge areas and skills development can enhance workforce capabilities in the construction industry. These results highlight how crucial it is to manage and promote workforce diversity to unlock its full potential for industry growth.

2.2.2.4 Socio-Economic Development

The socio-economic development of the construction industry contributes significantly by providing job creation, infrastructure development, and support for local businesses (Tafesse, Girma, and Dessalegn, 2022). Communities in proximity to construction projects, whether roads or buildings, often benefit economically, increase social interaction and create avenues for economic opportunities (Almahmoud and Doloi, 2020). Fostering the participation of local businesses, hiring local workers, and utilising locally sourced products or services can attract additional investment into the local economy and reduce environmental impacts, and minimise inconveniences for surrounding communities, while strengthening the economic resilience and social well-being (Montalbán-Domingo *et al.*, 2018).

Mega development projects provide substantial economic benefits by generating employment opportunities, addressing energy and irrigation needs, and achieving strategic developmental goals. Hussain *et al.* (2022) investigated how integrating socio-economic factors into local communities' daily activities might improve community development through public infrastructure projects. Construction activities in densely populated urban areas introduced unique challenges which can significantly affect residents and local economies. As a case study, the pipeline construction in Cairo demonstrated how its proposed model can identify the least disruptive construction plan and address resident relocation issues (Ibrahim, El-Anwar, and Marzouk, 2018). This enables planners to minimise socio-economic disruptions and align construction projects with broader goals of sustainability and community well-being.

2.2.2.5 Community Engagement

The needs, values, and aspirations of citizens and communities are integrated into various tiers and industries of policy development, strategic planning, decision-making, implementation, and evaluation. According to the 2005 Brisbane Declaration, while governments, businesses, and civil society involve stakeholders in these processes, community engagement is defined as a two-way process (United Nations, 2005). It is an ongoing endeavour that builds relationships within the community to understand their needs, often utilising forums such as interviews, surveys, or focus groups to create awareness and develop solutions tailored to addressing specific issues (Adabanya *et al.*, 2023). Such insights enable stakeholders to design services or programs that align with the community's priorities.

Building a community that addresses fundamental human needs requires significant effort and a thoughtful approach to engagement. Gil and Fu (2021) emphasised the importance of expanding the scope of responsibility in major construction projects through negotiations with the community. In agreement, Maddaloni and Sabini (2022) also emphasised the necessity of integrating external stakeholders, such as local communities, to guarantee social sustainability in mega construction projects and mitigate reputational risk. Similarly, Afieroho *et al.* (2024) proposed a framework with guiding principles to assist governments in adopting transformational approaches to community engagement. Community engagement fosters lasting networks, encourages cooperative action, and promotes public safety, thereby playing a pivotal role in creating equitable and resilient communities.

2.2.2.6 Accessibility to Social Infrastructure

Access to social infrastructure significantly influences people's quality of life worldwide. Social infrastructure, including schools, parking, public transport, and green spaces, form the backbone of public services and are essential for promoting sustainable development (Grum and Grum, 2020). Accessibility to these facilities is commonly measured using indicators such as number per capita, travel time, and travel distance (Guo *et al.*, 2024), which collectively evaluate their availability and equity in different regions.

Greco (2020) highlighted the shift from basic accessibility to inclusive design as a crucial element of social sustainability in urban spaces, emphasising the creation of environments that accommodate diverse groups, such as individuals with disabilities, the elderly, and children, to ensure equitable access to social infrastructure. Using Szczecin, Poland, as a case study, Chełstowska, Osypchuk, and Sosik (2024) demonstrated that while construction projects aim to enhance infrastructure, they often temporarily disrupt transportation networks, leading to challenges such as reduced mobility, longer travel times, and financial losses for local businesses. This underscored the importance of incorporating accessibility considerations in the early design phases of construction projects. Similarly, Fraser *et al.* (2024) identified stark disparities in accessibility linked to income levels, geographic location, and urban planning, advocating for targeted interventions to bridge these gaps and promote equity.

2.2.2.7 Cultural Heritage

Cultural heritage encompasses measures to protect architectural, archaeological, and paleontological resources, tribal cultural properties, and historic and artistic assets within areas impacted by construction projects (Montalbán-Domingo *et al.*, 2018).

Highlighted in the UN’s agenda for sustainable development, cultural heritage is important for fostering economic and social development, as emphasised in Goal 11 "Sustainable Cities and Communities", specifically Target 11.4, which seeks to “protect the world’s cultural and natural heritage” (Jokar *et al.*, 2024; Nocca, 2017). Nations with rich historical backgrounds are urged to safeguard their cultural assets against the pressures of urban development.

Historical sites and heritage buildings serve as tangible representations of a community's culture, promoting a sense of belonging and social cohesion (Almahmoud and Doloi, 2020). Khoo (2022) contrasted cultural sustainability approaches in George Town, Malaysia, and Kanazawa, Japan and stressed the need for cultural heritage to be at the core of sustainable urban planning. The study suggested adopting Kanazawa's model of fostering cultural diversity and heritage preservation through inclusive governance and urban planning. Similarly, Apostol, Mäkelä, and Vinnari (2023) highlighted the tension between economic interests and cultural preservation at the Rosia Montana mining site, underscoring heritage as a public good with intrinsic historical and cultural value. In post-crisis contexts, such as Baghdad, Fadhil and Ashour (2020) demonstrated how social sustainability practices, including community engagement and cultural activities, can revitalise heritage buildings, enhancing their physical, cultural, and social significance.

2.2.3 Governance Criteria

Organisational governance, according to the Project Management Institute (Project Management Institute, 2017), is a framework that supports value delivery systems in order to facilitate efficient workflows, handle problems and aid in decision-making. Project governance aligns with corporate governance because governance systems encompass monitoring, control, value evaluation, integration, and decision-making capacities (Evans and Farrell, 2023). Effective governance provides a framework for ethical leadership and regulatory compliance, safeguarding against corruption and fostering stakeholder trust. Strong governance practices are essential for maintaining public and investor confidence, enhancing the sector’s reputation, and promoting responsible project execution.

2.2.3.1 Transparency

In the complex world of construction, transparency is essential to maintaining the sustainability, effectiveness, and moral character of the industry. According to Elbashbishy, Ali and El-adaway (2022), transparency pertains to the availability and lucidity of project-related data, including expenses, schedules, performance indicators, and safety documentation. Abougamil, Thorpe, and Heravi (2023) asserted that transparency can foster a more cooperative environment and raise stakeholders' awareness of project dynamics.

The stakeholder theory states that increased transparency is essential to satisfying the needs of various stakeholders, including workers, clients, suppliers, the government, and the general public (Remo-Diez, Mendaña-Cuervo, and Arenas-Parra, 2024). One possible strategy to increase confidence and transparency in the construction industry is to integrate digital technologies. Mazzoli *et al.* (2021) emphasised that Building Information Modelling (BIM) technologies can promote data exchange and cooperative decision-making, increasing transparency across project lifecycles. Blockchain technology can guarantee data integrity, boost party confidence, and enable secure and transparent transactions in the construction industry (Gupta and Jha, 2023).

2.2.3.2 Anti-Corruption

International reports and research depict the construction industry as the most corrupt sector (Yap, Lee, and Skitmore, 2020). In construction, corruption is defined as the abuse of entrusted power and construction resources, to the detriment of the expected outcomes of construction projects, which manifest in various forms of corruption such as bribes, collusion, fraud, and so on manifests in all levels (Li and Adriaens 2023; Yu *et al.* 2019). Therefore, the construction industry is generally described as dishonest because corrupt practices transpire in all phases of a construction projects and among all levels of stakeholders (Leung, Ojo, and Ahmed, 2024), leading to loss of life, time and cost overrun, low productivity, building collapse, project abandonment, and so on (Kingsford Owusu and Chan, 2019; Yap, Chow, and Shavarebi, 2019).

The unique characteristics of construction projects in which multiple stakeholders are required, along with the high level of uncertainty that may result in corrupt behavior, thrive in the industry and remain inevitable. To successfully combat corruption in construction projects, Zarghami (2024) suggested implementing strict procurement policies, enhancing transparency through digital record-keeping, and promoting ethical leadership. Leung, Ojo, and Ahmed (2024) also emphasised the importance of fostering an ethical organisational culture by integrating anti-corruption training, whistleblower protection mechanisms, and third-party audits. The study concluded that a combination of regulatory enforcement and ethical leadership is essential for promoting integrity and accountability in construction projects.

2.2.3.3 Board Composition

As demands for greater accountability and transparency grow stronger, the functioning of the board of directors (BOD) has become a major focus in the corporate governance debate. The BOD is responsible for setting objectives, developing strategies to achieve these goals, establishing governance structures, and mitigating risks (Nurrizkiana *et al.*, 2024). Boards are essential in monitoring the opportunistic behavior of top management, thereby helping to prevent corporate misconduct (Lee *et al.*, 2018). This is especially important in the high-risk construction industry, where projects are often non-standardised and unforeseen events can arise during construction. Poor managerial decisions in this context can result in substantial costs to society, given that construction projects typically involve considerable labor, financial resources, and materials.

The construction industry is knowledge-based since carrying out construction tasks requires specialised expert knowledge and problem-solving abilities. This exclusive yet valuable information is essential for efficient project execution and enhancing organisational competitiveness (Lee *et al.*, 2018). Furthermore, companies should establish soft structures, such as a board manual outlining the BOD's responsibilities following relevant regulations, to ensure that the BOD effectively fulfills its role (Nurrizkiana *et al.*, 2024). Additionally, the structure and composition of the management team are critical to an organisation's success (Li, Zhang, and Yan, 2024). Gender diversity, in particular, enhances decision-making capabilities (Nguyen, Ntim, and Malagila, 2020) and has been linked to better voluntary carbon disclosure and improved quality of such disclosures, fostering increased transparency and accountability, which supports a low-carbon transition in the global economy (Caby, Coron, and Ziane, 2024).

2.2.3.4 Risk Management

Studies have proved that risk management is a key component of ESG compliance criteria (Oliver Yébenes, 2024; Meng and Shaikh, 2023). According to PMBOK (2018). A series of steps taken to increase the possibility and/or outcome of a positive risk while lowering the possibility and/or outcome of a negative risk is known as risk management. According to Okudan, Budayan, and Dikmen (2021), risk management entails determining the causes of unknowns, estimating the probability and effect of unknown events or conditions on a project, developing risk response plans, and lastly, monitoring the risks throughout the event. Given the risks that may develop during the project lifecycle, effective risk management is essential to the success of construction projects (Jackson and Priya, 2024).

Zhang (2024) presented the Risk Management Plan (RMP) concept and its practical application to the Grand Paris Express project as a case study. The RMP outlined a fair risk distribution among the customer, designer, and contractor, benefits all stakeholders, and meets all requirements. To reduce the dangers associated with subterranean construction, it made use of expertise, experience, and judgment in addition to a solid grasp of geotechnical and environmental conditions. All parties concerned must work together to execute the RMP in a cooperative atmosphere.

2.2.3.5 Stakeholder Engagement

A stakeholder refers to any individual, group, or organisation that can influence, be influenced by, or consider themselves impacted by the decisions, activities, or outcomes of a project, programme, or portfolio (Project Management Institute, 2013). Effective stakeholder engagement is critical in construction projects because it enhances commitment and aligns the goals of different parties with the organisation's values, ultimately improving project performance (Oliveira, Fernandes, and Pardini, 2023).

Given the complex nature of construction projects, which involve multiple professionals and parties, managing stakeholders efficiently is vital for project success (Cramer, 2023). Utilising tools like a stakeholder register helps to identify and prioritise key stakeholders, guiding communication strategies and preemptively addressing potential issues (Ebekozien, Aigbavboa, and Ramotshela, 2024). Additionally, empowering stakeholders through participation in decision-making and implementing governance systems can enhance engagement and facilitate smoother project execution (Tuan Son Nguyen and Mohamed, 2021). Establishing stakeholder platforms fosters collaboration and partnerships, contributing to optimal project outcomes by leveraging the collective expertise and insights of all involved parties (Haywood *et al.*, 2019; Figueiredo Filho, Bouzon, and Fettermann, 2021).

2.2.3.6 Ethical Leadership

For economies that rely on professional services to ensure financial accountability and uphold integrity across public and private sectors, galvanising ethical principles and enforcing appropriate governance standards are critical in construction projects (Kuoribo *et al.*, 2023). Ethical leadership is characterised by demonstrating morally appropriate behavior in personal actions and interactions while fostering the same conduct in followers through decision-making, communication, and reinforcement (Ren, Zhang, and Zhang, 2024). Setting an example, clearly conveying high performance standards to followers, and treating subordinates fairly are all components of ethical leadership (Ejaz *et al.*, 2021).

In construction projects, ethical leaders influence employee safety behaviours by exemplifying organisational norms in their conduct (Kaptein, 2019), serving as role models for their teams. Ethical management involves adherence to laws, regulations, and the establishment of ethical standards within organisations, ensuring decisions reflect the organisation's best interests (Li *et al.*, 2022). Moreover, corporate social responsibility strategies in construction often depend heavily on the moral beliefs and ethical leadership of senior leaders (Li *et al.*, 2019). Li *et al.* (2022) emphasised that ethical leadership also significantly reduces employee turnover rates by fostering trust, addressing concerns, retaining skilled workers, and improving workplace satisfaction, contributing to organisational stability and success.

2.2.3.7 Supply Chain Management

The construction industry has been progressively embracing supply chain management (SCM) as a means of enhancing the efficiency of construction deliveries. It includes a system of factories, distributors, retailers, suppliers, and customers in which information flows both ways and materials move from suppliers to customers (Ghamari, Abbasianjahromi, and Mirhosseini, 2024). Due to its capacity to effectively and efficiently manage intricate supply-chain networks, SCM has become more well-known in the industry in recent years (Wu *et al.*, 2021).

Sawant, Joshi, and Menon (2022) mentioned that the integration of blockchain technology in SCM in construction projects can ensure transparency, traceability, and trust through the creation of digital footprints for materials and activities, tracking their journey from production to delivery and payment. Moreover, stakeholders should enhance decision-making in areas such as transportation planning and partner selection. This can be achieved as the author reviewed the advancements in mathematical modelling and simulation techniques, necessitating tailored SCM approaches to align with project-specific requirements (Chen and Hammad, 2023).

2.3 Strategies for Improving ESG Compliance on Construction Projects

Achieving ESG compliance in construction projects is essential for fostering sustainability and accountability within the industry. As a sector characterised by high resource consumption and complex processes, the construction industry faces significant challenges in aligning operations with ESG principles. To address these challenges, it is crucial to implement targeted strategies that enhance environmental stewardship, promote social responsibility, and strengthen governance practices.

2.3.1 Enhancement of ESG Framework

The Listing Requirements of Bursa Securities Malaysia (Bursa Securities Malaysia Berhad, 2022), which are set by securities administrators, are the only sustainability criteria currently in place in Malaysia due to the absence of an ESG regulatory framework. Tang (2023) suggested establishing two ESG frameworks in Malaysia. The first is the creation of a specific regulatory framework that covers all the facets of ESG and explicitly identifies which businesses must adhere to it; ideally, this framework will be legally obligatory. Second, the third version of the guide reflects the disclosure structure, which is already comprehensive. Close adherence to a regulatory framework that outlines the main components and overall strategy of ESG in Malaysia would be advantageous for the guide. Regular conversations and consultations between the regulators and other stakeholders can offer avenues for gathering feedback and suggestions, ultimately fostering trust, transparency, accountability, and cooperation between the parties. This will help to facilitate stakeholder engagement in Malaysia for various purposes, including gaining support, deciding on reporting strategies, and assessing performance metrics.

To achieve the carbon neutrality objective, Malaysia is fully committed to playing a major role in the global shift to a low-carbon and eventually carbon-free society, which would be implemented alongside many efforts to promote green growth. According to Raihan *et al.* (2022), policymakers in Malaysia should support markets by establishing a robust regulatory structure that generates lasting benefits for decreasing emissions and persistently promoting innovative technologies that lead to a less environmentally damaging economy in order to prevent pollution at its source and alter the "pollute first, then treat" approach (Raihan et al., 2022). The real estate sector plays a crucial role in advancing ESG initiatives, particularly as governments worldwide implement policies such as Emissions Trading Systems (ETS) to regulate and mitigate the impacts of environmental and social control mechanisms. Lee and Liang (2024) investigated the impact of institutional frameworks, particularly carbon pricing mechanisms such as ETS, on the ESG performance of listed real estate companies. The findings reveal that stricter carbon pricing regulations, like ETS, significantly drive real estate companies to adopt more robust environmental initiatives, emphasising sustainability and innovation. Since a country's institutional context influences its regulatory pressures (Kölbel and Busch, 2021), policymakers are urged to enforce strict measures such as ETS to drive sustainability, while businesses are encouraged to embed ESG principles into their strategies to enhance competitiveness and retain investor confidence.

2.3.2 Influence of Governmental Support Policies

Governments in several nations have implemented ESG as a mandatory measure and offered incentives to promote its integration (Parameswar *et al.*, 2024). Companies with outstanding ESG performance or their investors can receive tax incentives to help alleviate the lack of support for integrating ESG into investment choices. By encouraging capital flows to companies that prioritise ESG, this strategy helps to strengthen ESG practices generally (Cherkasova and Nenuzhenko, 2022). This is consistent with the conclusions of Zumente, Bistrova, and Lace (2022), who suggested implementing particular laws and incentives, including tax breaks, reduced borrowing rates, and discounts for businesses that participate in sustainability projects. Similarly, Masyhur *et al.* (2024) emphasised the importance of government subsidies, loans, and financial incentives in encouraging green practices within Malaysia's construction industry, addressing hesitations due to perceived high costs. Tax incentives, feed-in tariffs, and stamp duty reductions for GBI-certified buildings are pivotal strategies used in Malaysia to encourage sustainable construction practices.

However, the lack of motivation among some companies to prioritise sustainability remains a concern, with many anticipating a decline in focus on sustainability, diverging from global trends of increased ESG emphasis (Bezerra, Martins, and Macedo, 2024). This underscores the need for stronger sustainability incentives, both nationally and internationally, to encourage businesses to prioritise ESG and contribute more significantly to achieving the SDGs. Government policies recognising and rewarding companies committed to sustainable practices are crucial to facilitating a greener and more responsible economy. Jonwall, Gupta, and Pahuja (2023) demonstrated the significant influence of tax benefits on individual investors' socially responsible investment behaviours in the United States, showing that such incentives guide investment decisions effectively.

In the realm of non-economic incentives, Simpeh and Smallwood (2024) highlighted the importance of award schemes and technical assistance in supporting green building practices in South Africa's construction market. However, He *et al.* (2020) observed that the information transmission mechanism may render green subsidies ineffective, as low government regulatory capacity struggles to identify contractors with genuine environmental practices due to information asymmetry. Consequently, contractors engaging in greenwashing behaviours are likely to secure subsidies intended for environmentally responsible contractors (Sun & Zhang, 2019). Therefore, the implementation of green subsidy strategies must enhance government regulatory capacity and carefully consider the dimensions of information transmission.

2.3.3 Adoption of Sustainable Building Materials

The construction industry remains the world's leading carbon emitter (Huang *et al.*, 2018), primarily due to the processes and products employed in conventional building practices. Sustainability is, therefore, a fundamental concept in many industries, and the construction industry is acknowledged as a key participant in this shift. Sustainable building materials (SBMs) are championed for their potential to reduce the environmental impact of construction projects, mitigate resource depletion, and address issues like pollution, GHG emissions, and ecosystem imbalances (Eze *et al.*, 2021). Recyclable, reusable, and environmentally neutral, SBMs are deemed "friends of the environment" and align with the principle of meeting present needs without compromising those of future generations. Despite their advantages, the adoption of SBMs in construction projects is hindered by barriers such as resistance to change and a lack of stakeholder awareness, as highlighted by Eze, Sofolahan, and Omoboye (2023). Addressing these challenges is essential to integrating SBMs into construction projects and retrofitting existing buildings to become greener.

In addition to encouraging modern construction methods, advanced and sustainable materials in the construction industry can greatly improve sustainability by lowering GHG emissions and lessening dependence on finite resources (Qian, Siriwardana, and Shahzad, 2024). By maximising local resources and promoting local economic growth through the use of alternative materials like geopolymer concrete (GPC) and interlocking blocks, Malaysia has advanced in the development of green building materials. Originating from agricultural waste, such as by-products of the palm oil industry, GPC is a practical substitute for traditional concrete that can cut carbon emissions from the production of Ordinary Portland Cement by up to 80% while providing better strength, durability, and fire and corrosion resistance (Ranjetha *et al.*, 2022). Given that Malaysia is the second-biggest palm oil producer in the world, the construction industry should take this advantage to produce and adopt GPC (Masyhur *et al.*, 2024). Similarly, interlocking compressed earth blocks are sustainable alternatives to traditional masonry and reduce embodied carbon emissions significantly (Abdullah *et al.*, 2020). According to an LCA from Asman *et al.* (2020), interlocking bricks emit nearly 40% less carbon than regular bricks. Furthermore, the effective recycling and reuse of C&D waste, particularly through recycled concrete aggregates (RCA), present another opportunity to conserve resources, lower landfill use, and reduce carbon emissions. Patil *et al.* (2024) detailed various methods for improving RCA quality, such as mechanical grinding, chemical treatments, and thermal methods, along with strategies like deconstruction and pozzolana slurry application to enhance durability and strength. Ultimately, as Abouhelal, Kamel, and Bassioni (2023) emphasised, selecting sustainable materials early in the project lifecycle is pivotal to minimising energy consumption, reducing waste, and mitigating carbon emissions. By refining material selection processes and overcoming adoption barriers, construction projects can achieve sustainability targets, enhance resource efficiency, and contribute meaningfully to climate change mitigation.

2.3.4 Optimisation of Energy Utilisation

As one of the most energy-intensive industries, the construction industry accounts for a significant share of global GHG emissions, energy consumption, and waste production (Masyhur *et al.*, 2024). In Malaysia, the construction industry contributes 24% of carbon emissions, with government buildings consuming 65% of their energy in operations alone. As the global population rises and demands for resources, including energy, continue to grow, the strain on natural ecosystems becomes increasingly evident (Hafez *et al.*, 2023). Energy consumption takes place throughout every phase of a construction project's lifecycle (Famiglietti *et al.*, 2022), from raw material extraction to machinery operation and building use, divided into embodied energy and operational energy. While operational energy makes up the majority of energy used in maintaining indoor environments through processes like heating and cooling, lighting, and appliance operation, embodied energy includes the energy stored in building materials during all production, on-site installation, and final demolition and disposal processes (Pakdel, Ayatollahi, and Sattary, 2021).

Recent technological advancements have introduced innovative strategies to improve energy efficiency in construction projects. Taha, Jasim, and Hatem (2020) highlighted the role of BIM technology in optimising energy use through simulations, daylight analysis, and integrating renewable energy sources like PV panels. By applying BIM during the design phase, significant reductions in energy consumption and associated costs were achieved, alongside improved thermal comfort and energy performance. Najjar *et al.* (2023) explored how ventilation apertures affected the energy efficiency of metal frame modular constructions using BIM, finding that smaller openings reduce HVAC energy demands, while larger ones enhance natural daylight access, lowering artificial lighting needs. In the context of building materials, Asim *et al.* (2020) examined natural fibre-reinforced lightweight concrete as a thermally efficient material, while Shi *et al.* (2022) showcased the climate-adaptive potential of optimised green roofs and natural night ventilation systems, achieving up to 12.2% annual energy savings. Furthermore, Tan *et al.*

(2025) evaluated smart PV windows, which combine electrochromic film and silicon solar cells, demonstrating their ability to significantly reduce energy loads, enhance daylight utilisation, and maintain occupant comfort. Collectively, these technologies illustrate the critical role of energy-efficient solutions in advancing sustainability and ensuring compliance with environmental standards in the construction industry.

2.3.5 Integration of Circular Economy Principles

The traditional linear model of construction has resulted in excessive waste generation and a lack of resource preservation through the process of extraction, production, use, and disposal (Benachio *et al.*, 2020). Throughout the building's life cycle, this detrimental environmental impact is visible, especially during the operation and end-of-life phases (Ruiz, Ramón, and Domingo, 2020) As a result, construction activities fall short of producing cleaner resources and being sustainable (Akanbi *et al.*, 2020). Therefore, circular economy (CE) has been proposed to minimise C&D waste and promote resource conservation in construction projects. Toxic chemicals are avoided because they prevent reuse and return to the biosphere, restoration is used in place of the end-of-life concept, renewable energy is used, and waste is to be eliminated through improved systems, products, and business model designs (Finamore and Oltean-Dumbrava, 2024). Through closed-loop production, by-product exchange, product reuse, and material recycling, CE is a means of achieving an economic system that prioritises protecting natural resources and minimising waste, in contrast to the existing linear economic paradigm (Bello *et al.*, 2024). By following the 9Rs framework, which tries to reduce material consumption and waste creation, a CE provides a workable substitute for the conventional linear economy (AlJaber, Martinez-Vazquez, and Baniotopoulos, 2024).

To accelerate CE adoption, Ogunjobi and Akinola (2024) advocated for enhanced regulations, financial incentives, technological advancements, and greater community and organisational engagement. For mega-scale construction projects, Alotaibi, Martinez-Vazquez, and Baniotopoulos (2024) emphasised the necessity of integrating CE principles across the project lifecycle, from design and procurement to operation and deconstruction, developing a comprehensive framework that incorporates CE principles into governance, regulatory policies, and organisational processes. Transitioning to CE requires both technological innovation and behavioural changes among stakeholders. Adabre *et al.* (2023) emphasised that CE is a socio-technical endeavour, necessitating systemic and integrated strategies to foster sustainability through resource reuse, waste reduction, and collaborative stakeholder engagement. Furthermore, traditional procurement practices often exclude contractors from early design and planning phases, limiting the integration of CE principles. Ahmed, Majava, and Aaltonen (2024) stressed the importance of collaborative procurement strategies that involve stakeholders, promote the use of recycled and reusable materials, and embed CE objectives into tender and contract documents. Additionally, GSCM provided a methodical way to transparently integrate supply chain participants and their operations (Xie *et al.*, 2022). While CE traditionally focuses on economic performance, GSCM places greater emphasis on environmental outcomes. This integration fosters collaboration and communication across the building lifecycle, advancing CE practices in the construction industry.

2.3.6 Adoption of Advanced Technologies

The world has started to transition to the Industrial Revolution 5.0 (IR5.0), and technological advancements will continue to advance. Currently, the most important factor reducing global warming is technical advancements. The Malaysian government has long placed a high importance on innovation, promoting the quick expansion of company scientific research endeavours, with technology innovation playing a bigger and bigger part (Raihan *et al.*, 2022). As part of its development trajectory, the construction industry in Malaysia is also adopting and gradually moving towards more economical, ecologically friendly, and sustainable solutions. Green Technology Master Plan and Rancangan Malaysia Ke-12 (RMK-12), which is the Twelfth Malaysia Plan, are just a few of the national initiatives that have promoted the use of technology within the industry. Furthermore, three-dimensional (3D) printing, innovative construction materials, Industrialised Building System (IBS), and construction machines are some examples of sustainable technologies that the Malaysian government encouraged the construction industry to employ in RMK-12 (Rahim *et al.*, 2023). Reduced CO_2 emissions may be the outcome of more patent applications, according to the study by Raihan *et al.* (2022), which examined the potential of technical innovation to lessen environmental deterioration in Malaysia. This suggests that improving Malaysia's environmental quality may be possible through the use of clean technologies in the industrial process.

Lee *et al.* (2024) proposed a methodology combining drone technology and BIM to improve hazardous waste lime earthwork management in construction projects. Unlike traditional methods requiring workers to enter dangerous areas with protective gear, drones enable safe data collection in hazardous zones, while BIM facilitates efficient project control, enhancing productivity and reducing project timelines. Moreover, the Blockchain-ESG Integrated framework was proposed by Gong *et al.* (2024) to provide a traceable and safe mechanism for managing ESG data for construction projects. Furthermore, Elrifaee *et al.* (2024) discovered how Internet of Things (IoT) technologies affect construction site safety, emphasising how IoT can mitigate risks and enhance safety management across three dimensions, which were labour monitoring, environmental monitoring, and site activities monitoring. When materials, production, and component installation were taken into account, the IBS reduced carbon emissions by 31.94% when compared to traditional construction methods, according to Zaini *et al.* (2020). IBS promotes sustainable construction by minimising on-site waste production and decreasing carbon emissions as well as health and safety risks (Masyhur *et al.*, 2024). Although work safety regulations provide rules for planning and preventing accidents, construction sites are environments that are prone to deviations, often as a result of inadequate training. Guimarães, Cavalcanti, and Vasconcelos (2024) highlighted how immersive technologies, such as virtual reality and serious games, improve workers' safety awareness and training efficacy by providing realistic, interactive simulations that allow users to experience and mitigate risks in a virtual environment.

2.3.7 Popularisation of Adopting Building Information Modelling

BIM is an information and communication technology that was developed to support the communication, project coordination and handling, and information demands from the stakeholders in the construction project life cycle (Rahim, Ismail, and Md Yusof, 2022; Rahim *et al.*, 2023). The capacity of BIM to replicate 3D modelling and perform clash detection, which guarantees design efficiency and project quality, is its most popular advantage over conventional techniques (Masyhur *et al.*, 2024). By integrating with green rating evaluation methods like GBI, it can analyse waste management, lighting, energy and water efficiency, and carbon production (Khoshdelnezamiha *et al.*, 2020; Solla *et al.*, 2022).

BIM was first used exclusively for internal government projects before being formally implemented by the Public Works Department (PWD) in 2007 to advance sustainable construction with technology (Zulkefli, Mohd-Rahim, and Zainon, 2020). The Malaysian government has mandated the use of BIM for projects worth above RM 100 million since 2020. The PWD set a goal to increase the rate of BIM adoption to 80% by 2025, however, as of 2019, it was only 49% (Ohueri *et al.*, 2019). According to a study, just 25% of Malaysian contractors are using BIM in their projects, even though the majority acknowledge its presence (Rahim *et al.*, 2020). Mamter, Mamat, and Abdul-Aziz (2017) discovered that the factors causing the delayed rate of BIM adoption were insufficient knowledge of BIM technicalities, reluctance to share knowledge, and inadequate guidelines. Windapo and Umeokafor (2023) emphasised the significance of implementing cutting-edge technologies like BIM and raising public awareness of the application in construction projects.

To improve a greater BIM adoption, strategies like providing BIM seminars or training, setting skilled design teams, and giving government subsidies and promotions were suggested to be implemented (Ohueri *et al.*, 2022). According to a systematic analysis, a variety of risk factors are interrelated and create feedback loops that increase their impact on the use of BIM in construction projects. To mitigate these risks, Zarghami (2024) recommended that holistic strategies are required, focusing on strengthening legislative clarity, enhancing technical capabilities, fostering organisational readiness, and ensuring robust data management practices. Manzoor *et al.* (2021) discovered the strategies for adopting BIM in sustainable construction projects in Malaysia and categorised them into four groups, which were standardisation-related, economic-related, awareness-related, and environment-related.

2.3.8 Enhancement of Corporate Governance

The construction industry is undergoing rapid transformation, particularly as a reaction to challenges like the COVID-19 pandemic (Nurdin Sutan Maruhun *et al.*, 2022), which exposed weaknesses in corporate governance (CG) practices among construction companies. During the pandemic, many companies within the industry failed to operate efficiently, with some even facing bankruptcy. These failures were frequently attributed to an insufficient knowledge and comprehension of CG principles, hindering the effective implementation of governance practices (Karsono, 2023). Smaller or newly established companies, constrained by limited resources, often struggle to employ the necessary expertise to uphold robust CG frameworks in construction projects. Effective governance is essential for integrating ESG compliance into corporate decision-making processes, thereby fostering accountability and transparency (Kartal *et al.*, 2024). It mitigates risks such as authority abuse by managerial staff and directors, enhances transparency in goal-setting and performance evaluation, and improves the company's reputation. A strong CG system incorporates key mechanisms such as board composition (Wang, 2023), board diversity (Wasiuzzaman and Subramaniam, 2023), board independence (Buchetti, Arduino, and Perdichizzi, 2025), and board size (Treepongkaruna, Kyaw, and Jiraporn, 2024), which play critical roles in aligning organisational strategies with sustainability goals.

Effective corporate governance, characterised by board diversity, independence, equity incentives, and strong external oversight, can alleviate the negative effect of ESG controversies on firm value. Wu *et al.* (2023) emphasised the importance of integrating governance practices to enhance ESG compliance, reduce controversies, and sustain firm value. Transparent communication and stakeholder trust emerge as critical factors, with robust governance fostering proactive risk management and alignment of managerial actions with long-term shareholder interests. Moreover, the integration of ESG dimensions into CG practices of construction projects has emerged as a priority. Many companies now link ESG-related incentives to executive compensation and establish sustainability committees (Cohen *et al.*, 2023). This holistic approach encourages the prioritisation of long-term value creation over short-term gains, committing companies to triple-bottom-line performance, balancing economic, social, and environmental objectives (Burke, 2022; Hussain *et al.*, 2018). For the construction industry, adopting such CG practices can drive sustainability, ethical management, and resilience in an increasingly complex and competitive environment. Moreover, team leaders tend to perceive senior subordinates as threats when they have extended tenure, leading to adversarial behaviours like negative feedback, career sabotage, and favouritism, creating a toxic work environment that undermines employee morale and performance to secure their positions. In this context, Evans and Farrell (2023) underscored the importance of balanced tenure policies and comprehensive governance frameworks to mitigate workplace conflicts and enhance team collaboration. CG is highlighted as a critical tool to address these issues by fostering transparency, ethical behaviour, and accountability, thus improving stakeholder trust and organisational sustainability.

2.3.9 Improvement in Ethical Leadership

Cheng *et al.* (2024) defined ethical leadership as exemplifying morally appropriate behavior through personal actions and interactions while fostering the same standards in followers via open communication, reinforcement, and decision-making. Unlike other morality-based leadership styles, such as transformational leadership, ethical leadership explicitly employs ethical standards to guide employees' behaviours through rewards and punishments (Hoch *et al.*, 2018). Freire and Bettencourt (2020) argued that ethical leadership imbues work roles with meaning, yielding positive outcomes for employee well-being. Ethical project leaders, guided by moral principles, address employee needs and role perceptions, fostering proactive behaviours. Furthermore, ethical leadership serves as a crucial sensemaking reference point, enabling leaders to model moral behaviour, inspire employees to internalise ethical principles, and encourage them to act ethically and efficiently (Zou *et al.*, 2022). Ethical leadership also plays a pivotal role in fostering goal commitment by leveraging ethical principles to influence subordinates and instill affective commitment towards organisational goals (Mubarak *et al.*, 2022). Hwang *et al.* (2020) observed that fair and preferential treatment enhances employees' positive perceptions and motivates their dedication to organisational objectives. As employee performance and ethical leadership can be directly or indirectly proportional, employees need ethical leadership to function well, and also, the impact of leadership on employee performance can be raised to a new level with solid corporate principles (Vasudevan, Hai Sam, and Thinakaran, 2023).

In the context of construction projects that are characterised by organisational temporality, team diversity, and task complexity, ethical leadership is particularly significant. Leaders with high levels of ethical leadership demonstrate honesty, integrity, and consistency, acting in the organisation's best interests, which aligns seamlessly with the ESG framework, as ethical leaders are better equipped to comply with regulations, address environmental concerns, and uphold employee rights (Li *et al.*, 2022). This contrasts sharply with abusive behaviours by fostering a supportive environment where workers feel valued and respected. Ju *et al.* (2024) highlighted that trust in managers can mitigate the adverse effects of abusive supervision, with affective-based trust and expressive guanxi closeness being more effective than instrumental counterparts. The results underscored the significance of developing interpersonal connections and trust to alleviate the consequences of negative leadership behaviors and improve worker well-being in high-pressure construction environments. A study by Ren, Zhang, and Zhang (2025) examined how project managers' leadership styles influence construction workers' safety behaviour, influenced by the alcohol conditions at construction sites and mediated by alcohol consumption. It revealed that ethical leadership positively affected workers' engagement and adherence to safety regulations by reducing alcohol consumption, whereas abusive leadership had the opposite effect, increasing alcohol use and decreasing adherence to safety protocols. Furthermore, corruption presents a critical barrier to public trust, economic growth, and effective service delivery, with issues such as state capture, patronage, and maladministration being widespread. Naidoo (2024) investigated corruption in South Africa's public sector and proposed ethical leadership and good governance as key strategies to combat these challenges. The study recommended measures such as strengthening legal frameworks, empowering anti-corruption agencies, enhancing whistle-blower protections, and promoting ethical leadership grounded in accountability, transparency, and professionalism to rebuild institutional integrity and foster public trust.

2.3.10 Collaborative Supply Chain Management

Due to resource depletion, climate change, and environmental deterioration, societies all over the world are facing previously unheard-of conditions. Growing social and environmental concerns are pushing the construction industry to “go green” (Badi and Murtagh, 2019). As a result, Green Supply Chain Management (GSCM) presents the possibility of a comprehensive strategy to support the construction industry’s transformation. According to Carvalho *et al.* (2020), GSCM is an evolution of supply chain management that integrates environmental thinking into every stage of the supply chain. By decreasing waste and improving processes, this emphasis on enhancing product quality throughout its lifecycle lessens the environmental effects of industrial activities while maximising economic gains (Marandi Alamdari *et al.*, 2023). The supply chain phases’ five main components of GSCM practices were identified as eco-design, green purchasing, internal environment management, customer collaboration for environmental issues, and investment recovery.

Amade (2021) revealed that increased awareness, market demand for green construction, and governmental incentives drive GSCM adoption, while managerial commitment, customer pressure, and enhanced education are essential for its successful implementation. However, by encouraging the creation of environmental performance metrics and incentive systems within businesses, GSCM can efficiently coordinate resource allocation, lower transaction costs, and result in Pareto improvements in energy use through methodical optimisation, which will propel the entire supply chain’s shift to low-carbon practices (Wang, Duan, and Zheng, 2025). In addition, by fostering relational trust and enhancing suppliers' environmental innovation capabilities, GSCM promotes effective carbon information exchange and supports long-term sustainability goals. Durable customer-supplier relationships are critical for these outcomes, as highlighted by Liew and Cao (2024), offering actionable insights for companies and policymakers to enhance supply chain sustainability. Xie *et al.* (2022) underscored the importance of governmental assistance, which was crucial for encouraging cooperation and boosting the use of GSCM, improving economic and environmental performance.

2.4 Summary of Chapter

This chapter explores the fundamental concepts of ESG compliance in construction projects, emphasising its significance in sustainable development. The chapter begins by introducing ESG and outlining a total of 21 ESG criteria that can be complied with in construction projects. It also reviews the literature on ESG principles, discussing their role in mitigating environmental impact, fostering social responsibility, and ensuring ethical governance practices. To enhance compliance, a total of 10 strategies for improving ESG compliance in construction projects are introduced. The chapter further highlights case studies and empirical research, demonstrating the tangible benefits of ESG compliance in improving project performance, enhancing corporate reputation, and attracting sustainable investments. By synthesising existing studies, it lays the foundation for evaluating ESG integration in construction projects and identifying areas for improvement.

CHAPTER 3
METHODOLOGY

3.1 Introduction

This chapter presents the selection of the research methodology for this study. It also explains the research method and the process of conducting the literature review. This chapter also outlines the sampling method, data collection methods, questionnaire survey design, and the method used for data analysis.

3.2 Research Method

According to Saunders, Lewis, and Thornhill (2016), "research" is the methodical process of obtaining and evaluating data to comprehend the phenomenon being studied. Additionally, research methods are generally divided into three groups: mixed methods, qualitative methods, and quantitative approaches. Since every approach has distinct qualities, advantages, and disadvantages that achieve particular research goals, the choice of approach is contingent upon the nature of the study.

3.2.1 Quantitative Research Approach

Hammond and Wellington (2020) defined quantitative research as a technique that collects data in numerical form, enabling statistical analysis to describe, explore, and explain various phenomena. It is associated with methodologies such as big data, experiments, surveys, systematic reviews, and meta-analysis. Unlike qualitative research, quantitative data does not require coding but must be cleaned before analysis to address missing values and ensure accuracy. In this method, research starts with a theory, followed by data collection to accept or reject the theory, and then proceeds with revisions or additional testing to refine the theory (Creswell and Creswell, 2018).

Quantitative research entails gathering and analysing numerical data because quantitative research is neither skewed nor influenced by the researcher, its results will be reliable and accurate (Creswell, 2015). The ability to extrapolate results to bigger samples or wider populations is another benefit of quantitative research. Larger sample sizes are used in quantitative approaches (Creswell & Creswell, 2018) to guarantee that results are representative of the entire population and to permit more precise forecasts. Furthermore, researchers can test hypotheses and determine causal correlations between variables using quantitative research methods (Neuman, 2014), which makes them especially helpful for analytical and predictive analysis.

One of the disadvantages of quantitative research is its lack of context and depth. This restriction results from the fact that gathering numerical data is the main goal of quantitative research (Neuman, 2014). Consequently, it does not offer a thorough grasp of the research subject and limits the capacity to investigate complicated phenomena in depth. The validity of research findings may be impacted by the sample size. While managing a big sample size might be time-consuming, a small sample size may lead to reduced accuracy of the results. Because the study strategy is usually predetermined and structured, quantitative research tends to be rigid (Creswell, 2015). This limits the ability to collect detailed feedback or carry out in-depth follow-up on the findings since it is challenging to adapt if unanticipated problems emerge throughout the research process.

3.2.2 Qualitative Research Approach

Hammond and Wellington (2020) referred to qualitative research as data generated in non-numeric forms, such as texts, images, sounds, and videos, requiring specific strategies like coding and categorisation to identify patterns. This method also entails gathering, evaluating, and interpreting data by observing people's conversations and activities (Rajput, 2023). Qualitative data can still be analysed quantitatively, such as in content analysis where codes are counted to show response distributions.

An in-depth understanding is one of the benefits of qualitative research. This is due to qualitative data gathering techniques such as open-ended interview questions and verbal descriptions of observations (Sekaran and Bougie, 2016). As a result, it enables researchers to engage with individuals in-depth to fully comprehend their perspectives and experiences. Additionally, the use of open-ended questions gives qualitative research a flexible structure (Creswell & Creswell, 2018). In other words, because predetermined questions or particular measurement instruments do not constrain qualitative research, researchers can communicate their findings more freely.

On the other hand, qualitative research is subjective and depends on individual experiences, viewpoints, and actions (Denicolo, Lathlean, and Denicolo, 2022). This indicates that the information gathered is predicated on unique perspectives and particular situations. The subjective character of qualitative research may also increase the likelihood of researcher bias, which could compromise the reliability and validity of the findings. It might be challenging to extrapolate the results to a larger population or different contexts because they are frequently customised to the specific environment, participants, and the researcher's interpretations. Furthermore, compared to quantitative methods, qualitative methods typically take longer. This is because it entails extensive participant interaction and meticulous data analysis.

3.3 Justification of Selection

The quantitative research method is utilised to evaluate the research objectives in this study. The primary purpose is to investigate the ESG compliance in Malaysian construction projects. Therefore, it is essential to gather information from a broad range of participants to obtain precise results.

The questionnaire is chosen as the preferred method within quantitative research strategies to obtain a large number of responses. This choice is driven by the fact that quantitative research often involves large, randomly selected samples (Creswell, 2015). Besides sampling, this approach relies on numerical data and statistical analysis, which offers objective and measurable results that can be generalised to a broader population. Furthermore, the structured and standardised nature of quantitative research minimises the influence of the researcher's personal biases on both data collection and analysis. Moreover, quantitative methods often involve the use of statistical software like Statistical Package for the Social Sciences (SPSS) to streamline the data analysis process. This software allows researchers to efficiently test hypotheses, identify patterns, and quantify relationships between variables. As a result, data analysis with quantitative methods tends to be less time-consuming compared to qualitative methods.

3.4 Literature Review

The process begins with identifying key terms relevant to the study. In this study, the primary keywords were "ESG criteria", "construction projects", "sustainability", and others. The second step involves searching relevant literature from various sources and databases. In this study, sources were sourced from journals and articles available through ScienceDirect, Elsevier, Google Scholar, as well as reference books available on Google Books. The emphasis was placed on primary sources, such as journal articles, books, and conference papers, while secondary sources were used less frequently to provide a broad summary of the study. The next step involves assessing and identifying the literature relevant to the topic of the study. The fourth step is to organise this literature by summarising key points and taking detailed notes. The final step is writing the literature review. This involves summarising the insights and findings from the reviewed literature to give a thorough synopsis of the study topic.

3.5 Quantitative Data Collection

A questionnaire was developed for this study. A questionnaire is a set of inquiries made to people to gather statistically significant data about a subject (Gautam, 2024).

3.5.1 Questionnaire Survey Design

Sections A, B, C, D, and E were the composition of the questionnaire survey. Section A was developed to gather background information from the respondents, including the types of company business, professions, position level, years of working experience, and company size. In addition, Sections B, C, and D were developed to evaluate the ESG compliance levels on construction projects. Lastly, Section E was about the strategies for improving compliance levels on construction projects. A 5-point Likert scale was employed in Sections B, C, D, and E, which required respondents to rate each aspect based on their personal opinions. The scale for Sections B, C, and D went from 1 (not compliance) to 5 (excellent compliance), with 2 (low compliance), 3 (acceptable compliance), and 4 (high compliance) serving as intermediate choices. The scale for Section E went from 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree) and lastly, to 5 (strongly agree).

3.5.2 Sampling Determination

Since obtaining responses from the entire population is difficult, selecting a representative sample is preferred. From a broader population, the process of choosing a subset from it is known as sampling determination (Sekaran and Bougie, 2016). Construction practitioners, which included those employed by developers, consultants, contractors and subcontractor/supplier companies, were the target respondents for this study. Simple random sampling was employed as the probability sampling method in this research. Given that every practitioner has an equal chance of being chosen, the results are likely to be more generalisable and less prone to bias (Sekaran and Bougie, 2016). Hence, the Cochran formula was employed to determine the sample size.

With a 5.0% margin of error and a 95.0% confidence level, the above formula yielded 1.96 as the result for z-scores. As per the Department of Statistics Malaysia, the construction industry in Selangor and Kuala Lumpur employed 355,600 people in total in 2020. Accordingly, Selangor and Kuala Lumpur had a combined workforce of 4,321,100 (Department of Statistics Malaysia Official Portal, 2021). Consequently, the value of p was 0.082 and the value of q was 0.918. By applying these values to the Cochran formula, it is calculated that the sample size will be 116 individuals.

3.5.3 Questionnaire Distribution

When the questionnaire and sample size were decided, the targeted respondents were contacted through email or social media. Google Forms was used to create an electronic questionnaire for this study, which was then disseminated in two ways to Klang Valley construction practitioners where their projects were located. The first approach involved emailing the questionnaire directly to the companies, while posting the survey link on social media sites, including Facebook, Instagram, WhatsApp, WeChat, and LinkedIn was the second strategy.

3.6 Data Analysis

Data analysis will be carried out to generalise the results following the collection of information from the respondents via the questionnaire survey. The data will be examined in light of the study's objectives. All quantitative data for this study will be analysed using SPSS. The Shapiro-Wilk test, the arithmetic mean, the Cronbach's alpha reliability test, the Kruskal-Wallis H test, and the Spearman's correlation test were the analyses employed in this study.

3.6.1 Shapiro-Wilk Test for Normality

The Shapiro-Wilk test is a statistical test which is used to evaluate whether the distribution of observed values in each variable category significantly differs from a specified distribution (Saunders, Lewis, and Thornhill, 2016). Two hypotheses are set. The alternative hypothesis (H_1) contends that the data deviates from normality, whereas the null hypothesis (H_0) asserts that the data is normally distributed. The test results are interpreted using p-values. The data is not normally distributed when the p-value falls below 0.05, whereas a p-value exceeding 0.05 indicates that the data is normally distributed (Field, 2017).

3.6.2 Arithmetic Mean

One of the most well-known metrics of central tendency is the arithmetic mean, which is frequently used to characterise the centre of a quantitative variable's frequency distribution by giving each observation equal weight (Dodge, 2010). According to Lord, Qin, and Geedipally (2021), the frequency of each response option is multiplied, and the resulting sum is then divided by the overall frequency.

Additionally, this study adopts interval-level measurement, where each scale level is divided into regular intervals to evaluate the weighted mean (Pimentel, 2019). The mean ranking of the ESG compliance and strategies for improving compliance levels in this study were calculated by analysing the mean scores for each item in the questionnaire's Sections B, C, D, and E. The ESG compliance levels and the level of agreement on the effectiveness of strategies for improving compliance levels were categorised into five levels, as stipulated in Table 3.1.

Table 3.1 Scale to Measure ESG Compliance and Strategies for Improving Compliance Levels (Pimentel, 2019)

Scale	Intervals	Differences	Description
1	1.00 - 1.79	0.79	Not Compliance
2	1.80 - 2.59	0.79	Low Compliance
3	2.60 - 3.39	0.79	Acceptable Compliance
4	3.40 - 4.19	0.79	High Compliance
5	4.20 - 5.00	0.80	Excellent Compliance

3.6.3 Cronbach's Alpha Reliability Test

A statistical technique for determining if the items measure the intended construct is the Cronbach's alpha reliability test, which examines the internal consistency or reliability of data derived from Likert scale-based questions. Higher values indicate more consistency and reliability. The coefficient alpha, which has a range of 0 to 1, shows how well a set's items are positively associated with one another (Sekaran and Bougie, 2016; Wong *et al.*, 2025).

Cronbach's alpha is generally regarded to be acceptable if it is below 0.7, poor if it is below 0.60, and outstanding if it is above 0.80 (Sekaran and Bougie, 2016). It should be noted that eliminating an item typically has a negative impact on the measure's validity even while it increases its reliability. Moreover, the reliability test is widely applied in psychological research, the social sciences, and business surveys, including ESG compliance assessments in construction projects. Cronbach's alpha was utilised in this study to assess the internal reliability of Likert scale-based items in the questionnaire's Sections B, C, D, and E, ensuring the precision and consistency of the data collected.

3.6.4 Kruskal-Wallis H Test

Pallant (2020) described the Kruskal-Wallis test, also referred to as the Kruskal-Wallis H test, as a non-parametric counterpart to the one-way between-groups analysis of variance. Using ranking data, this test determines if three or more independent groups differ significantly from one another. The test compares the sum of ranks for each group after ranking the data for each group. The test statistic (H) follows a chi-square distribution, and if significant, it indicates that at least one group differs from the others. However, it does not specify which groups differ, requiring further post-hoc tests.

3.6.5 Spearman's Rank-Order Correlation Test

Spearman's rank-order correlation test is a non-parametric statistical test which is utilised to ascertain the direction and degree of a relationship between two ordinal variables (Dodge, 2010).

The correlation coefficient (ρ) that results from this measurement of the degree of relationship between two sets of data ranging from -1 to +1, where 0 denotes no correlation, -1 denotes a perfect negative correlation, and +1 denotes a perfect positive correlation (Morgan, 2013). In contrast to a negative correlation, which occurs when an increase in one variable is accompanied by a decline in the other, a positive correlation occurs when one variable rises together with the other (Weaver, 2018). According to Dancey (2004), a ρ-value above 0.40 indicates a strong relationship, while values below 0.39 suggest a weak relationship, and values under 0.19 denote a negligible relationship. This test is widely applied in research settings to evaluate relationships between ordinal variables, particularly in assessing consensus among respondent groups (Lord, Qin, and Geedipally, 2021). This test was employed in this study to assess the correlation between the environmental compliance, social compliance, governance compliance, and strategies for improving compliance levels. The interpretation of correlation strength is detailed in Table 3.2, which sheds light on the degree of relationship between the studied variables..

Table 3.2 Strength of Correlation for Spearman's Coefficient (Dancey and Reidy, 2004)

Spearman, ρ	Strength of Correlation
≥0.70	Highly significant correlation
0.40 - 0.69	Substantial correlation
0.30 - 0.39	Moderate correlation
0.20 - 0.29	Weak correlation
0.01 - 0.19	No or minimal correlation

3.7 Summary of Chapter

This chapter describes the research methodology by detailing the research method, design of questionnaire, determination of sampling, distribution of questionnaire, and data analysis. The study uses a quantitative research methodology, which enables the collection of numerical data to evaluate ESG compliance in Malaysian construction projects. A questionnaire survey was selected as the primary data collection method, ensuring a broad response pool while minimising researcher bias. The questionnaire is structured into multiple sections, covering respondents' backgrounds, ESG compliance assessment, and strategies for improvement, using a 5-point Likert scale to gauge compliance levels and agreement with proposed strategies.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Introduction

This chapter uses SPSS to analyse data from a survey questionnaire. It will provide a concise overview of the respondents' demographics and results on the ESG compliance and strategies for improving compliance levels in construction projects in Klang Valley, Malaysia. Additionally, quantitative analysis will be performed, including the Shapiro-Wilk test for normality, arithmetic mean, Kruskal-Wallis H test, Cronbach's alpha reliability test, and Spearman's rank-order correlation test.

4.2 Background of Respondents

101 sets of questionnaires were gathered from various types of respondents through email and social media platforms. As indicated in Table 4.1,. The demographic background of the respondents was determined by Section A of the questionnaire and included information on the types of company business, professions, position level, years of working experience, and company size.

Table 4.1: Overview of Demographic Information

Category	Items	Frequency (N=101)	Percent (%)
Types of Company Business	Developer	29	28.7
	Consultant	30	29.7
	Contractor	21	20.8
	Subcontractor / Supplier	21	20.8
Profession	Project Manager	23	22.8
	Architect	11	10.9
	C&S Engineer	20	19.8
	M&E Engineer	21	20.8
	Quantity Surveyor	18	17.8
	Others	8	7.9

Category	Items	Frequency (N=101)	Percent (%)
Position Level	Junior Executive	41	40.6
	Senior Executive	33	32.7
	Manager/ Team Leader/ Supervisor	10	9.9
	Assistant Director/ Technical Director	13	12.9
	Director	4	4.0
Years of Working Experience	Less than five years	62	61.4
	Five to ten years	26	25.7
	Eleven to fifteen years	12	11.9
	Sixteen to twenty years	1	1.0
	More than twenty years	0	0.0
Company Size	Less than five employees	0	0.0
	Five to twenty-nine employees	44	43.6
	Thirty to seventy-five employees	32	31.7
	More than seventy-five employees	25	24.8

Table 4.1 outlines the frequency and the percentage of the respondents in terms of types of company business, profession, position level, years of working experience, and company size. The data collected presents 28.7% from the developer, 29.7% from the consultant, and 20.8% from the contractor and subcontractor/supplier, respectively. Besides that, 22.8%, 10.9%, 19.8%, 20.8%, 17.8%, and 7.9% are the percentages for project manager, architect, civil and structural (c&s) engineer, mechanical and electrical (m&e) engineer, quantity surveyor, and others respectively, while the others are consisted of interior designer, site engineer, site supervisor, and sustainability expert.

Moreover, the data shows that 40.6% of the respondents are from junior executive, 32.7% are from senior executive, 9.9% are from manager/ team leader/ supervisor, 12.9% are from assistant director/ technical director, and 4.0% are from director. In addition, of the respondents, 61.4% have less than five years of working experience, 25.7% have five to ten years of working experience, 11.9% have eleven to fifteen years of working experience, and 1.0% have sixteen to twenty years of working experience, however, none of the respondents have more than twenty years of working experience. Other than that, the data also shows that no respondents come from company size with less than five employees, but there are 43.6%, 31.7%, and 24.8% respondents from company size with five to twenty-nine employees, thirty to seventy-five employees, and more than seventy-five employees, respectively.

4.3 Shapiro-Wilk Test for Normality

The Shapiro-Wilk test was employed in this study to determine whether the dataset collected from the ESG compliance survey in construction projects follows a normal distribution. This test is particularly suited for small to medium-sized samples ($n < 2000$), such as the one used in this study with 101 respondents.

According to the results shown in Table 4.2, all ESG-related variables, including those under Environmental Compliance (EC01–EC07), Social Compliance (SC01–SC07), Governance Compliance (GC01–GC07), and Strategies for Improving Compliance Levels (S01–S10), recorded significance (Sig.) values of less than 0.001. This strongly indicates that none of the variables are normally distributed, as all p-values fall below the 0.05 significance threshold. Consequently, the null hypothesis (H_0), which assumes the data is normally distributed, is rejected for every item.

This outcome implies that the distribution of responses across all ESG criteria deviates significantly from a bell-shaped curve. The non-normality may be attributed to the skewed distribution of respondent ratings, possibly influenced by subjective perceptions or differing ESG policy maturity among companies in the Malaysian construction industry.

From a methodological standpoint, this finding has direct implications for the selection of appropriate statistical analyses. Since the data does not meet the assumption of normality required for parametric tests, the study rightly relies on non-parametric alternatives such as the Kruskal-Wallis H Test and Spearman's Rank-Order Correlation, which are robust to non-normal data distributions.

In the context of ESG compliance, the non-normal distribution of responses may also reflect varied levels of awareness, implementation, and experience with ESG practices among construction stakeholders. For example, items such as EC06 = “Standards and Regulations”, SC02 = “Occupational Health and Safety”, and S07 = “Popularisation of Adopting of Building Information Modelling” may elicit more consistent high scores due to their prominence in industry discussions, while items like SC03 = “Community Engagement” or GC03 = “Board Composition” may vary greatly in perception and importance among respondents.

Table 4.2 Results of Shapiro-Wilk Test for Normality

Items	Shapiro-Wilk		
	Statistic	df	Sig.
EC01	0.856	101	<.0.001
EC02	0.857	101	<.0.001
EC03	0.888	101	<.0.001
EC04	0.850	101	<.0.001
EC05	0.852	101	<.0.001
EC06	0.790	101	<.0.001
EC07	0.897	101	<.0.001
SC01	0.833	101	<.0.001
SC02	0.817	101	<.0.001
SC03	0.808	101	<.0.001
SC04	0.831	101	<.0.001
SC05	0.861	101	<.0.001
SC06	0.855	101	<.0.001
SC07	0.845	101	<.0.001
GC01	0.835	101	<.0.001
GC02	0.832	101	<.0.001
GC03	0.839	101	<.0.001
GC04	0.837	101	<.0.001

Items	Shapiro-Wilk		
	Statistic	df	Sig.
GC05	0.845	101	<.0.001
GC06	0.853	101	<.0.001
GC07	0.850	101	<.0.001
S01	0.778	101	<.0.001
S02	0.777	101	<.0.001
S03	0.722	101	<.0.001
S04	0.777	101	<.0.001
S05	0.774	101	<.0.001
S06	0.736	101	<.0.001
S07	0.696	101	<.0.001
S08	0.747	101	<.0.001
S09	0.723	101	<.0.001
S10	0.748	101	<.0.001

4.4 Cronbach's Alpha Reliability Test

Table 4.3 indicates the results of the reliability analysis on environmental compliance, social compliance, governance compliance, and strategies for improving compliance levels.

Table 4.3 Results of Cronbach's Alpha Reliability Test

Items	Cronbach's Alpha	N of Items	Internal Consistency
Environmental Compliance	0.831	7	Excellent
Social Compliance	0.645	7	Acceptable
Governance Compliance	0.776	7	Good
Strategies for Improving Compliance Levels	0.704	10	Good

The 7-item environmental compliance construct has a Cronbach's alpha of 0.831. High reliability is indicated by this value, which is far higher than the generally recognised cutoff of 0.7. The items within this category demonstrate strong internal consistency, suggesting that they effectively measure the same underlying construct related to environmental criteria in ESG compliance. The social compliance construct, which also consists of 7 items, obtained a Cronbach's alpha of 0.645. While this value is below the commonly accepted threshold of 0.7, it still indicates moderate internal consistency. For governance compliance, Cronbach's alpha was 0.776 across 7 items, demonstrating good reliability. This indicates that the items used to measure governance-related aspects of ESG compliance are internally consistent and reliable. The strategies for improving compliance levels construct, which includes 10 items, yielded a Cronbach's alpha of 0.704. While this is slightly above the 0.7 threshold, it indicates acceptable reliability.

4.5 Arithmetic Mean

The mean values of ESG compliance, along with overall ESG compliance and strategies for improvement, were evaluated and ranked to assess ESG compliance levels and identify potential strategies for enhancing compliance in Malaysian construction projects in this section.

4.5.1 Mean Ranking of Environmental Compliance

Table 4.4 shows the results of the mean ranking for environmental compliance. Among environmental compliance criteria, EC06 = "Standards and Regulations" and EC04 = "Water Consumption" ranked as the highest two criteria, with a mean score of 4.05 and 3.79, respectively. This implies that regulatory frameworks and water conservation measures are considered to have high environmental compliance in construction projects. The prioritisation of standards and regulations suggests that construction companies recognise the critical role of environmental policies in guiding sustainability practices. According to Huang *et al.* (2024), this supports the result that underlined the importance of regulatory frameworks in directing sustainable construction practices.

Additionally, the high ranking of water consumption signifies the industry's growing awareness of water scarcity challenges and the importance of efficient water management strategies in construction activities. Therefore, it is crucial to identify processes and activities with high water consumption, quantify their respective water demands, and implement effective conservation measures throughout the construction phase (Irfeey *et al.*, 2023).

On the other hand, EC07 = “Sustainable Construction Materials”, with the lowest mean score of 3.47 in environmental compliance, suggests that while material sustainability is acknowledged, it may not be as actively prioritised as other criteria. Eze, Sofolahan, and Omoboye (2023) argued that while sustainable materials significantly contribute to reducing a project's environmental impact, their adoption is often hindered by inadequate regulations and funding for research and resistance to change.

Table 4.4 Mean Ranking of Environmental Compliance

Items	Criteria	Mean	Std. Deviation	Rank
EC06	Standards and Regulations	4.05	1.135	1
EC04	Water Consumption	3.79	1.194	2
EC05	Biodiversity	3.72	1.242	3
EC02	Energy Efficiency	3.71	1.244	4
EC01	Carbon Footprint	3.67	1.266	5
EC03	Waste Management	3.58	1.160	6
EC07	Sustainable Construction Materials	3.47	1.205	7

4.5.2 Mean Ranking of Social Compliance

Table 4.5 shows the results of the mean ranking for social compliance. SC02 = “Occupational Health and Safety” is perceived as the highest compliance criterion in social sustainability within construction projects, with the greatest mean score of 4.06. This highlights the industry's prioritisation of worker safety, aligning with Mohandes *et al.* (2022), who believed that comprehensive health and safety plans can enhance sustainability adoption and ensure that construction projects maintain long-term operational efficiency and workforce protection.

The second highest compliance criterion is SC04 = “Socio-Economic Development”, with a mean score of 3.98. This implies that reinforcing the industry's recognition of social contributions is pivotal towards sustainability initiatives. Just as mentioned in the study of Almahmoud and Doloi (2020), construction projects contribute significantly to local economic growth by boosting employment, improving infrastructure, and assisting regional companies.

In contrast, SC06 = “Accessibility to Social Infrastructure” received the lowest mean ranking in social compliance. This highlights that infrastructure accessibility may not be a primary consideration in ESG compliance within construction projects. The lower emphasis on accessibility could be attributed to limited regulatory enforcement, lack of financial incentives, or a focus on other immediate project deliverables. However, this is contradicted by the study of Tsampoulatidis *et al.* (2022), which argued that efficiently managing accessibility concerns and meeting the specific needs of individuals with disabilities can lead to a thriving business environment and significant market potential.

Table 4.5 Mean Ranking of Social Compliance

Items	Criteria	Mean	Std. Deviation	Rank
SC02	Occupational Health and Safety	4.06	1.278	1
SC04	Socio-Economic Development	3.98	1.068	2
SC01	Workplace Well-Being	3.96	1.086	3
SC03	Workforce Diversity	3.93	1.194	4
SC07	Cultural Heritage	3.79	1.219	5
SC05	Community Engagement	3.78	1.154	6
SC06	Accessibility to Social Infrastructure	3.77	1.199	7

4.5.3 Mean Ranking of Governance Compliance

Table 4.6 shows the results of the mean ranking for governance compliance. GC03 = “Board Composition” is the highest-rated compliance criterion with the mean score of 3.98, suggesting that a well-structured and diverse board is substantial in the success of construction projects. This is in line with the study by Li, Zhang, and Yan (2024), which highlighted how a diverse management team could assist the company in making better decisions regarding its sustainability policies by bringing a wider range of insights and creative thinking to the table.

GC02 = “Anti-Corruption” is ranked as the second highest compliance criterion with a mean score of 3.94, suggesting that transparent anti-corruption disclosures and governance mechanisms are important in fostering corporate accountability and ethical business practices. As Utami and Barokah (2024) highlighted, government ownership, high-quality auditors, and strong regulatory frameworks significantly influence companies' commitment to disclosing anti-corruption measures, reinforcing the significance of accountability structures in the construction industry.

Contrariwise, the criterion with the lowest mean score in governance compliance is GC06 = “Ethical Leadership”, which is 3.76. This implies that while ethical leadership is recognised as important, it may not be prioritised over other governance criteria. However, Zhu, Zhi, and Fang (2025) highlighted that ethical leadership plays a crucial role in fostering regulatory compliance and transparency, which are essential for sustainable governance in construction projects. This additionally suggests that despite its lower ranking, ethical leadership remains a vital factor in promoting long-term accountability and trust among industry stakeholders.

The result also further revealed that all governance compliance criteria recorded mean scores below the 4.0 threshold. This contrasts with the environmental and social compliance categories, where at least one criterion in each exceeded 4.0. Even if it's the three highest-rated governance criteria suggest moderate recognition of governance priorities, yet not enough to classify any as “High Compliance”. This implies that governance compliance, although acknowledged, is not as strongly embedded in the daily operations of construction projects. Often viewed as broader corporate-level responsibilities, governance practices may be overlooked during project execution. This highlights the need for stronger awareness and integration of governance principles within project delivery frameworks.

Table 4.6 Mean Ranking of Governance Compliance

Items	Criteria	Mean	Std. Deviation	Rank
GC03	Board Composition	3.98	1.029	1
GC02	Anti-Corruption	3.94	1.103	2
GC01	Transparency	3.93	1.107	3
GC05	Stakeholder Engagement	3.88	1.125	4
GC04	Risk Management	3.87	1.172	5
GC07	Supply Chain Management	3.83	1.158	6
GC06	Ethical Leadership	3.76	1.218	7

4.5.4 Mean Ranking of Overall ESG Compliance

Table 4.7 outlines the results of the mean ranking for the overall ESG compliance. The analysis of overall ESG compliance reveals a diverse representation of criteria across all three ESG pillars. The top five ranked compliance items are SC02 = "Occupational Health and Safety", EC06 = "Standards and Regulations", SC04 = "Socio-Economic Development", GC03 = "Board Composition", and SC01 = "Workplace Well-Being". These findings reflect a relatively well-balanced perception of ESG priorities among construction practitioners, with a notable emphasis on social and regulatory considerations.

The highest-rated criterion, SC02 = "Occupational Health and Safety", signifies the industry's growing recognition of safety as a fundamental component of responsible project execution. The construction industry's inherently hazardous environment makes health and safety a pressing concern, often tied directly to legal compliance and worker welfare. Its position at the top reinforces the priority placed on ensuring physical protection, risk mitigation, and regulatory adherence on-site.

Following closely is EC06 = "Standards and Regulations", highlighting the importance of meeting environmental and legal compliance benchmarks, such as those defined under Malaysia's GBI. Its strong ranking indicates that practitioners value structured guidance and frameworks that define environmental expectations in construction projects.

SC04 = "Socio-Economic Development" and SC01 = "Workplace Well-Being" ranked third and fifth, respectively, underlining the growing awareness of construction's impact beyond physical infrastructure. Respondents recognise the importance of uplifting local communities through job creation, supporting small businesses, and fostering inclusive and healthy work environments. These priorities reflect broader social sustainability goals, which align with national development plans and the UN SDGs.

GC03 = "Board Composition", the sole governance criterion in the top five, stands out as a governance concern that resonates with practitioners. It likely reflects an increased awareness of how diverse and well-structured leadership can influence ethical project delivery and decision-making.

In summary, the overall ESG compliance ranking suggests that while environmental and social aspects are more prominently recognised in day-to-day construction practices, certain governance elements are also beginning to emerge as important. The results point to a maturing awareness of ESG integration within construction projects, particularly in areas tied to human well-being, legal requirements, and leadership accountability.

Table 4.7 Mean Ranking of Overall ESG Compliance

Items	Criteria	Mean	Std. Deviation	Rank
SC02	Occupational Health and Safety	4.06	1.278	1
EC06	Standards and Regulations	4.05	1.135	2
SC04	Socio-Economic Development	3.98	1.068	3
GC03	Board Composition	3.98	1.029	4
SC01	Workplace Well-Being	3.96	1.086	5
GC02	Anti-Corruption	3.94	1.103	6
GC01	Transparency	3.93	1.107	7
SC03	Workforce Diversity	3.93	1.194	8
GC05	Stakeholder Engagement	3.88	1.125	9
GC04	Risk Management	3.87	1.172	10
GC07	Supply Chain Management	3.83	1.158	11
EC04	Water Consumption	3.79	1.194	12
SC07	Cultural Heritage	3.79	1.219	13
SC05	Community Engagement	3.78	1.154	14
SC06	Accessibility to Social Infrastructure	3.77	1.199	15
GC06	Ethical Leadership	3.76	1.218	16
EC05	Biodiversity	3.72	1.242	17
EC02	Energy Efficiency	3.71	1.244	18
EC01	Carbon Footprint	3.67	1.266	19
EC03	Waste Management	3.58	1.160	20
EC07	Sustainable Construction Materials	3.47	1.205	21

4.5.5 Mean Ranking of Strategies for Improving Compliance Levels

Table 4.8 presents the mean ranking results for the ten proposed strategies aimed at improving ESG compliance levels in construction projects. All strategies achieved mean scores above the 4.0 benchmark, ranging from 4.25 to 4.52, indicating a uniformly high level of agreement among construction professionals regarding the relevance and importance of these strategies. This result reflects the awareness among industry stakeholders that ESG compliance is no longer a peripheral concern but a core component of responsible and sustainable construction delivery.

Leading the ranking is S07 = "Popularisation of Adopting Building Information Modelling", which received the highest mean score of 4.52. This suggests that BIM is widely recognised as a transformative tool capable of enhancing multiple ESG dimensions within construction projects. Its advanced features support integrated planning, real-time monitoring, and efficient resource management, aligning well with ESG goals. Al-Raqeb and Ghaffar (2025) affirm that BIM facilitates sustainability by enabling better life cycle analysis, minimising material wastage, and optimising construction logistics. As Malaysia continues to digitalise its construction sector under national blueprints such as the Construction Industry Transformation Programme, the strategic use of BIM will be critical in aligning project execution with environmental and governance standards.

Ranked second is S09 = "Improvement in Ethical Leadership", with a strong mean score of 4.45. This indicates widespread recognition that leadership plays a central role in institutionalising ESG values throughout project lifecycles. Ethical leadership drives a culture of compliance, fairness, and accountability—particularly vital in an industry that is often exposed to corruption risks, safety violations, and stakeholder conflicts. As Zahari *et al.* (2024) found, ethical leadership can effectively influence organisational behavior by discouraging unethical practices and fostering trust among employees and external stakeholders. In the context of construction, such leadership is essential for ensuring fair labour practices, responsible procurement, and equitable stakeholder engagement, cornerstones of social and governance performance under the ESG framework.

In third place is S06 = "Adoption of Advanced Technologies", with a mean score of 4.44. This reflects a growing appreciation for digital innovation as a lever for improving ESG compliance. Technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), and blockchain offer new capabilities in risk monitoring, energy efficiency, site safety, and transparent supply chain management. These tools enable real-time tracking of environmental impact, automate compliance reporting, and ensure traceability across construction activities. Rehman and Umar (2025) emphasised that Industry 5.0 technologies are instrumental in creating a more resilient and sustainable construction ecosystem, where data-driven decision-making enhances not only performance outcomes but also corporate responsibility.

The remaining strategies also achieved commendable scores, illustrating a consistent industry-wide commitment to ESG improvement. Strategies such as S08 = “Enhancement of Corporate Governance”, S10 = “Adoption of Green Supply Chain Management”, and S01 = “Enhancement of ESG Framework” all scored above 4.30, signalling support for structural reforms that extend beyond individual project sites. These strategies point to the need for regulatory alignment, cross-sector collaboration, and an ecosystem-wide approach to sustainability.

Collectively, the uniformly high mean scores across all ten strategies reinforce the conclusion that the Malaysian construction industry is not only aware of the challenges in ESG compliance but is also highly receptive to implementing strategic, forward-thinking solutions. The emphasis on digitalisation, ethical leadership, and systemic governance reflects a sector that is gradually moving toward maturity in ESG integration, an encouraging trend that aligns with both national sustainability goals and international best practices.

Table 4.8 Mean Ranking of Strategies for Improving Compliance Levels

Items	Strategies	Mean	Std. Deviation	Rank
S07	Popularisation of Adopting Building Information Modelling	4.52	0.657	1
S09	Improvement in Ethical Leadership	4.45	0.741	2
S06	Adoption of Advanced Technologies	4.44	0.670	3
S08	Enhancement of Corporate Governance	4.40	0.749	4
S10	Adoption of Green Supply Chain Management	4.39	0.761	5
S03	Adoption of Sustainable Building Materials	4.39	0.774	6
S04	Optimisation of Energy Utilisation	4.31	0.797	7
S01	Enhancement of ESG Framework	4.26	0.820	8
S05	Integration of Circular Economy Principles	4.26	0.856	9
S02	Influence of Governmental Support Policies	4.25	0.827	10

4.6 Kruskal-Wallis H Test

This section reveals the results for the Kruskal-Wallis test, which investigated the discernible distinctions in ESG compliance and strategies for improving compliance levels in construction projects across the demographic information of the respondents.

4.6.1 Kruskal-Wallis H Test on Types of Company Business

Kruskal-Wallis test is employed to determine the discernible distinctions in ESG compliance and strategies for improving compliance levels among various types of company business, including developers, consultants, contractors, and also subcontractors/suppliers. Given that four responder groups were evaluated, discernible distinctions are present when the chi-square value surpasses 7.815, which is determined by a degree of freedom of 3, and the p-value is less than 0.05.

4.6.1.1 ESG Compliance in Construction Projects

The following are the two hypotheses that were developed:

Null hypothesis (H_0): There is no discernible distinction across the types of company business on the ESG compliance if the H-value is less than 7.815.

Alternative hypothesis (H_1): There is a discernible distinction across the types of company business on the ESG compliance if the H-value is more than 7.815. the types of company business on the ESG compliance.

Table 4.9 Kruskal-Wallis H Test between Types of Company Business and ESG Compliance

Code	Criteria	Kruskal-Wallis H	Asymp. Sig.
EC05	Biodiversity	10.548	0.014*
EC06	Standards and Regulations	8.522	0.036*

The Kruskal-Wallis test results between corporate business types and ESG compliance are shown in Table 4.9. A p-value of less than 0.05 and an H-value of greater than 7.815 were found for two environmental criteria, EC05 = "Biodiversity" and EC06 = "Standards and Regulations," respectively. This suggests that developers, consultants, contractors, and also subcontractors/suppliers have rather different opinions about how effective certain compliance measures are. Thus, the null hypothesis (H_0) for the two compliance criteria is declined.

Table 4.10 Mean Ranking of Types of Company Business across ESG Compliance

Code	**Criteria**	**Types of Company Business**	**N**	**Mean Rank**
EC05	Biodiversity	**Developer**	29	**58.5**
		Consultant	30	57.83
		Contractor	21	46.07
		Subcontractor / Supplier	21	*35.81*
EC06	Standards and Regulations	*Developer*	29	*43.71*
		Consultant	30	**62.13**
		Contractor	21	44
		Subcontractor / Supplier	21	52.17

Note: **The highest mean rank is bolded**

The lowest mean rank is italicised

According to Table 4.10, it is discovered that the developer ranked the compliance level of the biodiversity criterion the highest. This suggests that developers play a pivotal role in biodiversity conservation through compliance with environmental regulations. As highlighted by Kimbowa and Mourad (2019), project developers should conduct thorough Environmental and Social Impact Assessments to ensure transparent communication of potential risks and adopt strategic interventions to mitigate adverse environmental effects. Furthermore, it is revealed that consultants have a higher mean rank than other types of company business in terms of standards and regulations criterion. This suggests that consultants play a critical role in ensuring compliance with environmental regulations and integrating sustainability measures within construction projects. As highlighted by Aung, Shengji, and Fischer (2020), the effectiveness of environmental impact assessments depends on the robustness of regulatory frameworks and their alignment with international best practices, reinforcing the consultant's responsibility in driving ESG adherence through rigorous environmental and regulatory evaluations.

4.6.1.2 Strategies for Improving Compliance Levels in Construction Projects

The following are the two hypotheses that were developed:

Null hypothesis (H_0): There is no discernible distinction across the types of company business on the strategies for improving compliance levels if the H-value is less than 7.815.

Alternative hypothesis (H_1): There is a discernible distinction across the types of company business on the strategies for improving compliance levels if the H-value is more than 7.815.

Although S08 = "Enhancement of Corporate Governance" has a very high H-value of 6.716, it is not lower than the p-value. Therefore, it is concluded that there are no discernible distinctions found between the types of company business and the strategies for improving compliance levels.

4.6.2 Kruskal-Wallis H Test on Professions

Kruskal-Wallis Test is undertaken to unveil the discernible distinctions in ESG compliance and strategies for improving compliance levels across different professions, including project manager, architect, civil & structural engineer, mechanical & electrical engineer, quantity surveyor, as well as others such as interior designer, site engineer, site supervisor, and sustainability expert. Given that six responder groups were evaluated, discernible distinctions are present when the chi-square value surpasses 11.070, which is determined by a degree of freedom of 5, and the p-value is less than 0.05.

4.6.2.1 ESG Compliance for Construction Projects

The following are the two hypotheses that were developed:

Null hypothesis (H_0): There is no discernible distinction across the professions on the ESG compliance if the H-value is less than 11.070.

Alternative hypothesis (H_1): There is a discernible distinction across the professions on the ESG compliance if the H-value is more than 11.070

Table 4.11 Kruskal-Wallis H Test between Professions and ESG Compliance

Code	Criteria	Kruskal-Wallis H	Asymp. Sig.
EC01	Carbon Footprint	13.093	0.023
SC03	Workforce Diversity	11.652	0.040
SC06	Accessibility to Social Infrastructure	14.926	0.011

Table 4.11 outlines the results of the Kruskal-Wallis test between professions and ESG compliance, wherein three criteria, EC01 = "Carbon Footprint", SC03 = "Workforce Diversity", and SC06 = "Accessibility to Social Infrastructure", have an H-value greater than 11.070 and a p-value less than 0.05. This suggests a significant difference in perspectives among the different professions regarding the effectiveness of these compliance measures. Thus, the null hypothesis (H_0) for these three compliances is declined.

Table 4.12 Mean Ranking of Professions across ESG Compliance

Code	Criteria	Types of Company Business	N	Mean Rank
EC01	Carbon Footprint	Project Manager	23	49.61
		Architect	11	54.27
		C&S Engineer	20	49.05
		M&E Engineer	21	56.38
		Quantity Surveyor	18	**60.67**
		Others	8	*19.50*
SC03	Workforce Diversity	Project Manager	23	40.78
		Architect	11	**66.55**
		C&S Engineer	20	50.40
		M&E Engineer	21	48.19
		Quantity Surveyor	18	63.42
		Others	8	*39.94*
SC06	Accessibility to Social Infrastructure	Project Manager	23	41.72
		Architect	11	58.77

C&S Engineer	20	52.70
M&E Engineer	21	54.17
Quantity Surveyor	18	**64.39**
Others	8	*24.31*

Note: **The highest mean rank is bolded**

The lowest mean rank is italicised

As exemplified in Table 4.12, it is shown that the quantity surveyor has a more significant mean rank in EC01 = "Carbon Footprint" and SC06 = "Accessibility to Social Infrastructure", while the architect has a higher mean rank in SC03 = "Workforce Diversity". The high mean ranking of quantity surveyors in EC01 = "Carbon Footprint" magnifies their significant role in managing and mitigating environmental impacts within construction projects. By integrating cost analysis with carbon footprint assessments, quantity surveyors can add value by acting as both cost and carbon management experts (Shehu, 2023). They can determine the carbon emissions of different developments using proven methodologies, and they can create carbon models that fit cost-planning formats, allowing for better decision-making (DOMINIC, 2023). Their ability to assess the financial viability of green building practices further reinforces their role in promoting environmentally responsible construction.

In terms of SC06 = "Accessibility to Social Infrastructure", quantity surveyors are crucial in managing project budgets and financial allocations to ensure the inclusion of essential public amenities, such as transportation links and community facilities. Their expertise in cost planning helps optimise resource distribution, indirectly enhancing accessibility and supporting social sustainability in construction projects (Kamaruddin, Adul Hamid, and Abd Ghani, 2020). Similarly, effective cost management directly impacts the feasibility and implementation of inclusive infrastructure, improving accessibility and enhancing the quality of life for surrounding communities (Sanmi and Ayodeji, 2019).

Furthermore, the high mean rank of SC03 = "Workforce Diversity" among architects reflects their diverse skills, experiences, and backgrounds, which contribute to fostering inclusivity within the construction industry. This aligns with Othman and Ibrahim Fouda (2022), who discovered that the workforce composition in architectural design companies will influence design innovation and project outcomes.

4.6.2.2 Strategies for Improving Compliance Levels in Construction Projects

The following are the two hypotheses that were developed:

Null hypothesis (H_0): There is no discernible distinction across the profession on the strategies for improving compliance levels if the H-value is less than 11.070.

Alternative hypothesis (H_1): There is a discernible distinction across the profession on the strategies for improving compliance levels if the H-value is more than 11.070.

Table 4.13 Kruskal-Wallis H Test between Profession and Strategies for Improving Compliance Levels

Code	**Strategy**	**Kruskal-Wallis H**	**Asymp. Sig.**
S01	Enhancement of ESG Framework	12.006	0.035

Table 4.13 shows the results of the Kruskal-Wallis test between professions and strategies for improving compliance levels, wherein the strategy, S01 = "Enhancement of ESG Framework", had a p-value less than 0.05 and an H-value greater than 11.070, respectively. This suggests that opinions on the effectiveness of this strategy vary significantly among professions. Thus, the null hypothesis (H_0) for this strategy is rejected.

Table 4.14 Mean Ranking of Professions across Strategies for Improving Compliance Levels

Code	**Strategy**	**Professions**	**N**	**Mean Rank**
S01	Enhancement of ESG Framework	Project Manager	23	45.2
		Architect	11	49.55
		C&S Engineer	20	54.13
		M&E Engineer	21	56.43
		Quantity Surveyor	18	61

Others	8	25.13

Note: **The highest mean rank is bolded**

The lowest mean rank is italicised

As illustrated in Table 4.14, the significant mean rank of quantity surveyors in S01 = "Enhancement of ESG Framework", a key strategy for improving compliance levels in construction projects, underscores their pivotal role in advancing sustainability initiatives. This implies that quantity surveyors highly recognise the importance of developing a structured ESG framework as a fundamental driver for sustainable construction practices (Wong *et al.*, 2025). By ensuring that sustainability metrics are embedded within financial planning and procurement strategies, quantity surveyors help establish a more transparent, accountable, and efficient ESG framework (Murphy, 2022).

4.6.3 Kruskal-Wallis H Test on Position Level

Kruskal-Wallis Test is taken to investigate the discernible distinctions in ESG compliance and strategies for improving compliance levels across different position levels, including junior executive, senior executive, manager/team leader/supervisor, assistant director/technical director, as well as director. Given that five respondent groups were evaluated, discernible distinctions are present when the chi-square value surpasses 9.488, which is determined by a degree of freedom of 4, and the p-value is less than 0.05.

4.6.3.1 ESG Compliance in Construction Projects

The following are the two hypotheses that were developed:

Null hypothesis (H_0): There is no discernible distinction across the position levels on the ESG compliance if the H-value is less than 9.488.

Alternative hypothesis (H_1): There is no discernible distinction across the position levels on the ESG compliance if the H-value is more than 9.488.

As all the H-values of the ESG compliance are less than 9.488, it is concluded that no discernible distinctions are found between the position levels and the ESG compliance.

4.6.3.2 Strategies for Improving Compliance Levels in Construction Projects

The following are the two hypotheses that were developed:

Null hypothesis (H_0): There is no discernible distinction across the position levels on the strategies for improving compliance levels if the H-value is less than 9.488.

Alternative hypothesis (H_1): There is a discernible distinction across the position levels on the strategies for improving compliance levels if the H-value is more than 9.488.

As all the H-values of strategies for improving compliance levels are less than 9.488, it is concluded that no discernible distinctions are found between the position levels and the strategies for improving compliance levels.

4.6.4 Kruskal-Wallis H Test on Years of Working Experience

Kruskal-Wallis Test is used to investigate the discernible distinctions in ESG compliance and strategies for improving compliance levels across different years of working experience, including less than five years, five to ten years, eleven to fifteen years, sixteen to twenty years, as well as more than twenty years. Although there are five groups of years of working experience, there are no respondents from the "more than twenty years" group. Therefore, only four groups of respondents were tested, discernible distinctions are present when the chi-square value surpasses 7.815, which is determined by a degree of freedom of 3, and then the p-value is less than 0.05.

4.6.4.1 ESG Compliance in Construction Projects

The following are the two hypotheses that were developed:

Null hypothesis (H_0): There is no discernible distinction across the years of working experience on the ESG compliance if the H-value is less than 7.815.

Alternative hypothesis (H_1): There is a discernible distinction across the years of working experience on the ESG compliance if the H-value is more than 7.815.

As all the H-values of ESG compliance are less than 7.815, it is concluded that there are no discernible distinctions found between the years of working experience and the ESG compliance.

4.6.4.2 Strategies for Improving Compliance Levels in Construction Projects

The following are the two hypotheses that were developed:

Null hypothesis (H_0): There is no discernible distinction across the years of working experience on the strategies for improving compliance levels if the H-value is less than 7.815.

Alternative hypothesis (H_1): There is a discernible distinction across the years of working experience on the strategies for improving compliance levels if the H-value is more than 7.815.

Although S05 = "Integration of Circular Economy Principles" has a very high H-value of 7.289, it is not lower than the designated H-value. Therefore, it is concluded that there are no discernible distinctions found between the years of working experience and the strategies for improving compliance levels.

4.6.5 Kruskal-Wallis H Test on Company Size

Kruskal-Wallis Test is employed to investigate the discernible distinctions in ESG compliance and strategies for improving compliance levels across different years of working experience, including less than five employees, five to twenty-nine employees, thirty to seventy-five employees, as well as more than seventy-five employees. Although there are four groups of company size, there are no respondents from the "less than five employees" group. Therefore, only three groups of respondents were tested, discernible distinctions are present when the chi-square value surpasses 5.991, based on a degree of freedom of 2, and the p-value is less than 0.05.

4.6.5.1 ESG Compliance in Construction Projects

The following are the two hypotheses that were developed:

Null hypothesis (H_0): There is no discernible distinction across the company size on the ESG compliance if the H-value is less than 5.991.

Alternative hypothesis (H_1): There is a discernible distinction across the company size on the ESG compliance if the H-value is more than 5.991.

Table 4.15 Kruskal-Wallis H Test between Company Size and ESG Compliance

Code	Criteria	Kruskal-Wallis H	Asymp. Sig.
EC03	Waste Management	6.509	0.039

Table 4.15 shows the results of the Kruskal-Wallis H test between the company size and ESG compliance, wherein the criterion, EC03 = “Waste Management”, has an H-value greater than 5.991 and a p-value less than 0.05. This suggests that opinions regarding the effectiveness of this strategy vary significantly between various company sizes. Thus, the null hypothesis (H_0) for this strategy is declined.

Table 4.16 Mean Ranking of Company Size across ESG Compliance

Code	Criteria	Company Size	N	Mean Rank
EC03	Waste Management	**Small**	44	**58.85**
		Medium	32	*42.56*
		Large	25	47.98

Note: **The highest mean rank is bolded**

The lowest mean rank is italicised

As showcased in Table 4.16, the environmental compliance, EC03 = "Waste Management," has a higher significance in small companies that consist of 5 to 29 employees, as these companies often operate with limited resources and emphasise cost-effective waste reduction strategies to enhance sustainability. Due to their constrained budgets, small companies are more likely to implement waste minimization practices to comply with environmental regulations while reducing operational expenses (Nabais and Franco, 2024).

4.6.5.2 Strategies for Improving Compliance Levels in Construction Projects

The following are the two hypotheses that were developed:

Null hypothesis (H_0): There is no discernible distinction across the company size on the strategies for improving compliance levels if the H-value is less than 5.991.

Alternative hypothesis (H_1): There is a discernible distinction across the company size on the strategies for improving compliance levels if the H-value is more than 5.991.

As all the H-value of strategies for improving compliance levels are less than 5.991, it is concluded that there are no discernible distinctions found between the company size and the strategies for improving compliance levels.

4.7 Spearman's Rank-Order Correlation Analysis

Tables 4.17, 4.18, 4.19, and 4.20 present Spearman's rank-order correlation analysis results for all ESG compliance and strategies for improving compliance levels. Among the 465 unique correlations, the number of positive correlations varied across ESG compliance and strategies for improving compliance levels.

As shown in Table 4.17, it was observed that environmental Compliance were more significant in comparison to the other groups, each of which demonstrated a positive correlation between 14 and 22. This implies that environmental compliance criteria, such as carbon footprint, energy efficiency, and water consumption, play a more interconnected role in ESG compliance than social and governance factors do. Moreover, environmental initiatives, such as waste management and water conservation, are widely supported by governmental policies and international sustainability commitments (Emmanuel, Ghani, and Nikolaiev, 2024; Sohu *et al.*, 2024), further reinforcing their strong associations with ESG compliance. Therefore, it is necessary to strengthen the integration of social and governance compliance with environmental strategies to achieve more balanced ESG implementation in construction projects. This is in line with Meiden and Silaban (2023), who emphasised that addressing environmental issues in isolation is insufficient and stressed the demand for a comprehensive strategy that takes into account the interconnectedness of ESG dimensions, enabling organisations to align their environmental goals with social and governance objectives. This can be achieved by aligning social compliance, such as OHS, workforce diversity, and cultural heritage, with sustainability efforts to ensure that ESG compliance is not only environmentally focused but also socially responsible. Likewise, governance compliance criteria, including transparency, anti-corruption, and ethical leadership, must be further integrated into sustainability frameworks to promote ethical decision-making and accountability in ESG adoption (Aziz *et al.*, 2024). Additionally, strategies such as the enhancement of the ESG framework and the integration of circular economy principles should be prioritised to establish a more structured and holistic approach to ESG compliance, ensuring that sustainability efforts align with both regulatory requirements and industry best practices.

In contrast, social compliance showed less significance than other groups, each of which demonstrated positive correlations between 12 and 22, as indicated in Table 4.18. It was observed that compliance criteria such as community engagement and cultural heritage had weaker intercorrelations both within the social compliance group and with environmental compliance, and governance compliance, and strategies for improving compliance levels. This further implies that social sustainability aspects in construction projects may operate more independently rather than being strongly linked to other ESG criteria. The rationale behind this is that social compliance often involves qualitative and community-driven factors, making them harder to quantify and standardise because of their subjective and contextual nature (Montalbán-Domingo *et al.*, 2021), in contrast to environmental and governance compliance. Unlike environmental regulations or corporate governance frameworks, which are well-defined through policies and measurable targets, social compliance criteria, such as cultural heritage conservation or accessibility to social infrastructure, rely more on stakeholder perceptions (Rostamnezhad and Thaheem, 2022). To address this, it is necessary to establish a precise categorisation of social compliance at different stages of the project life cycle, as these compliances vary from one stage to another (Kordi, Belayutham, and Che Ibrahim, 2021), ensuring better integration within the ESG framework. This can be achieved by strengthening stakeholder engagement processes (Wen and Qiang, 2022), incorporating social impact assessments into sustainability reporting (Fatourehchi and Zarghami, 2020), and examining the social responsibility of mega-infrastructure projects (Xue *et al.*, 2020), thereby ensuring a more structured and measurable approach to social sustainability in construction projects.

Additionally, the Spearman's correlation test results in Table 4.19 illustrated that governance compliance exhibited similar significance to environmental compliance, with each demonstrating between 14 and 22 positive correlations. This implies that governance compliance criteria, such as transparency, stakeholder engagement, and ethical leadership, are strongly interrelated with other ESG criteria.

These correlations indicate that well-structured governance mechanisms are crucial for ensuring environmental sustainability and regulatory compliance (Qaderi, 2025) within construction projects. The rationale behind this is that governance acts as an enabler for ESG compliance by providing the frameworks, policies, and accountability structures necessary for effective sustainability implementation (Annesi *et al.*, 2025). Unlike social compliance, which often relies on voluntary initiatives, governance measures are embedded in corporate policies, risk-management strategies, and regulatory requirements to ensure structured implementation and enforceability. As Abdulla and Elshandidy (2023) highlighted, governance frameworks are pivotal in enhancing risk management disclosure and regulatory compliance, demonstrating their structured nature. Similarly, Petrović, Orlandić, and Marković (2023) emphasised that legal and regulatory frameworks strengthen corporate governance and transparency, reinforcing their enforceability. To further strengthen governance integration within ESG strategies, reinforcing compliance monitoring, corporate accountability, and risk-management frameworks is essential. According to Efunniyi *et al.* (2024), robust governance mechanisms, including transparent reporting, strong board oversight, and ethical leadership, are important for ensuring regulatory adherence and maintaining accountability. The integration of Construction 4.0 technologies and Regulatory technology offers promising solutions for enhancing governance by automating regulatory processes, improving monitoring capabilities, and streamlining compliance procedures (Heijden, 2024). By embedding these governance enhancements within ESG frameworks, construction projects can achieve greater regulatory alignment, enhance operational transparency, and strengthen risk resilience, ultimately fostering a more sustainable and compliant built environment.

Table 4.20 presents the Spearman's correlation results for strategies aimed at improving compliance levels. Each strategy demonstrated between 2 and 21 positive correlations, averaging 10 correlations per item. This indicates that while some strategies, such as enhancement of the ESG framework, influence of governmental support policies, and improvement in ethical leadership, exhibited moderate associations with ESG compliance, many functioned as broader governance frameworks rather than being directly linked to specific ESG criteria. This implies that while some strategies are effective in driving compliance, their impact on specific ESG elements may be indirect or limited. The rationale behind this is that compliance strategies typically operate at a macro level rather than project-specific ESG concerns. Just as Brunet (2021) has mentioned, governance frameworks in megaprojects function at a macro level, ensuring regulatory enforcement and corporate governance structures. Additionally, ESG compliance should not just be about meeting regulatory requirements, but it should be fully integrated into the core strategic framework of construction projects to ensure that sustainability objectives are embedded within the project life cycle (Korkashvili, 2024). Therefore, it is necessary to refine ESG compliance strategies in construction projects by integrating targeted implementation mechanisms to strengthen their direct impacts on specific ESG criteria. According to Solaimani (2024), digital dashboards and key performance indicators monitoring can serve as a proactive compliance strategy by providing real-time visibility into ESG performance metrics, enabling organisations to track, analyse, and report key indicators with accuracy, transparency, and data-driven accountability. Ghazwani (2025) highlighted that integrating board cultural diversity with robust anti-corruption policies serves as a strategic compliance approach that enhances corporate transparency by mitigating governance risks and directly strengthening ESG concerns related to ethical leadership and stakeholder trust. Furthermore, Zhang *et al.* (2024) proposed a structured compliance strategy for architecture, engineering, and construction companies by integrating project-level ESG metrics, which directly enhance environmental sustainability through pollution prevention and resource utilisation, improve social responsibility via labour welfare and community engagement, and strengthen governance through regulatory adherence and ethical project management.

Table 4.17 Spearman’s Rank-Order Correlation Analysis between Environmental Compliance and Other Items

Items	EC01		EC02		EC03		EC04		EC05		EC06		EC07	
	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.
EC01	1.000		.491**	0.000	.381**	0.000	.349**	0.000	.400**	0.000	.397**	0.000	.454**	0.000
EC02	.491**	0.000	1.000		.282**	0.004	.431**	0.000	.342**	0.000	.428**	0.000	.468**	0.000
EC03	.381**	0.000	.282**	0.004	1.000		.353**	0.000	.231*	0.020	.327**	0.001	.438**	0.000
EC04	.349**	0.000	.431**	0.000	.353**	0.000	1.000		.352**	0.000	.341**	0.000	.204*	0.040
EC05	.400**	0.000	.342**	0.000	.231*	0.020	.352**	0.000	1.000		.323**	0.001	.291**	0.003
EC06	.397**	0.000	.428**	0.000	.327**	0.001	.341**	0.000	.323**	0.001	1.000		.392**	0.000
EC07	.454**	0.000	.468**	0.000	.438**	0.000	.204*	0.040	.291**	0.003	.392**	0.000	1.000	
SC01	0.191	0.056	.259**	0.009	0.180	0.072	.333**	0.001	.235*	0.018	0.171	0.087	0.071	0.482
SC02	.332**	0.001	.350**	0.000	.435**	0.000	.303**	0.002	.362**	0.000	.320**	0.001	.197*	0.048
SC03	.232*	0.020	.372**	0.000	0.114	0.257	.460**	0.000	.323**	0.001	.229*	0.021	.210*	0.035
SC04	.250*	0.012	.386**	0.000	0.154	0.123	0.187	0.061	.287**	0.004	.320**	0.001	.360**	0.000
SC05	.274**	0.006	.255*	0.010	.279**	0.005	0.183	0.067	-0.024	0.813	.229*	0.021	.264**	0.008
SC06	.514**	0.000	.384**	0.000	0.179	0.074	.435**	0.000	.383**	0.000	.234*	0.018	.287**	0.004
SC07	.244*	0.014	.230*	0.021	0.137	0.172	.216*	0.030	.358**	0.000	.221*	0.027	0.152	0.128
GC01	.217*	0.029	.329**	0.001	.300**	0.002	.331**	0.001	0.183	0.066	.315**	0.001	.327**	0.001
GC02	0.018	0.855	.203*	0.041	.237*	0.017	.217*	0.029	0.073	0.466	.257**	0.009	.372**	0.000
GC03	0.124	0.216	0.061	0.542	.271**	0.006	.316**	0.001	.231*	0.020	.236*	0.017	0.182	0.068

GC04	0.172	0.086	.250*	0.012	.222*	0.026	.215*	0.031	0.063	0.529	0.170	0.089	0.173	0.084
GC05	.293**	0.003	.359**	0.000	0.136	0.176	.340**	0.001	0.187	0.061	0.194	0.052	.396**	0.000
GC06	.310**	0.002	.489**	0.000	.369**	0.000	.436**	0.000	.298**	0.002	.376**	0.000	.389**	0.000
GC07	.203*	0.042	0.085	0.397	.249*	0.012	0.047	0.640	.198*	0.047	.237*	0.017	.302**	0.002
S01	.408**	0.000	.350**	0.000	0.133	0.184	.397**	0.000	.390**	0.000	.221*	0.026	.248*	0.012
S02	.279**	0.005	.323**	0.001	0.137	0.171	0.168	0.094	.274**	0.005	0.117	0.245	0.040	0.691
S03	0.172	0.086	.314**	0.001	-0.036	0.719	0.047	0.644	0.179	0.073	0.120	0.232	0.082	0.413
S04	0.142	0.157	0.046	0.649	0.030	0.770	0.118	0.239	0.019	0.848	0.075	0.454	0.056	0.577
S05	0.108	0.281	.244*	0.014	-0.005	0.961	.388**	0.000	.201*	0.044	0.080	0.428	-0.053	0.600
S06	0.128	0.201	-0.031	0.758	-0.095	0.343	-0.118	0.241	0.104	0.301	0.172	0.086	0.046	0.648
S07	0.060	0.552	0.031	0.761	-0.068	0.497	-0.013	0.897	0.073	0.465	0.013	0.901	-0.105	0.297
S08	0.143	0.153	0.033	0.744	0.050	0.619	-0.023	0.817	0.101	0.313	0.073	0.471	0.193	0.053
S09	0.052	0.603	0.166	0.097	0.162	0.106	0.105	0.298	0.135	0.179	0.128	0.201	.231*	0.020
S10	0.092	0.358	0.081	0.423	-0.003	0.974	0.152	0.128	0.080	0.424	0.155	0.121	0.137	0.172

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 4.18 Spearman's Rank-Order Correlation Analysis between Social Compliance and Other Items

Items	SC01		SC02		SC03		SC04		SC05		SC06		SC07	
	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	ρ	C. C.	ρ	C. C.	ρ

EC01	0.191	0.056	.332**	0.001	.232*	0.020	.250*	0.012	.274**	0.006	.514**	0.000	.244*	0.014
EC02	.259**	0.009	.350**	0.000	.372**	0.000	.386**	0.000	.255*	0.010	.384**	0.000	.230*	0.021
EC03	0.180	0.072	.435**	0.000	0.114	0.257	0.154	0.123	.279**	0.005	0.179	0.074	0.137	0.172
EC04	.333**	0.001	.303**	0.002	.460**	0.000	0.187	0.061	0.183	0.067	.435**	0.000	.216*	0.030
EC05	.235*	0.018	.362**	0.000	.323**	0.001	.287**	0.004	-0.024	0.813	.383**	0.000	.358**	0.000
EC06	0.171	0.087	.320**	0.001	.229*	0.021	.320**	0.001	.229*	0.021	.234*	0.018	.221*	0.027
EC07	0.071	0.482	.197*	0.048	.210*	0.035	.360**	0.000	.264**	0.008	.287**	0.004	0.152	0.128
SC01	1.000		.320**	0.001	.295**	0.003	0.094	0.349	-0.094	0.349	.248*	0.012	.269**	0.007
SC02	.320**	0.001	1.000		.338**	0.001	0.158	0.116	0.114	0.258	.236*	0.018	.256**	0.010
SC03	.295**	0.003	.338**	0.001	1.000		.268**	0.007	0.014	0.888	.379**	0.000	.236*	0.017
SC04	0.094	0.349	0.158	0.116	.268**	0.007	1.000		0.178	0.074	.204*	0.041	.227*	0.022
SC05	-0.094	0.349	0.114	0.258	0.014	0.888	0.178	0.074	1.000		.214*	0.032	0.134	0.182
SC06	.248*	0.012	.236*	0.018	.379**	0.000	.204*	0.041	.214*	0.032	1.000		0.160	0.111
SC07	.269**	0.007	.256**	0.010	.236*	0.017	.227*	0.022	0.134	0.182	0.160	0.111	1.000	
GC01	0.141	0.160	.373**	0.000	.319**	0.001	.363**	0.000	0.168	0.093	.295**	0.003	.200*	0.045
GC02	.345**	0.000	.255**	0.010	.204*	0.041	0.157	0.116	.233*	0.019	0.124	0.215	0.170	0.088
GC03	.201*	0.043	.300**	0.002	.310**	0.002	0.136	0.175	0.129	0.200	.291**	0.003	.248*	0.012
GC04	-0.082	0.415	.288**	0.003	0.189	0.059	0.192	0.054	.366**	0.000	0.165	0.098	0.189	0.058
GC05	.313**	0.001	.396**	0.000	.296**	0.003	0.195	0.051	0.119	0.235	.465**	0.000	0.131	0.192
GC06	.266**	0.007	.528**	0.000	.363**	0.000	.399**	0.000	.204*	0.041	.336**	0.001	0.175	0.081

GC07	0.082	0.412	.326**	0.001	0.165	0.098	0.141	0.159	.258**	0.009	0.140	0.162	.276**	0.005
S01	0.187	0.062	.332**	0.001	.480**	0.000	0.057	0.568	0.142	0.156	.475**	0.000	.332**	0.001
S02	.207*	0.038	.295**	0.003	.221*	0.026	0.123	0.221	-0.076	0.453	.286**	0.004	0.169	0.091
S03	0.010	0.919	.225*	0.024	.239*	0.016	.256**	0.010	0.069	0.492	0.120	0.232	.399**	0.000
S04	0.131	0.192	0.060	0.548	0.087	0.385	0.009	0.928	0.002	0.985	0.137	0.171	0.002	0.985
S05	0.129	0.199	0.113	0.261	.296**	0.003	0.114	0.258	0.095	0.344	.222*	0.026	.304**	0.002
S06	0.011	0.915	0.146	0.146	-0.041	0.684	0.153	0.126	0.020	0.839	0.056	0.577	0.089	0.374
S07	0.099	0.323	0.115	0.253	0.110	0.273	-0.001	0.993	-0.014	0.888	-0.016	0.877	0.128	0.200
S08	0.195	0.051	0.180	0.071	0.058	0.562	0.190	0.056	-0.030	0.767	0.153	0.128	.225*	0.024
S09	0.139	0.167	.334**	0.001	.333**	0.001	0.142	0.158	.202*	0.043	0.056	0.578	.273**	0.006
S10	-0.007	0.949	0.050	0.617	0.098	0.327	.261**	0.008	0.043	0.668	0.174	0.082	0.168	0.092

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 4.19 Spearman's Rank-Order Correlation Analysis between Governance Compliance and Other Items

Items	GC01		GC02		GC03		GC04		GC05		GC06		GC07	
	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.
EC01	.217*	0.029	0.018	0.855	0.124	0.216	0.172	0.086	.293**	0.003	.310**	0.002	.203*	0.042
EC02	.329**	0.001	.203*	0.041	0.061	0.542	.250*	0.012	.359**	0.000	.489**	0.000	0.085	0.397
EC03	.300**	0.002	.237*	0.017	.271**	0.006	.222*	0.026	0.136	0.176	.369**	0.000	.249*	0.012

EC04	.331**	0.001	.217*	0.029	.316**	0.001	.215*	0.031	.340**	0.001	.436**	0.000	0.047	0.640
EC05	0.183	0.066	0.073	0.466	.231*	0.020	0.063	0.529	0.187	0.061	.298**	0.002	.198*	0.047
EC06	.315**	0.001	.257**	0.009	.236*	0.017	0.170	0.089	0.194	0.052	.376**	0.000	.237*	0.017
EC07	.327**	0.001	.372**	0.000	0.182	0.068	0.173	0.084	.396**	0.000	.389**	0.000	.302**	0.002
SC01	0.141	0.160	.345**	0.000	.201*	0.043	-0.082	0.415	.313**	0.001	.266**	0.007	0.082	0.412
SC02	.373**	0.000	.255**	0.010	.300**	0.002	.288**	0.003	.396**	0.000	.528**	0.000	.326**	0.001
SC03	.319**	0.001	.204*	0.041	.310**	0.002	0.189	0.059	.296**	0.003	.363**	0.000	0.165	0.098
SC04	.363**	0.000	0.157	0.116	0.136	0.175	0.192	0.054	0.195	0.051	.399**	0.000	0.141	0.159
SC05	0.168	0.093	.233*	0.019	0.129	0.200	.366**	0.000	0.119	0.235	.204*	0.041	.258**	0.009
SC06	.295**	0.003	0.124	0.215	.291**	0.003	0.165	0.098	.465**	0.000	.336**	0.001	0.140	0.162
SC07	.200*	0.045	0.170	0.088	.248*	0.012	0.189	0.058	0.131	0.192	0.175	0.081	.276**	0.005
GC01	1.000		.439**	0.000	.264**	0.008	.234*	0.019	.344**	0.000	.387**	0.000	0.167	0.095
GC02	.439**	0.000	1.000		.226*	0.023	0.148	0.139	.286**	0.004	.453**	0.000	.265**	0.007
GC03	.264**	0.008	.226*	0.023	1.000		.284**	0.004	.234*	0.018	.254*	0.010	.384**	0.000
GC04	.234*	0.019	0.148	0.139	.284**	0.004	1.000		.313**	0.001	.356**	0.000	.323**	0.001
GC05	.344**	0.000	.286**	0.004	.234*	0.018	.313**	0.001	1.000		.476**	0.000	0.186	0.063
GC06	.387**	0.000	.453**	0.000	.254*	0.010	.356**	0.000	.476**	0.000	1.000		.199*	0.046
GC07	0.167	0.095	.265**	0.007	.384**	0.000	.323**	0.001	0.186	0.063	.199*	0.046	1.000	
S01	0.155	0.122	0.072	0.472	0.176	0.079	.212*	0.033	.374**	0.000	.268**	0.007	.204*	0.040
S02	0.070	0.490	-0.182	0.069	0.079	0.435	-0.062	0.535	.250*	0.012	0.092	0.363	0.061	0.542

S03	.211*	0.034	0.077	0.442	-0.060	0.552	0.153	0.126	0.139	0.165	.230*	0.021	-0.023	0.817
S04	0.110	0.274	0.090	0.373	0.077	0.442	-0.157	0.118	.238*	0.017	0.112	0.266	-0.066	0.514
S05	0.094	0.348	0.108	0.282	0.159	0.112	0.023	0.820	0.052	0.609	0.160	0.110	0.005	0.960
S06	0.092	0.359	-0.002	0.985	0.007	0.948	-0.075	0.458	0.073	0.470	-0.032	0.748	0.184	0.066
S07	-0.046	0.650	-0.042	0.678	-0.125	0.211	-0.187	0.062	0.095	0.347	-0.147	0.141	-0.040	0.693
S08	0.150	0.133	-0.019	0.847	0.166	0.096	0.058	0.566	.284**	0.004	0.073	0.467	0.159	0.113
S09	.217*	0.029	.321**	0.001	0.062	0.535	.205*	0.039	.229*	0.022	.269**	0.006	0.103	0.303
S10	0.192	0.055	0.118	0.240	.221*	0.026	.211*	0.034	0.193	0.053	0.153	0.127	.197*	0.048

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 4.20 Spearman's Rank-Order Correlation Analysis between Strategies for Improving Compliance Levels and Other Items

Items	S01		S02		S03		S04		S05		S06		S07		S08		S09		S10	
	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.	ρ	Sig.
EC01	.408**	0.000	.279**	0.005	0.172	0.086	0.142	0.157	0.108	0.281	0.128	0.201	0.060	0.552	0.143	0.153	0.052	0.603	0.092	0.358
EC02	.350**	0.000	.323**	0.001	.314**	0.001	0.046	0.649	.244*	0.014	-0.031	0.758	0.031	0.761	0.033	0.744	0.166	0.097	0.081	0.423
EC03	0.133	0.184	0.137	0.171	-0.036	0.719	0.030	0.770	-0.005	0.961	-0.095	0.343	-0.068	0.497	0.050	0.619	0.162	0.106	-0.003	0.974
EC04	.397**	0.000	0.168	0.094	0.047	0.644	0.118	0.239	.388**	0.000	-0.118	0.241	-0.013	0.897	-0.023	0.817	0.105	0.298	0.152	0.128
EC05	.390**	0.000	.274**	0.005	0.179	0.073	0.019	0.848	.201*	0.044	0.104	0.301	0.073	0.465	0.101	0.313	0.135	0.179	0.080	0.424
EC06	.221*	0.026	0.117	0.245	0.120	0.232	0.075	0.454	0.080	0.428	0.172	0.086	0.013	0.901	0.073	0.471	0.128	0.201	0.155	0.121

EC07	.248*	0.012	0.040	0.691	0.082	0.413	0.056	0.577	-0.053	0.600	0.046	0.648	-0.105	0.297	0.193	0.053	.231*	0.020	0.137	0.172
SC01	0.187	0.062	.207*	0.038	0.010	0.919	0.131	0.192	0.129	0.199	0.011	0.915	0.099	0.323	0.195	0.051	0.139	0.167	-0.007	0.949
SC02	.332**	0.001	.295**	0.003	.225*	0.024	0.060	0.548	0.113	0.261	0.146	0.146	0.115	0.253	0.180	0.071	.334**	0.001	0.050	0.617
SC03	.480**	0.000	.221*	0.026	.239*	0.016	0.087	0.385	.296**	0.003	-0.041	0.684	0.110	0.273	0.058	0.562	.333**	0.001	0.098	0.327
SC04	0.057	0.568	0.123	0.221	.256**	0.010	0.009	0.928	0.114	0.258	0.153	0.126	-0.001	0.993	0.190	0.056	0.142	0.158	.261**	0.008
SC05	0.142	0.156	-0.076	0.453	0.069	0.492	0.002	0.985	0.095	0.344	0.020	0.839	-0.014	0.888	-0.030	0.767	.202*	0.043	0.043	0.668
SC06	.475**	0.000	.286**	0.004	0.120	0.232	0.137	0.171	.222*	0.026	0.056	0.577	-0.016	0.877	0.153	0.128	0.056	0.578	0.174	0.082
SC07	.332**	0.001	0.169	0.091	.399**	0.000	0.002	0.985	.304**	0.002	0.089	0.374	0.128	0.200	.225*	0.024	.273**	0.006	0.168	0.092
GC01	0.155	0.122	0.070	0.490	.211*	0.034	0.110	0.274	0.094	0.348	0.092	0.359	-0.046	0.650	0.150	0.133	.217*	0.029	0.192	0.055
GC02	0.072	0.472	-0.182	0.069	0.077	0.442	0.090	0.373	0.108	0.282	-0.002	0.985	-0.042	0.678	-0.019	0.847	.321**	0.001	0.118	0.240
GC03	0.176	0.079	0.079	0.435	-0.060	0.552	0.077	0.442	0.159	0.112	0.007	0.948	-0.125	0.211	0.166	0.096	0.062	0.535	.221*	0.026
GC04	.212*	0.033	-0.062	0.535	0.153	0.126	-0.157	0.118	0.023	0.820	-0.075	0.458	-0.187	0.062	0.058	0.566	.205*	0.039	.211*	0.034
GC05	.374**	0.000	.250*	0.012	0.139	0.165	.238*	0.017	0.052	0.609	0.073	0.470	0.095	0.347	.284**	0.004	.229*	0.022	0.193	0.053
GC06	.268**	0.007	0.092	0.363	.230*	0.021	0.112	0.266	0.160	0.110	-0.032	0.748	-0.147	0.141	0.073	0.467	.269**	0.006	0.153	0.127
GC07	.204*	0.040	0.061	0.542	-0.023	0.817	-0.066	0.514	0.005	0.960	0.184	0.066	-0.040	0.693	0.159	0.113	0.103	0.303	.197*	0.048
S01	1.000		.398**	0.000	.284**	0.004	.196*	0.049	.311**	0.002	0.125	0.214	0.171	0.086	.232*	0.020	.228*	0.022	.238*	0.017
S02	.398**	0.000	1.000		.204*	0.041	0.085	0.396	0.145	0.149	.237*	0.017	.212*	0.033	.255**	0.010	0.102	0.308	0.158	0.113
S03	.284**	0.004	.204*	0.041	1.000		0.051	0.610	0.172	0.085	0.143	0.154	.252*	0.011	0.038	0.704	.281**	0.004	0.028	0.781
S04	.196*	0.049	0.085	0.396	0.051	0.610	1.000		.216*	0.030	.218*	0.028	0.102	0.310	.246*	0.013	.243*	0.014	.286**	0.004
S05	.311**	0.002	0.145	0.149	0.172	0.085	.216*	0.030	1.000		0.191	0.056	0.068	0.500	0.088	0.383	.231*	0.020	.259**	0.009

S06	0.125	0.214	.237*	0.017	0.143	0.154	.218*	0.028	0.191	0.056	1.000		0.135	0.180	.238*	0.016	0.124	0.216	.240*	0.016
S07	0.171	0.086	.212*	0.033	.252*	0.011	0.102	0.310	0.068	0.500	0.135	0.180	1.000		-0.055	0.582	0.063	0.531	-0.093	0.356
S08	.232*	0.020	.255**	0.010	0.038	0.704	.246*	0.013	0.088	0.383	.238*	0.016	-0.055	0.582	1.000		0.192	0.055	0.083	0.410
S09	.228*	0.022	0.102	0.308	.281**	0.004	.243*	0.014	.231*	0.020	0.124	0.216	0.063	0.531	0.192	0.055	1.000		.274**	0.006
S10	.238*	0.017	0.158	0.113	0.028	0.781	.286**	0.004	.259**	0.009	.240*	0.016	-0.093	0.356	0.083	0.410	.274**	0.006	1.000	

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

4.8 Summary of Chapter

Chapter 4 presents a comprehensive analysis of ESG compliance in construction projects based on quantitative research conducted among the demographic of respondents with ESG compliance and strategies for improving compliance levels. After receiving a total of 101 responses, various statistical analyses, such as the Shapiro-Wilk test, arithmetic mean, Cronbach's alpha reliability test, Kruskal-Wallis H test, and Spearman's correlation test, were applied to evaluate the data.

The Shapiro-Wilk test for normality shows that the null hypothesis of assuming that the data is normally distributed is rejected, indicating the dataset deviates significantly from a normal distribution.

Other than that, the outcome of arithmetic means presented that SC02 = "Occupational Health and Safety" and S07 = "Popularisation of Adopting Building Information Modelling" had the highest compliance in their current construction projects.

The Cronbach's Alpha reliability test results demonstrate that the Environmental Compliance achieved excellent internal consistency. The Governance Compliance and Strategies for Improving Compliance Levels are both classified as good, while the Social Compliance is deemed to be acceptable.

Additionally, the Kruskal-Wallis tests further examined the discernible distinctions in ESG compliance and strategies for improving compliance levels in construction projects across the demographic information of the respondents. For ESG compliance, it was found that the types of company business has resulted in two significant compliance criteria, which are EC05 = "Biodiversity" and EC06 = "Standards and Regulations". EC01 = "Carbon Footprint", SC03 = "Workforce Diversity", and SC06 = "Accessibility to Social Infrastructure" have discernible distinctions when analysing between professions and ESG compliance. Similarly, it was found that there were discernible distinctions between company size and ESG compliance, which is the criterion EC03 = "Waste Management". In terms of strategies for improving compliance levels, it was found that there is a discernible distinction in professions, which is S01 = "Enhancement of ESG Framework".

Furthermore, the results of the Spearman's Correlation test demonstrate that environmental compliance exhibited the highest number of significant positive correlations, whereas social compliance demonstrates weaker correlations. Meanwhile, governance compliance showed strong interrelations with both environmental compliance and social compliance. Lastly, the correlation results for strategies for improving compliance levels indicate that while some had moderate associations with ESG compliance, others operated more as macro-level governance frameworks rather than direct ESG interventions.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

As the final chapter of this study, section 5.2 reflects the achievements of the research objectives, section 5.3 discusses the research contributions, section 4 identifies the research limitations, and section 5.5 provides the research recommendations for future work.

5.2 Achievements of Research Objectives

This study successfully achieved its research objectives, as outlined in Chapter 1. The primary focus was to examine the ESG criteria relevant to construction projects, to evaluate the compliance of ESG practices on construction projects, and to suggest recommendations for improving ESG compliance in future construction projects in Malaysia. Through statistical analyses, including the Shapiro-Wilk test for normality, arithmetic mean, Cronbach's alpha reliability test, Kruskal-Wallis H test, and Spearman's rank-order correlation test, the study provided meaningful insights into the prioritisation and interconnectedness of ESG compliance and strategies for improving ESG compliance levels. These findings enhance the understanding of ESG compliance and its implications for sustainable construction practices in Malaysia.

5.2.1 Objective 1: To examine the ESG criteria relevant to Malaysian construction projects

The study successfully discovered key ESG criteria in Malaysian construction projects through thorough readings on past literature and concluded a total of 21 ESG criteria, where each category has 7 criteria. The identified environmental criteria are EC01 = "Carbon Footprint", EC02 = "Energy Efficiency", EC03 = "Waste Management", EC05 = "Water Consumption", EC06 = "Standards and Regulations", and EC07 = "Sustainable Construction Materials", while for social criteria, there are SC01 = "Workplace Well-Being", SC02 = "Occupational Health and Safety", SC03 = "Workforce Diversity", SC04 = "Socio-Economic Development", SC05 = "Community Engagement", SC06 = "Accessibility to Social Infrastructure", and SC07 = "Cultural Heritage". In terms of governance criteria, GC01 =

"Transparency", GC02 = "Anti-Corruption", GC03 = "Board Composition", GC04 = "Risk Management", GC05 = "Stakeholder Management", GC06 = "Ethical Leadership", and GC07 = "Supply Chain Management" are found.

5.2.2 Objective 2: To evaluate the compliance of ESG practices on construction projects

The study successfully identified key ESG compliance and strategies for improving compliance levels in Malaysian construction projects through an extensive survey and statistical analysis. From the findings, it is discovered that SC02 = "Occupational Health and Safety", EC06 = "Standards and Regulations", and SC04 = "Socio-Economic Development" have the highest compliance while EC07 = "Sustainable Construction Materials" and EC = "Waste Management" have the lowest compliance in construction projects. In evaluating which ESG criterion is the most important to be implemented, SC02 = "Occupational Health and Safety" clearly stands out. It should be prioritised across all construction projects, not only because of its immediate implications on human safety and regulatory compliance but also because it serves as a foundation for building trust, accountability, and responsible project execution. Strengthening safety protocols and fostering a proactive safety culture can significantly elevate the social dimension of ESG compliance, laying the groundwork for broader sustainability integration in the Malaysian construction industry.

5.2.3 Objective 3: To suggest recommendations for improving ESG compliance in future construction projects in Malaysia

Through thorough readings on past literature, the study successfully recognised a total of 10 strategies for improving compliance levels, which are S01 = "Enhancement of ESG Framework", S02 = "Influence of Governmental Support Policies", S03 = "Adoption of Sustainable Construction Materials", S04 = "Optimisation of Energy Utilisation", S05 = "Integration of Circular Economy", S06 = "Adoption of Advanced Technology", S07 = "Popularisation of Adopting Building Information Modelling", S08 = "Enhancement of Corporate Governance", S09 = "Improvement in Ethical Leadership", and S10 = "Collaborative Supply Chain Management".

5.3 Research Contribution

This study shows valuable insights into the current state of ESG compliance within Malaysia's construction industry, addressing a pivotal gap in the literature regarding ESG compliance and strategies for improving compliance levels. This research enhances the understanding of how different backgrounds of respondents from the construction industry prioritise ESG compliance and strategies for improving compliance levels, contributing to a more structured method for improving sustainability in the construction industry.

The research offers practical recommendations for improving ESG compliance in construction projects, which can inform policymakers and regulatory bodies. These recommendations could serve as guidelines for crafting more robust sustainability regulations or enhancing existing policies, ensuring that construction projects align with Malaysia's national development goals and international sustainability commitments like the Paris Agreement.

The study's focus on ESG impacts contributes to greater awareness of the role that construction projects play in issues such as carbon emissions, waste generation, worker safety, and corporate accountability. By emphasising the importance of ESG compliance, the study encourages the adoption of green building practices, resource efficiency, improved working conditions, and enhanced governance structures such as ethical leadership and anti-corruption. This fosters a more responsible and sustainable construction industry, ensuring compliance with both regulatory standards and corporate best practices.

As investors increasingly prioritise sustainability and ethical governance, the findings of this study help construction companies understand how ESG compliance can improve their project feasibility and financial viability. By integrating strong governance practices such as transparent procurement, risk management, and ethical decision-making, construction companies can enhance stakeholder confidence and regulatory compliance.

The study fills a research gap by exploring ESG compliance specifically within the context of Malaysia's construction industry. It adds to the growing body of academic literature on sustainability, corporate responsibility, and project management, particularly in the context of emerging markets like Malaysia. This contribution is essential for both academics and practitioners looking for region-specific insights into sustainable construction practices.

The study's results serve as a foundation for future research on sustainability in construction, especially in Southeast Asia. By identifying the current limitations and challenges in ESG adoption, the research paves the way for subsequent studies to explore innovative solutions, technologies, or strategies for improving sustainability and governance in construction projects.

5.4 Research Limitations

The availability of data on ESG compliance in construction projects remains a challenge, as many companies may not have fully adopted transparent sustainability reporting. Additionally, ESG data in Malaysia may be fragmented or inconsistent, impacting the depth and reliability of the analysis.

According to the sampling determination section in Chapter 3, the calculated sample size was 116; however, the total number of responses collected was 101. This smaller sample size may limit the generalisability of findings, potentially affecting the representativeness of stakeholder perspectives in the Malaysian construction industry.

The absence of highly experienced professionals, those with over two decades of industry experience, may have influenced the depth of responses in areas related to strategic decision-making, long-term project governance, and leadership perspectives on ESG integration. These individuals often hold senior roles and may possess deeper insights into the evolution of ESG practices and policy alignment. However, their limited participation may be attributed to their lower likelihood of engaging with online survey platforms or time constraints that prevent involvement in academic research activities.

Similarly, the absence of responses from micro-sized construction firms (with fewer than five employees) suggests a gap in data from the smallest segment of the industry. These companies often operate on tight margins and may prioritise operational survival over ESG adoption. Additionally, such firms may have limited access to digital communications or be less engaged in professional networks through which the survey was distributed, leading to their underrepresentation in the sample.

Additionally, the responses were collected from construction projects located in the Klang Valley area, restricting the study's scope to this region. Variations in

ESG implementation across other states in Malaysia were not fully explored, limiting the study's ability to capture broader national trends in ESG compliance.

Given the time constraints of the study, it was not possible to conduct longitudinal analyses of ESG impacts over an extended period. As a result, the study provides a snapshot of ESG practices rather than a comprehensive long-term evaluation.

Lastly, subjectivity in ESG reporting among companies presents a limitation. Many organisations interpret and apply ESG criteria differently, leading to variability in the data and limiting the accuracy of cross-company comparisons. This subjectivity may affect the consistency and reliability of ESG compliance assessments in the construction industry.

5.5 Recommendations for Future Work

Future research should expand on this study by conducting longitudinal analyses to track ESG compliance trends over time. A more extended study period would provide deeper insights into the evolving impact of sustainability initiatives and regulations within the construction industry.

In order to supplement the quantitative results, future research should also incorporate qualitative techniques like case studies and interviews. This approach would provide richer insights into the motivations, challenges, and decision-making processes associated with ESG adoption.

Further research could also explore the effectiveness of various policy interventions and incentive structures in promoting ESG compliance. This includes assessing the role of government incentives, industry-led sustainability programs, and financial benefits linked to ESG compliance.

Lastly, expanding the study's geographical scope beyond Malaysia to include regional comparisons within Southeast Asia would be beneficial. This would allow for an evaluation of best practices across different markets and regulatory environments, helping to identify scalable solutions for improving ESG compliance at a broader level.

5.6 Conclusion

This study offers a thorough analysis of ESG compliance in Malaysian construction projects, highlighting key ESG criteria, compliance levels, and strategies for improvement. The findings underscore the importance of OHS, regulatory adherence, socio-economic impact, governance structures, and workplace well-being. The study concludes that enhanced digital adoption, ethical leadership, and stakeholder collaboration are crucial for strengthening ESG compliance in the Malaysian construction industry. These insights act as a basis for future research and policy development aimed at advancing sustainability in construction projects.

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APPENDICES

APPENDIX A: SURVEY QUESTIONNAIRE

Cover Letter

Dear Sir/Madam,

I am Wong Yau Yii, a postgraduate student who is pursuing a Master of Project Management in Universiti Tunku Abdul Rahman (UTAR). I am currently conducting a survey for my final year project entitled "Environmental, Social, Governance (ESG) Compliance on Construction Projects" as a partial fulfilment of the programme structure. The purpose of this research is to identify the ESG compliance level on the construction projects in Malaysia.

This questionnaire consists of FIVE (5) sections and it would take approximately 10 to 15 minutes to complete. I would like to express my appreciation for your participation in this survey and I believe that your professionalism and experiences will significantly contribute to the success of this research. Your responses given for this survey will be kept confidential and remain anonymous. The responses will be solely used for academic purposes.

If you have any questions regarding this survey, please do not hesitate to contact me for further information and clarification.

Student name: Wong Yau Yii

Contact number: 016-676 3394

E-mail: wongyauyii@1utar.my

Thank you for your participation and precious time.

Section A: Demographic Information

DI01) Which of the following best describes your company's business activities?

1. Developer
2. Consultant
3. Contractor
4. Subcontractor / Supplier
5. Others (Please specify): _______

DI02) Which of the following best describes your profession?

1. Project Manager
2. Architect
3. C&S Engineer
4. M&E Engineer
5. Quantity Surveyor
6. Others (Please specify): _______

DI03) What is your position in your organisation?

1. Junior Executive
2. Senior Executive
3. Manager/ Team Leader/ Supervisor
4. Assistant Director/ Technical Director
5. Director
6. Others (Please specify): _______

DI04) How many years of working experience do you have in the construction industry?

1. Less than 5 years
2. 5 - 10 years
3. 11 - 15 years
4. 16 - 20 years
5. More than 20 years

DI05) How many employees in your organisation?

1. Less than 5 employees
2. 5 - 29 employees
3. 30 - 75 employees
4. More than 75 employees

Section B: Environmental Compliance Level on Construction Projects

Based on a most recently completed construction project that you have handled, evaluate the compliance level with the **Environmental** criteria by rating the following statements on a scale of 1 (No Compliance) to 5 (Excellent Compliance).

Environmental Compliance Level on Construction Projects	Not Compliance (1)	Low Compliance (2)	Acceptable Compliance (3)	High Compliance (4)	Excellent Compliance (5)
Carbon Footprint *The measure of the overall amount of carbon emissions directly and indirectly caused by an activity or accumulated over the life stages of a construction project.*					
Energy Efficiency *The optimisation of energy use during construction and building operations to reduce consumption and greenhouse gas emissions.*					
Waste Management *Involves strategies to minimise, reuse, and recycle construction waste, ensuring sustainable disposal practices.*					
Water Consumption *Focuses on efficient water use and conservation throughout the construction process to reduce resource depletion.*					
Biodiversity *Emphasises the protection and preservation of local ecosystems and natural habitats impacted by construction activities.*					
Standards and Regulations *Relates to compliance with environmental laws, policies, and best practices to ensure sustainable construction processes.*					
Sustainable Construction Materials					

Entails the use of environmentally friendly and durable materials that minimise ecological impact and promote resource efficiency.					

Section C: Social Compliance Level on Construction Projects

Based on a most recently completed construction project that you have handled, evaluate the compliance level with the **Social** criteria by rating the following statements on a scale of 1 (No Compliance) to 5 (Excellent Compliance).

Social Compliance Level on Construction Projects	Not Compliance (1)	Low Compliance (2)	Acceptable Compliance (3)	High Compliance (4)	Excellent Compliance (5)
Workplace Well-Being *Focuses on creating a supportive and healthy work environment that promotes employees' physical and mental well-being.*					
Occupational Health and Safety *Prioritises measures to safeguard workers from hazards and ensure safety throughout construction processes.*					
Workforce Diversity *Encourages inclusivity by promoting varied demographics and perspectives within the construction workforce.*					
Socio-Economic Development *Emphasises contributions to local economic growth and improved social conditions through construction activities.*					
Community Engagement *Involves collaboration and communication with local communities to address their needs and foster positive relationships.*					
Accessibility to Social Infrastructure					

Ensures that construction projects provide equitable access to essential public facilities and services.					
Cultural Heritage *Aims to preserve and integrate historical and cultural assets into construction projects, respecting the local heritage.*					

Section D: Governance Compliance Level on Construction Projects

Based on a most recently completed construction project that you have handled, evaluate the compliance level with the **Governance** criteria by rating the following statements on a scale of 1 (No Compliance) to 5 (Excellent Compliance).

Governance Compliance Level on Construction Projects	Not Compliance (1)	Low Compliance (2)	Acceptable Compliance (3)	High Compliance (4)	Excellent Compliance (5)
Transparency *Ensures openness and clarity in decision-making processes, financial reporting, and project activities to build trust with stakeholders.*					
Anti-Corruption *Focuses on preventing unethical practices such as bribery and fraud by implementing stringent policies and monitoring mechanisms.*					
Board Composition *Refers to the diversity, independence, and expertise of board members to ensure balanced decision-making and effective governance.*					
Risk Management *Involves identifying, assessing, and mitigating potential risks to ensure the smooth execution and long-term success of construction projects.*					
Stakeholder Engagement *Promotes collaboration and communication with all parties involved, ensuring*					

their interests and concerns are addressed throughout the project lifecycle.					
Ethical Leadership *Highlights the role of leaders in fostering a culture of integrity, fairness, and accountability within the organisation.*					
Supply Chain Management *Focuses on optimising procurement, logistics, and supplier relationships to ensure sustainability and efficiency in project delivery.*					

Section E: Strategies for Improving ESG Compliance Level on Construction Projects

This section assesses the strategies for improving ESG compliance on construction projects. Rate your agreement levels for the following statements on a scale of 1 (Strong disagree) to 5 (Strongly agree).

Strategies for Improving ESG Compliance Level on Construction Projects	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)
Enhancement of ESG Framework *Involves strengthening policies and guidelines to effectively integrate environmental, social, and governance considerations into construction practices.*					
Influence of Governmental Support Policies *Highlights the role of government incentives, regulations, and programmes in encouraging ESG adoption in the construction sector.*					
Adoption of Sustainable Building Materials *Focuses on using eco-friendly materials to minimise environmental impact and promote resource efficiency in construction projects.*					
Optimisation of Energy Utilisation					

Focuses on improving energy efficiency and reducing consumption across all stages of construction to minimise environmental impact.					
Integration of Circular Economy Principles *Involves minimising waste and maximising resource reuse and recycling by adopting closed-loop construction practices.*					
Adoption of Advance Technologies *Encourages integrating innovative tools and technologies to improve efficiency, sustainability, and ESG compliance in construction activities.*					
Popularisation of Adopting Building Information Modelling *Promotes the use of BIM to enhance collaboration, reduce waste, and optimise ESG performance in project management.*					
Enhancement of Corporate Governance *Aims to strengthen organisational structures and decision-making processes to ensure accountability, transparency, and ESG alignment.*					
Improvement in Ethical Leadership *Emphasises the role of leaders in fostering a culture of integrity, fairness, and commitment to ESG principles.*					
Adoption of Green Supply Chain Management *Focuses on implementing sustainable practices throughout the supply chain to reduce environmental impacts and improve resource efficiency.*					

End of Questionnaire Survey

Thank you very much for participating in this survey!