Exploring Sustainability Considerations in Construction Project Manager Decision Making in China: An investigation using the Q Methodology

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MASTER OF SCIENCE

In **Construction Management & Engineering**

By

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Preface

As I am about to complete my master's degree, I am both excited and grateful. My studies at Delft University of Technology are coming to a successful conclusion, which for me is not only the end of an academic journey, but also the beginning of a new life. I am extremely excited about the upcoming opportunities and challenges, and I would like to thank all the people who have helped and supported me in this journey.

First and foremost I would like to express my gratitude to my thesis committee. I am extremely grateful to my thesis committee chair, Dr. ir. Ad Straub, for his firm support and guidance throughout the process. His critical insights and feedback were very helpful to me. I am thankful to my first supervisor Dr. Johan Ninan who guided and assisted me in completing my thesis and kept me on the right direction. I also benefited from his knowledge and understanding of academic learning throughout the completion of my thesis. I would also like to express my sincere gratitude to my second supervisor, Dr. Mark de Bruijne, for being very supportive and inspiring during this challenging journey. His knowledge of methodology helped me to finish my thesis in a solid way.

I would also like to thank my family, especially my parents and siblings, who have given me unlimited love and support during this journey. They were my strong backing and always encouraged me to work tirelessly when I encountered difficulties and challenges. I would also like to thank my classmates and friends, whose company and support have enriched my research life.

Looking back, I am proud of my achievements. I am looking forward to the future and am eager to continue to learn, grow, and contribute to this field. Finally, I would like to thank myself for my perseverance and hard work during this extraordinary journey.

Xiaoyang Xu

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Executive summary

Abstract

Integrating sustainability into the decision-making process of construction project management is essential to the success of modern construction projects. This study explores how construction project managers consider sustainability factors in their decision-making process, especially within the constraints of cost, time and quality. It then focuses on the specific case of China to provide detailed examples of these practices in a unique cultural and economic context. The study employs the Q-methodology to understand the different management perspectives and strategies in the sustainability integration process and the complex balancing act in which managers consider sustainability as well as other indicators of program success.

Incorporating sustainability into construction project management is complex due to the multifaceted nature of construction projects and the need to balance various constraints such as cost, time, quality and sustainability. The main research question is how project managers in China manage these constraints while integrating sustainability into their decision-making process. The focus of this study is to understand the complexities and differences in these processes and to identify strategies for effective integration of sustainability.

Keywords： Sustainability, Construction project management, China, Q method, Trade-offs

Research Methodology

This study used the Q methodology, which combines qualitative and quantitative methods, to analyze the perceptions of construction project managers on sustainability. This methodology includes a detailed Q-ranking procedure that provides insight into individual perspectives and strategies in sustainability integration. This methodology is beneficial in

capturing subjective perspectives and helps to reveal the different perspectives of construction project managers on sustainability and the various approaches used for implementation.

Results and Recommendations

From that study we identified three main perspectives of construction project managers, the three perspectives are people and cost, people and sustainability, and cost and quality. From the analysis of these three main perspectives we see that the current emphasis on sustainability is still low. Instead, there is a strong emphasis on the safety of construction projects. And the study found that project managers' views on sustainability integration varied, with some seeing sustainability integration as complementary to project goals, while others saw potential conflicts and the need to weigh the pros and cons. This study promotes the need for continuous research and adaptation in the field, emphasizing the evolving nature of sustainability in the construction industry. At the same time effective sustainability integration requires innovative planning and methods, also recognizing the diversity of management perspectives and the complexity of construction projects.

This research informs the construction project management field in integrating sustainability into the decision-making process. It provides practical references and recommendations for practitioners, emphasizing the importance of a holistic approach and the need to develop flexible and adaptable strategies. There are some limitations, despite considering that this study offers valuable insights into how construction project managers make decisions about sustainability. These limitations are caused by external factors like the subjectivity of the data, the impact of regional circumstances, and shifting environmental conditions. For future research could focus on a comparative analysis of sustainability factors in different countries, examining how cultural, economic, regulatory, and environmental factors influence the integration of sustainability in construction projects. This could deepen the understanding of universal principles of sustainable building and reveal unique challenges and solutions.

Content

1.Introduction

1.1Background

As a driving force of economic prosperity, the construction industry has had a huge impact on the gross domestic product and the job market of individual countries (Hillebrandt, 2000). But this economic development has come at a great environmental cost. The construction industry is a major consumer of resources (including raw materials, water and energy) and produces a lot of greenhouse gases. According to the International Energy Agency (IEA), the building and construction sector collectively accounts for more than one-third of the world's final energy consumption and is responsible for nearly 40% of direct and indirect carbon dioxide emissions (Ryłko-Polak et al., 2022).

As people visualize the environmental impact of the industry through these data, they begin to look for better solution to that impact. Thus the concept of sustainability in the construction industry has gradually shifted from being an optional "add-on" to a necessary specification. The Brundtland Commission published a report in 1987 entitled Our Common Future, in which it defined sustainable development and emphasized the need for a balance between economic growth, environmental protection and social equity. This report laid the groundwork for the international community to later integrate sustainable development into various fields, including the construction industry (Yaman & Ghadas, 2022). For the construction industry, the impact of this report is multi-faceted. It has encouraged policy makers and industry leaders to rethink traditional construction practices, advocating an approach that balances economic efficiency, environmental stewardship and social responsibility. This shift has further led to the development and implementation of new regulations, standards, and practices that emphasize sustainability in building projects. These changes are reflected in the adoption of green building standards, an increased emphasis on resource-efficient construction methods, and the integration of sustainability

assessments into project planning and execution(Yaman & Ghadas, 2022; Barendsen et al., 2021).

In the decades following the Brundtland report, international environmental agreements, such as the Kyoto Protocol and the Paris Agreement, have increased pressure on the construction industry to mitigate its environmental impacts. These agreements have led to the development of various sustainability standards and certification systems, all aimed at reducing the environmental impact of construction project activities (Crawley & Aho, 1999; Weerasinghe, 2022). Among these are the Leadership in Energy and Environmental Design (LEED) and the Building Research Establishment Environmental Assessment Method (BREEAM), which provide a framework for assessing and improving the sustainability performance of buildings.

Despite the establishment of these frameworks, construction projects still face many challenges in terms of sustainable practices. This is because the complexity of construction projects, the diversity of stakeholders, and the traditional iron triangle prioritization of cost, time, and quality objectives often result in sustainability as a factor taking a back seat. The problem is complicated by the fact that the construction industry is decentralized, with a multitude of contractors and subcontractors that can lead to a disconnect between sustainability efforts (Sari et al., 2023).

China has experienced rapid urbanization and infrastructure development in recent decades, and the booming construction industry along with it has contributed to the rapid economic development. At the same time, the construction industry in China is a significant consumer of resources and a major contributor to greenhouse gas emissions, which is an issue that needs to be emphasized in a country facing serious environmental challenges (Ying-Bin et al., 2022). In China, the concept of sustainability in the construction industry is becoming increasingly recognized and important (Ma et al., 2018). This shift has been influenced by the global sustainability landscape, including the principles outlined in the Brundtland Commission's report "Our Common Future" (Ma et al., 2018). These principles need to be applied to China's own policies and initiatives aimed at promoting sustainable development. China has signed international environmental agreements, such as the Kyoto Protocol and

the Paris Agreement, which have placed increased demands and pressure on the Chinese construction industry to reduce its environmental impacts. While the sustainability standards and certification systems for China's construction industry have been influenced by Western frameworks such as LEED and BREEAM, they are customized to fit the unique features of China's construction industry. These features include the scale of construction projects, urbanization, local environmental challenges and specific national sustainable development goals (Babatunde & Low, 2015; Qi & Xia, 2022).

Despite these efforts, construction project managers in China still face significant challenges in fully adopting sustainable practices. This is because construction project managers need to take more factors into account when making practical decisions, such as the complexity of the project, the diversity of stakeholders, the fragmentation of the industry, and the focus on cost, time, and quality goals (Arabpour & Silvius, 2023). Meanwhile, decision-making by construction project managers is critical to addressing the gap between sustainability theory and practice. Because the capabilities of project managers and every decision they make has the potential to significantly impact project outcomes, the decisions they make can either advance or hinder the integration of sustainability practices. Yet the extent to which sustainability is considered in each project manager's management decisions is also influenced by many factors. Factors such as personal values, level of knowledge about sustainability, and organizational culture all play a role in how sustainability is integrated into project management practices (Sinxadi & Awuzie, 2021).

1.2 Problem statement

China's construction industry has been the cornerstone of the country's economic growth, driving rapid urbanization and infrastructure development, with China's urbanization rate increasing from 19.4% to 52.6% between 1980 and 2012 (Tang, 2013). This rate of growth is significant globally and has led to interest and concern about the construction industry in China. This growth is accompanied by a number of negative environmental effects, as the construction industry is a significant contributor to resource exhaustion, waste generation and greenhouse gas emissions, posing a serious challenge to China's environmental sustainability goals. Since 2010, the Chinese construction market has become the largest in the world (Senaratne & Sandanayake, 2012). The rapid economic development of China has led to a significant increase in energy consumption and carbon emissions (Shao et al., 2014). China accounts for 21% of global consumption of primary energy and has surpassed the United States as the world's top carbon emitter (Wang & Liang, 2013). The construction industry sector is energy-intensive and its energy consumption is still increasing , as shown in Figure 01. The construction industry has been one of the major contributors to China's carbon emissions due to the large amount of energy and large amount of materials utilization (Lin & Liu, 2015). The importance of the construction industry in the nation's economy and the construction industry's intensive use of resources have led to higher carbon emissions. Chang et al. (2010) estimated that China's construction industry accounts for 25% of the country's total carbon emissions (Hou et al., 2020). The urgency of this issue is underscored by Chinese President Xi Jinping's commitment at the 2020 United Nations General Assembly (Zhao, 2022)to peak carbon emissions by 2030 and achieve carbon neutrality by 2060.

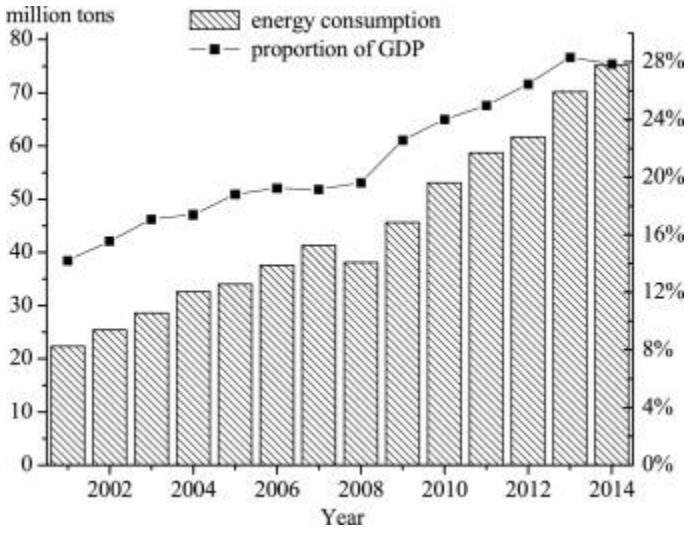

Figure 01. Energy consumption and proportion of the construction industry (Du et al., 2019)

The challenges of integrating sustainability into construction project management are manifold. Project managers usually adopt the traditional project management model and do not bother to fully consider other factors such as environmental and social factors. Traditional project management approaches are primarily aimed at optimizing cost, time, and quality, while sustainability is often something that is considered only after these requirements have been met (Fathalizadeh et al., 2021). Construction project managers are often faced with the tension between adhering to sustainability principles and meeting traditional project constraints such as cost, time, and quality when directing projects (Silvius et al., 2017; Fathalizadeh et al., 2021). Construction projects are dynamic in themselves, characterized by frequent and unpredictable changes. This dynamism increases the complexity of project management, especially with the integration of sustainability (Brady & Davies, 2014). The dynamic character of construction projects complicates the decision-making process, and the rapid growth of the construction industry in China has increased these challenges. Because project managers are often under pressure to deliver projects rapidly, project managers tend to apply traditional project management methods to meet the three elements first, which often results in less sustainability (Wong & Zhang, 2013).

The construction industry has low barriers to entry and is highly fragmented (Cheah & Chew, 2005). There are many different types of firms in the Chinese construction market, and Chinese construction firms are usually categorized into three groups: state-owned

enterprises (SOEs), urban and rural collectively owned enterprises (COEs), and rural construction teams (RCTs) (Low, 2003; Cheah & Chew, 2005; Zhou & Pheng, 2014). This fragmentation has led to a lack of standardization in practice, as well as differences in the adoption of sustainability approaches. Zhang et al. (2023) summarized five major barriers in the transformation of China's construction industry as data fragmentation, lack of core technology, weak digital infrastructure configuration, lack of technical talent, and lack of technical standards (Zhou & Pheng, 2014). While the implementation of sustainability standards and certifications in China is gradually improving, they are not being applied uniformly across the industry (Hu et al., 2023). The role of these sustainability standards in promoting sustainable practices is also often subject to some questioning, particularly in terms of whether they will be adapted to the unique conditions of construction projects in China (Chang et al., 2016; Chang, 2017). For example, while some large state-owned enterprises (SOEs) may have the resources and motivation to pursue sustainability, many small and medium-sized enterprises (SMEs) lack the knowledge, skills, and financial capabilities to undertake sustainable practices (Yu & Bell, 2007).

Legal policies and measures enacted by the government can also play a key role in influencing sustainability. The Chinese government has developed and implemented a number of laws, regulations and policies, such as Environmental Impact Assessment La, Regulation on Energy Conservation in Civil Buildings and Action Plan for Promoting Green Building (Chang et al., 2016) , as shown in Figure 02. While China has made many efforts to promote green building standards and sustainable urban development, these policies have not been consistently implemented and enforced in projects (Zhu et al., 2015). There is still a large gap between policy and practice, such as a lack of the necessary regulation and transparency in sustainable practices, which prevents the implementation of effective sustainable development measures (Liu et al., 2022; Zhu et al., 2015). In addition, existing research on sustainable buildings in China has focused mainly on policy and technology, with less attention paid to human and managerial factors that play a key role in implementing sustainability (Wang et al., 2021; Wang et al., 2022).

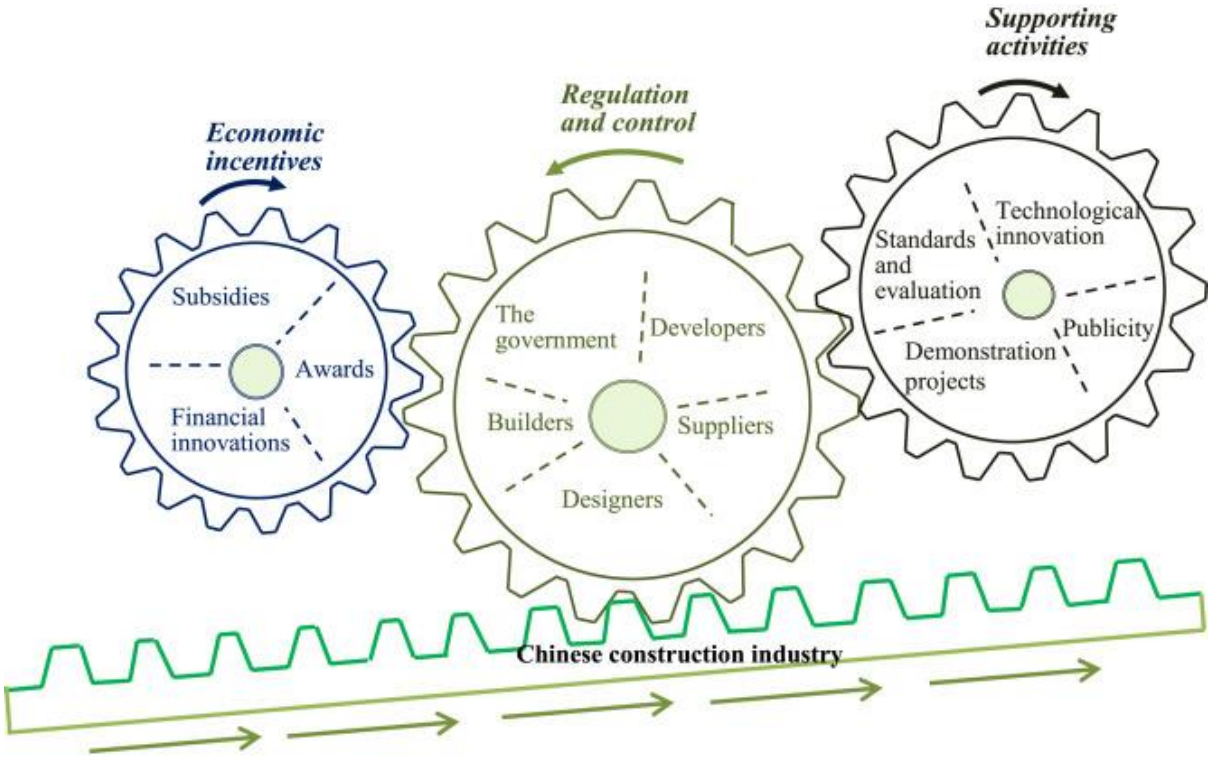

Figure 02. Policy Gear Model for Sustainable Construction in China (Chang et al., 2016)

There is a need for an in-depth understanding of how Chinese construction project managers consider and integrate sustainability into their daily decision-making processes (Silvius et al., 2017), and what barriers and facilitators exist in this context. The aim of this study is to explore how construction project managers in China integrate sustainability considerations into their decision-making processes. The study attempts to identify the factors that influence these processes, the challenges that managers face in balancing sustainability with other project goals, and strategies that can facilitate the integration of sustainability into construction project management practices in China (Josa & Aguado, 2019).

1.3 Research Gap

In recent years, against the backdrop of rapid urbanization and increasing environmental concerns, the integration of sustainable development into construction project management has received increasing attention and focus (Ohiomah et al., 2019). At the same time the construction industry, as a major contributor to global economic growth, has a profound impact on the environment and society (Khalim & Lee, 2020). Therefore, understanding how construction project managers incorporate sustainability considerations into their decision-making process is important for promoting the practical aspects of sustainability in the industry (Silvius et al., 2017; Zubko et al., 2021).

There is a growing number of literatures on sustainability in the construction industry, but there is still a lack of in-depth discussion on the specific practices of Chinese construction project managers in terms of sustainability integration. The construction industry in China is unique due to the country's rapid urbanization, the scale of construction projects, and specific regulatory and cultural contexts. First, China's urbanization rate far outpaces that of other countries, growing from 19.4% in 1980 to 52.6% in 2012 (Tang, 2013), and this rapid urbanization has led to a huge demand for construction resources and corresponding environmental pressures. Second, the scale of construction projects in China is usually larger, which not only implies more resource consumption and environmental impacts, but also a significant increase in the complexity of project management (Fernández, 2007). In addition, China's unique policy and regulatory environment, such as national-level guidance on building standards and sustainability, as well as cultural backgrounds that differ from those of Western countries, have a unique impact on the management and sustainable practices of construction projects. For example, green building standards and urban sustainability policies promoted by the Chinese government (Chang et al., 2016), although influenced by international agreements such as the Kyoto Protocol and the Paris Agreement, still need to be adapted to China's specific socio-economic conditions and cultural practices during actual implementation. Therefore, it is a very worthwhile topic for Chinese construction project managers to investigate how to incorporate sustainability under these unique conditions. Meanwhile existing research provides a broad understanding of how project managers in

general approach sustainability, yet few studies delve into the nuanced challenges facing the construction industry and the Chinese construction industry. For example, a study conducted by Zhang (2020) highlights the importance of constructing a bid evaluation index system characterized by green development for the procurement of public projects by the Chinese government. Ibrahim (2010) emphasized the importance of Key Performance Indicators (KPIs) in supporting Malaysian Architecture, Engineering and Construction (AEC) firms' decision making in sustainability assessment for project management in China. These studies, although valuable, did not specifically address the decision-making process of Chinese construction project managers in sustainability integration. In addition, there is limited empirical data on the decision-making frameworks used by Chinese construction project managers when considering sustainability goals, which is also a clear research gap. An in-depth study of the existing situation with the current state of research is needed.

This study aims to fill this gap by investigating, specifically for the Chinese construction industry, how Chinese construction project managers balance the competing demands of sustainability with the other constraints like cost, time and quality. The research explores the extent to which sustainability is considered in the decision-making process and identify the barriers that prevent sustainability from being integrated into the decision-making process. By focusing on the Chinese context, the research contributes to a more localized understanding of sustainable construction project management. The research also provides insights into how project managers can better equip themselves with the knowledge, tools and support they need to prioritize sustainability in their projects.

In summary, despite the wealth of knowledge on sustainability in construction globally, there is a noticeable gap in understanding the specific challenges and practices faced by construction project managers in China. This study aims to bridge this gap and provide valuable insights to inform academic discussions and practical applications in the field of sustainable construction project management.

1.4 Research Questions

The main research question to this study is

"How do construction project managers in China integrate sustainability into their decision-making processes?"

The main research question of this study focuses on exploring how construction project managers in China integrate the concept of sustainability into their work decisions. This question aims to provide an in-depth understanding of the ways in which construction project managers practically apply and perspective on sustainability factors in their management processes, and how these practices affect project execution and results. The study focuses not only on the theories and principles of sustainability, but also on how project managers translate these concepts and perspectives into concrete actions in their work.

As shown in Table 01, the main question is divided into three sub-questions.

Table 01. Sub questions

	Sub-questions (SQ)	Methodology
SQ 1	What factors influence Chinese construction project managers' decision-making process regarding sustainability factors?	Literature review Interview
SQ 2	What are the different perspectives of Chinese construction project managers in incorporating sustainability factors into the decision-making process?	Q- methodology Interview

SQ 3	How do Chinese construction project managers balance the trade-offs between sustainability goals and project constraints in the decision-making process?	Interview

These sub-questions are intended to provide a multi-dimensional perspective on the main research question in order to gain a more nuanced understanding of the complexities involved in incorporating sustainability into construction project management decision-making.

1.5 Research object

The study aims to deepen the understanding of sustainability practices in the field of construction project management in China. A key expected outcome is to explore the various factors that influence the sustainability decision-making process of project managers and explore how some possible factors taken into consideration into decision-making processes such as time constraints, funding constraints, project size, personal values of managers, prevailing organisational culture, and expectations of various stakeholders interact with each other (Ashkezari et al., 2022). This study explores the factors that need to be considered in decision-making, providing a fine-grained perspective on their relative influence and interdependence.

In addition to mapping the terrain of decision-making, the study reveals the various perspectives held by Chinese construction project managers on integrating sustainability. Using a methodology that explores people's subjective thoughts, the study dissects the subjective views of these professionals, revealing how they reconcile the often competing demands of economic efficiency, environmental stewardship and social responsibility (Banihashemi et al., 2021). This dimension of the research is expected to highlight the differences between policy and practice in the field, thus providing a nuanced understanding of how project managers understand and think about sustainable development.

An important aspect of the study was to examine the trade-offs made by Chinese construction project managers between sustainability objectives and project constraints such as time, cost and scope (Lotfi et al., 2022). The research aims to shed light on the strategies and decision-making frameworks that enable the alignment of sustainability goals with project deliverables. This investigation delves into the methods used by project managers, such as prioritisation techniques, stakeholder engagement processes and other methods, to balance these often conflicting constraints and demands (Oliver et al., 2019).

The expected outcomes of this study will specifically reveal the key factors that Chinese construction project managers consider in their sustainability decision-making, such as constraints of time, money, and project size and sustainability. We expect to identify the

specific factors that influence these decisions, such as managers' personal values, organizational culture, and stakeholders' expectations, and how these factors interact with each other to affect the final sustainability outcomes of the project. In addition, the study will specifically show the specific strategies and approaches used by Chinese construction project managers in integrating sustainability. This includes showing how project managers can overcome challenges in sustainability practices through stakeholder engagement, priority setting, and resource allocation. The study will also explore in detail the current perceptions and perspectives of project managers in the industry regarding the integration of sustainability into project decision-making, providing practical guidance and recommendations for promoting sustainable construction project management. The data and results obtained from this study will provide practical references and guidance for future academic research and industry practice in sustainable construction project management.

1.6 Research Outline

This paper's structure was thoughtfully created to help the reader comprehend a thorough discussion of how sustainability is incorporated into construction project management in China, as shown in Figure 03. The structure of the paper is as follows:

Introduction: By outlining the problem statement, research gaps, research objectives, and research background, the opening section establishes the framework for the entire study. It defines the study's context, emphasizes the importance of sustainability to the construction industry, and highlights project managers' contributions to the advancement of sustainable practices. It also describes the research questions and objectives of the study.

Literature Review: Following the introduction, a comprehensive literature review will be conducted to provide an in-depth exploration of existing research on sustainable building project management and the important factors that determine project success. An overview of the major theories, models, and empirical studies is given in this section, giving the study a strong scholarly foundation and direction (Ali et al., 2022; Ziraba et al., 2020).

Research Methodology: Chapter 3 details the research design and methodology employed in this study. The chapter explains why the Q-methodology was chosen to capture the subjective views of construction project managers on the integration of sustainability into project management and outlines the specific analytical methods used in the Q-methodology (Ahmad et al., 2022; Gain et al., 2022; Maqbool & Jowett, 2022).

Results: In this key section, the data collected through the Q methodology will be analyzed and the final results of the analysis will be obtained. This chapter presents the results of the study in a structured way, explaining the program manager's perspective on sustainability. The research questions of the study are also answered based on the final analysis (Górecki & Utrilla, 2022; Dai & Kang, 2023).

Conclusions and Recommendations: The final chapter summarizes the conclusions based on the analysis and discussion. While this study does not provide a set of prescriptive recommendations, it provides potential pathways for future research and considers the

practical implications of the findings for the construction industry (Newton, 2022). The chapter also discusses the limitations of this thesis and the direction of future research, providing some direction for future research on related areas.

Appendixes and References: Appendices contain supporting documents like comprehensive data tables, surveys, and more analyses. All sources cited in the paper will be painstakingly documented in the references section in accordance with stringent academic guidelines.

This structured approach ensures that the content flows logically and helps the reader to clearly understand how sustainability factors are integrated into the decision-making process of Chinese construction project managers. Each chapter builds on the previous one, culminating in a comprehensive understanding of the research topic.

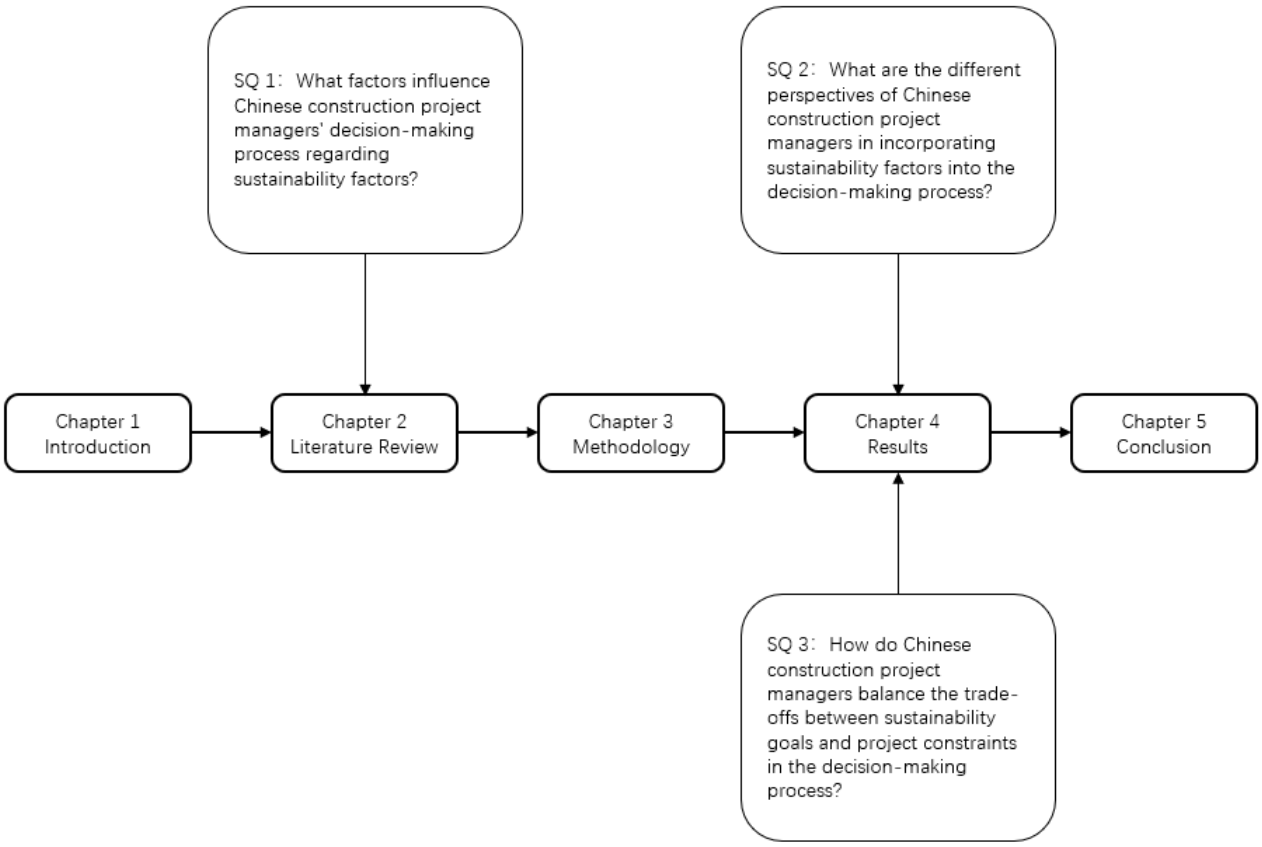

Figure 03. Thesis outline

2. Literature review

2.1 Construction Project and Sustainability

2.1.1 Construction projects

Construction is a complex and time-consuming endeavour and the development of a construction project usually consists of several phases and requires a wide variety of professionals and construction techniques (Sears et al., 2015). Construction projects are complex and multifaceted endeavours that involve the planning, design, construction and management of various infrastructure and building works. The process of executing a construction project involves a number of phases, beginning with project initiation and feasibility studies, followed by the design planning phase, construction activities, and finally project delivery and commissioning. Throughout the project lifecycle, construction management professionals are responsible for overseeing all aspects, including budget, schedule, quality control, safety and stakeholder management. The construction industry covers a wide range of projects including residential and commercial buildings, bridges, roads, dams, airports and various other infrastructure developments (Kibert, 2016). These construction projects effectively contribute to economic development while shaping the liveable built environment and providing necessary facilities to the society and people(Paoletti & Vettori, 2021).

Construction projects are characterised by their complexity and successful project delivery requires effective coordination, communication and adherence to project constraints, often referred to as the principle of the triple constraint (Atkinson, 1999). The triple constraint consists of three factors: time, cost, and quality (Silvius et al., 2017). Traditionally, construction projects prioritise meeting these constraints to ensure project success. However, this focus on immediate goals can have unintended negative consequences for the environment and society (Marquès et al., 2011). Due to its size and resource-intensive nature, the construction industry has significant environmental, social and economic

impacts, and therefore sustainability considerations are critical in the management of construction projects.

2.1.2 Sustainability in construction projects

The construction industry is crucial in contributing to socio-economic progress. However, the industry, with its inherent characteristics of fragmentation, uniqueness and complexity, has always been faced with constant challenges. For example, time overruns (70%), cost overruns (14% on average) and waste generation (10% of material costs) (Hussin et al., 2013). Conventional approaches in construction procedures and management practices have limitations in effectively responding to escalating dilemmas, particularly escalating carbon emissions (Hariram et al., 2023). These experiments highlight the need for practitioners to reassess and improve methods and techniques for managing the construction process (Hussin et al., 2013).

In November 1994, the first International Conference on Sustainable Building was held in Tampa. Kiebert, the organiser of this conference in Florida, USA, defined sustainable building as "the creation of healthy built environments using resource-efficient, ecological principles". The field of sustainable building includes the following.

Economic Sustainability - Improving profitability through smarter use of resources including labour, materials, water and energy. Economic sustainability in construction projects emphasises the responsible use of resources to achieve long-term economic viability (Singh et al., 2021). This includes assessing lifecycle costs, considering the return on investment of sustainable practices, and evaluating potential risks and benefits. Sustainable building projects seek to balance upfront costs with long-term benefits, ensuring that economic considerations are aligned with environmental and social objectives. Economic considerations in this regard include job creation, improved competitiveness, job creation and thus increased productivity, among many other factors.

Environmental Sustainability - Demonstrates wise management of natural resources while minimising waste generation (Mallick et al., 2022). The aim is to protect the environment from harmful and potentially irreversible impacts. The environmental dimension is intertwined with the definition of methods for design, construction, operation and maintenance, and eventual demolition, all of which aim to minimise harmful impacts on the environment. This includes the adoption of energy-efficient technologies, the use of renewable energy sources, the promotion of sustainable water management, the implementation of waste minimisation strategies and the reduction of greenhouse gas emissions (Bragança et al., 2014). Sustainable building projects prioritise resource efficiency and strive to minimise impacts on environmental degradation. In addition, reducing waste and minimising resource extraction has significant economic benefits (Ajayi et al., 2015).

Social Sustainability - Meet individual needs and increase customer satisfaction at every step of the construction process (Okitasari et al., 2022). In addition, fostering close cooperation with customers, suppliers, labour force and local population for mutual benefit. The social dimension deals with issues related to improving the quality of life of individuals. It aims to improve the welfare of project stakeholders, workers and local communities. This includes promoting fair labour practices, ensuring safe working conditions, engaging in community development activities, and creating infrastructure that improves quality of life (Ajayi et al., 2015). Social sustainability focuses on promoting inclusive and equitable development, taking into account the needs and aspirations of diverse communities.

Sustainability in construction projects refers to the integration of environmental, social and economic factors throughout the life cycle of a project(Chang et al., 2016). The overall goal is to create structures and infrastructure that balance human needs with natural ecosystems and resource conservation. Sustainability aims to minimise the ecological footprint of a building project, optimise the use of resources and promote social well-being while ensuring economic viability (Hill & Bowen, 1997).

Sustainable building can be seen as a subset of sustainable development and applies to the construction industry. It can be defined as "the creation and responsible management of a healthy built environment based on resource efficiency and ecological principles" (Kibert,

1994). Sustainable building encompasses three main aspects: the social, economic and environmental domains, whereas the conventional view focuses mainly on aspects such as economy, practicality and longevity. In contrast, this includes areas such as air emissions, waste emissions, water utilisation, land use, etc. (. The construction industry holds great potential to contribute to sustainable development by addressing a wide range of issues in the economic, social and environmental spheres. By adopting sustainable building practices, the construction industry has the ability to reduce total energy consumption while optimising the viability of renewable energy supplies. In addition, sustainable construction can reduce waste, protect limited water resources, improve water quality, adopt designs that are compatible with water dynamics, and reduce vulnerability to flooding. At the same time, project management reduces the emission of pollutants into water bodies, the atmosphere and the soil, and reduces noise and light disturbances. Project management embodies a methodical and strategic approach to coordinating, executing, monitoring and regulating the range of resources, tasks and parties involved in a project.

2.2 Construction projects and project management

2.2.1 Project management

Project management embodies a methodical and strategic approach for coordinating, executing, monitoring and supervising a range of resources, tasks and vested interests intertwined in a project, with the ultimate aim of achieving different objectives within a predetermined scope (Esangbedo & Ealefoh, 2021) , as shown in Figure 04 . In the field of construction engineering, project management plays a crucial role in coordinating numerous aspects, ensuring effective information exchange between different stakeholders (Cerezo-Narváez et al., 2021) and ultimately succeeding in realising projects that comply with benchmarks of excellence. This includes adherence to quality benchmarks, financial constraints and time parameters (Kerzner, 2017).

Figure 04. Overview of project management (Kerzner, 2017)

Project management processes involve a series of interrelated steps that guide a project from conception to completion. These processes provide a structured framework for managing the project life cycle. For construction projects, these processes are adapted to the specific challenges inherent in construction work. A typical project management life cycle includes the following phases:

Initiation: This phase involves defining the scope, objectives and key stakeholders of the project. It is a key step for the project manager to define the purpose of the project and align it with the organisation's goals; Planning: The planning phase involves developing a comprehensive project plan detailing the scope, schedule, resources and potential risks. This includes estimating costs, allocating resources, and developing strategies to address potential challenges; Execution: In this phase, project managers put the plan into action. They coordinate resources, manage tasks, and communicate with stakeholders to ensure that the project is progressing as expected; Monitor: In this phase, project managers track the progress of the project against the plan, identify any deviations, and take corrective action as needed. This step is critical to ensure that the project stays on track and that any potential issues are resolved in a timely manner; Closing: The closing phase involves completing all project activities, documenting lessons learned, and obtaining stakeholder approval. This marks the formal end of the project and transition to the operational phase (PMI, 2017).

2.2.2 Project Management for Construction

There is a need to expand the overall concept of management to fit the context of the definition of construction project management, which can be succinctly stated as follows: the process of representing the client's interests in the careful design, coordination and supervision of a project from inception to completion, including the commissioning phase. This involves identifying the client's desires in terms of practicality, efficacy, quality, time considerations and financial outlay. This involves the configuration of symbiotic resource interrelationships, the integration, vigilance and supervision of the contributions and

products of the different players involved in the project, and the discernment and selection of the best course of action in pursuit of the client's satisfaction with the project's outcomes (Walker, 2015).

In this context, the term "resources" encompasses a wide range, covering materials, machinery, financial assets and, above all, personnel. An omission in many project management definitions is the lack of specific reference to how individuals are coordinated to achieve a project. Whilst we can infer that collaborative effort is inherent in the achievement of project outcomes, it is still important that the definition clearly emphasises this fundamental aspect of project management. Putting this definition into practice can take many forms, depending on the nature of the project and the context in which it operates. However, regardless of the organisational framework, the effort embedded in the definition should be clearly visible, which is an affirmation of project management implementation.

The field of construction project management (CPM) has two main objectives. Firstly, it requires the identification of optimal project objectives, which are typically delineated through the prisms of time considerations, financial outlay and quality of outcomes. These objectives are formulated with a keen grasp of the intrinsic rationale for the project's existence, the client's expectations, and the contextual environment in which the project is being undertaken. At the same time, the second aim of project management is to establish a structural framework for managing the project according to mutually agreed objectives. These objectives include the technical aspects, the different participants and the contextual environment in which the project is to take place (Brown & Adams, 2000).

2.3 Sustainability and Project Management

2.3.1 Sustainable Project Management

Given the changing uncertainties and dwindling availability of natural resources, it has become imperative to intricately integrate sustainability considerations into all aspects of business operations (Armenia et al., 2019). This urgency stems from the desire to ensure that the trajectory of a business is both durable and profitable in the long term. In the field of project management, the interplay between sustainability and project management has been individually studied by many scholars (Chawla et al., 2018; Gao, 2022). However, efforts to uncover contemporary methodologies for assessing and integrating sustainable project management remain an avenue that has yet to be fully explored, with only limited progress to date (Chawla, 2018).

Sustainable project management (SPM) embodies a methodology that aims to integrate the principles of sustainable development into the continuum structure of project management (Toljaga-Nikolić et al., 2020). This approach recognises the intrinsic nature of the intertwined economic, ecological and social dimensions, and hopes to ensure that projects not only achieve their designated objectives, but also contribute positively to the overall ethos of sustainable development. SPM recognises that choices made during project conception, execution and closure can have a cascading effect on the community, the ecosystems, and the legacy that is left to future generations.

2.3.2 Principles of Sustainable Project Management (SPM)

At the heart of sustainable development project management is the alignment of project management practices with the principles of sustainable development. This means considering not only the immediate objectives of a project, but also its long-term environmental, social and economic impacts. The following are some of the key principles of sustainable project management:

Holistic Approach: Sustainable project management takes a holistic view, considering the entire project life cycle and its interactions with various stakeholders and the environment. This approach requires project managers to anticipate and address potential environmental and social impacts throughout the project (Silvius & Schipper, 2014).

Integrating Sustainability: Sustainable project management requires the integration of sustainability factors into all aspects of the project management process. This includes material selection, energy-efficient design, waste reduction strategies, and even the treatment of project workers and local communities (Elmualim & Alp, 2016).

Stakeholder Engagement: Stakeholder engagement is a fundamental aspect of SPM. Project managers must actively engage with relevant stakeholders, such as local communities, environmental experts, and social organizations, to gather different perspectives and ensure that the project meets the needs and values of all interested parties (Elmualim & Alp, 2016).

Long-term impact assessment: Sustainable project management includes assessing the long-term impacts of project decisions. This includes assessing the potential impacts of projects on climate change, resource depletion, and community well-being. Through such assessments, project managers can make informed choices that balance short-term benefits with long-term sustainability (Chawla, 2018).

2.3.3 Benefits of Sustainable Project Management

Implementing the SPM approach can yield a range of benefits beyond the immediate project objectives:

Risk reduction: SPM emphasizes risk management, considering both traditional project risks and potential sustainability-related risks. By identifying and mitigating these risks early, project managers can avoid costly delays, reputational damage, and legal issues (Chofreh et al., 2019).

Enhance reputation: Sustainable projects often receive positive attention from the public, investors, and regulators. Organizations that consistently practice sustainable project management can build a reputation for being responsible and ethical, which increases stakeholder trust and support (Chofreh et al., 2019).

Innovation and Efficiency: Incorporating sustainability principles can drive innovation in project design, resource management, and construction techniques. These innovations can increase operational efficiency, reduce waste and improve overall project performanc (Elmualim & Alp, 2016).

There are several promising options waiting to be explored in order to advance sustainable project management. The diversity of computational technologies and evolutionary algorithms in this field presents revolutionary opportunities for sustainable project management, as they enable the identification and utilization of optimal allocations of resources. At the same time, it is imperative to incorporate key elements of sustainable project management such as profitability, safety, transparency, ethical considerations, environmental compatibility, social resonance, and alignment with stakeholder and customer expectations. These parameters can be used as key weighting factors to construct a multi-objective paradigm for sustainable project management. This approach helps to identify and quantify sustainability considerations relevant to a given project. In addition, a groundbreaking framework can be conceptualized that integrates and coordinates all aspects of project management sustainability. This novel framework would include both evaluation and assessment aspects, coherently integrating a feedback mechanism that would incorporate every aspect of the organization's work, decisions and policies. By incorporating these multifaceted elements, the framework could provide a holistic perspective through which project management sustainability can be comprehensively measured and discerned (Chawla, 2018).

2.3.4 Project success and decision-making in construction project management

A core element of project management is the phase-gate process (Kerzner, 2017; Silvius et al., 2017). The phase-gate process is the facilitation mechanism that guides the decision-making trajectory of a project. As identifiable gateways, junctions constitute delineated checkpoints strategically set at the apex of each project phase. These gateways serve a dual purpose - they are both gateways that ensure the recognition needed to proceed further, and tools for early detection of potential setbacks. Through this early detection, resources can be allocated wisely, preventing them from being wasted on less favourable work and instead being used for more promising work.

Through project management, project managers must make decisions (Bhagwat & Sharma, 2007). The quality of these decisions depends on the acumen of the decision maker to conduct a two-pronged assessment: i) scrutinize the current status of the project against its original objectives - asking questions that include the trajectory to date and the broader current progress(Marquès et al., 2011); and ii) envision a plausible trajectory for the project based on the decisions made and the events that are unfolding - gaining insights into the upcoming changes and their impact on the project . The prism of performance assessment is a conduit for system configuration or adjustment and management of existing systems. It is an integral part of effective planning and control and coexists in harmony with the decision-making domain.

Atkinson (1999), Cooke-Davis (2002) pointed out that project management activities using only time, cost or quality measures can be flawed (Marquès et al., 2011). They explain that using the Iron Triangle (cost-time-quality) as a criterion for success is not optimal. In particular, Atkinson (1999) stated that the Iron Triangle is not related to control errors, which can lead to less than optimal task results (Marquès et al., 2011). The stage-gate process arose because the traditional hierarchical command and control structure is ineffective for ad hoc processes such as projects that imply "horizontal" workflows across organizational boundaries (Silvius et al., 2017). Therefore, project performance should be measured through the overall objectives of the project, not just through the universal traditional measures of cost, time and quality (Marquès et al., 2011).

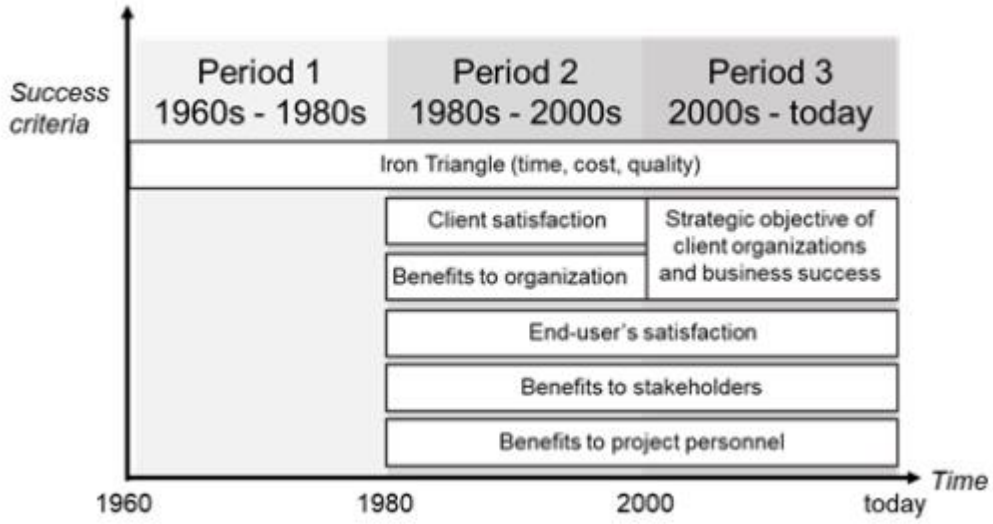

Figure 05. Evolution of project success criteria (Silvius et al., 2017)

Project success is one of the most emphasized concepts in project management research (Ika, 2009). Both decision making and reviewing are process monitoring to achieve project success. Most of the early research on project success emphasized three dimensions: time, budget, and quality. However, this approach has now been widely criticized. Since the beginning of the last century (De Bakker et al., 2010; Correa et al., 2018), many studies on success criteria have emerged. Figure 05 shows the evolution of project success criteria from an 'iron triangle' to a more comprehensive set of criteria that also includes benefits generated and stakeholder satisfaction.

Dubois and Silvius (2020) created a conceptual model to examine the impact of sustainable project management on project success by exploring a range of relationships between sustainable project management and project success (shown in Figure 06). It was concluded that considering sustainability in project management would contribute to project success (Dubois & Silvius, 2020). In our study, we can apply the same model to explore the importance of sustainability in project decision-making. Since our study also explored the link between sustainable project management factors and project success, it is also interesting to explore how sustainability influences project success decisions in the context of the fact that sustainability is known to improve project success (Pirotti et al., 2020).

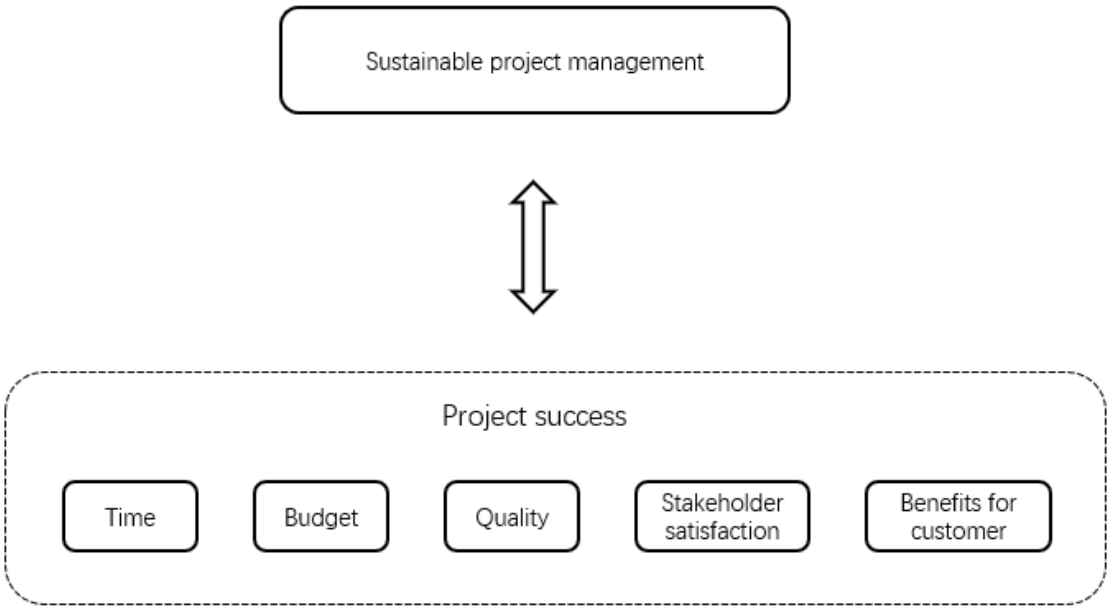

Figure 06. Conceptual model (Dubois & Silvius, 2020)

2.4 Sustainable project management for construction projects

2.4.1Principles of sustainability

When considering sustainability in project management, it is important to build on a clear set of guiding principles(Silvius et al., 2017). This is because these principles can provide the necessary framework for overall project management, ensuring that sustainability objectives are not only met, but also practically applied throughout the project lifecycle. By focusing not only on perspectives related to the project management process, such as how a project operates, but also on the depth and breadth of sustainability, such as a project's environmental impacts and societal benefits, the principles provide a comprehensive perspective on the practice of sustainability. By applying these principles, sustainability project management focuses not only on the immediate success of a project, but also considers its long-term environmental and social impacts.

The sustainability principles used in this study were refined based on a comprehensive review of a wide range of literature sources as shown in Table 02. This entails a thorough examination of books, journal articles, book chapters, and conference proceedings from both domestic and foreign conferences in order to pinpoint and condense fundamental ideas and viewpoints on sustainability from a variety of fields and disciplines. These principles are seen as key elements of sustainability in construction project management and guide how we assess and integrate sustainability goals. For example, by analyzing works such as John Elkington's Cannibals with Forks and Paolo Sassi's Strategies for Sustainable Architecture, we have refined principles such as comprehensiveness and systems thinking, and technology and innovation driven. We used these guidelines in the study's particular implementation at all project management stages, such as planning, initiation, execution, monitoring, and closure. An application like this makes sure that sustainability is applied in project management's real-world operations and decision-making processes, not just as a theoretical concept.

Table 02. Summary of Principles of sustainability

Principles of sustainability	**Source**
Comprehensiveness and Systems Thinking	(Elkington, 1999)
Technology and Innovation Driven	(Sassi, 2006)
Community Participation and Cultural Adaptability	(Mussinelli, 2021)
Risk Management and Health Safety	(Soltanzadeh et al., 2022)
Balancing and harmonizing social, environmental and economic interests	(Silvius et al., 2017)

2.4.2 Sustainability in project management for construction

Comprehensiveness and Systems Thinking: This principle requires project managers to consider the environmental, social and economic impacts of a project in the decision-making process. This approach emphasizes a comprehensive analysis of the construction project, including an assessment of the project's impact on the local ecosystem, the sustainable use of resources and the overall environmental footprint of the project throughout its life cycle (Petrelli et al., 2023; Ohiomah et al., 2019b). In addition, systems thinking means considering how the project will impact the community and society, including employment opportunities, community development and social equity issues (Khanaum & Hossain, 2023; Ghufran et al., 2022). Project managers can ensure that projects meet current needs without

risking the interests of future generations by using this comprehensive and integrated approach, which emphasizes environmental protection and social responsibility as well as the identification and mitigation of potential negative impacts.

Technology-Driven and Ecological Innovation: In order to increase sustainability, this principle places a strong emphasis on the application of modern technology and eco-innovation in construction project management. It motivates project managers to investigate and implement technological solutions that dramatically increase resource efficiency and lessen their negative effects on the environment. This includes the use of digital tools such as Building Information Modelling (BIM) to optimize the design process and improve material efficiency (McAuley et al., 2020), and the use of modular construction techniques to speed up the construction process and reduce waste from on-site operations. In addition, eco-innovation includes the application of renewable energy sources, green building materials and energy-efficient technologies to achieve both environmental sustainability and economic efficiency. This approach not only helps to reduce the carbon footprint of construction projects, but also facilitates the development and application of new technologies, laying the foundation for the future of the sustainable construction industry (Wei et al., 2020).

Community Participation and Cultural Adaptability: This principle highlights how important it is for project managers to actively involve local communities in the planning and execution of projects while recognizing and adjusting to their unique cultural practices. This means that to understand the needs and expectations of the community and take these into account when designing the project, project teams must collaborate and have meaningful conversations with members of the community (Hoyos-Gómez et al., 2021). This involvement increases the project's social acceptability and success while ensuring that it is meeting the actual needs of the local community. Furthermore, by using this approach, local cultural heritage is protected and promoted, and project outcomes are aligned with the community's long-term interests and sustainable development objectives (Hasana, 2022).

Risk Management and Health Safety: The principles of Risk Management and Health Safety focus on preventing risks and promoting safety in the administration of construction

projects. This entails assessing, evaluating, and controlling project risks, particularly those related to the health and safety of employees (Soltanzadeh et al., 2022). Project managers need to ensure that appropriate safety measures are taken during construction, such as the use of safety equipment, training of employees, and implementation of emergency response plans. In addition, this principle emphasizes the importance of considering long-term health and safety issues, such as air quality, noise control and pollution prevention, during project planning and execution (Hasana, 2022). Projects can enhance their overall sustainability and success while also protecting the safety of workers and community members through the adoption of effective risk management practices.

Balancing and harmonizing social, environmental and economic interests: Sustainability is about balancing and harmonizing social, environmental and economic interests. This principle acknowledges that social, environmental, and economic interests must be balanced and compared as the fundamental components of sustainability in construction project management(Silvius et al., 2017). It also means that decisions about projects take into account social welfare, economic gains, and environmental preservation at the same time. For example, consider the amount and sources of energy used in the project, the long-term contribution of the construction project to the local economy, and the consequences for society and the environment. This balanced approach requires project managers to undertake comprehensive considerations, including social responsibility (Makeev, 2021), environmental impact assessment, and economic benefit analysis. As discussed by Petrelli et al. (2023), not all practices in construction project management positively impact sustainability, highlighting the need for a nuanced approach.

These principles provide a framework for project managers in sustainable project management to effectively integrate sustainability considerations into all phases of a construction project. It is possible to meet the traditional project objectives—such as profit and time savings—as well as make sure the project has a positive social and environmental impact by incorporating these principles into the various project processes. These principles specifically outline the necessity for project managers to take into account the long-term effects of a project at every stage, including the ongoing effects on the local community, environment, and economy in addition to the project's cost and time. For instance, take into

account the long-term environmental effects of the materials and construction methods you choose; when interacting with stakeholders, think about how to best involve the community and address its needs. In addition, these principles mean that when faced with potential conflicts between economic, environmental and social goals, project managers need to take an innovative and strategic approach to finding a balance. This may include adopting new technologies to improve efficiency, or using innovative design and construction methods to minimize environmental impacts.

3.Methodology

3.1 Q methodology

Q methodology as a research methodology focuses on exploring and analyzing the subjective views and attitudes of individuals(Brown, 1993). It was pioneered by British physicist and psychologist William Stephenson(Qu et al., 2015), who developed the methodology in the 1930s (Stephenson, 1968). Q methodology combines the strengths of both qualitative and quantitative research (Qu et al., 2015) through a process known as "Q-sorting," which allows researchers to gain detailed insights into how individuals perceive particular topics or opinions (Watts, 2012). Through a process called "Q-sorting," researchers are able to gain a detailed understanding of how individuals perceive a particular topic or point of view.

In the Q-sorting process, participants are asked to rank a series of statements (i.e., a Q-set) to reflect the extent to which they agree or disagree with the statements, as shown in Figure 07. The statements were carefully selected and designed according to the research topic while covering various aspects of that topic (Brown, 1982). The results of the participants' ranking reveal their personal views and evaluation criteria of these statements, and thus can provide the researcher with a different perspective, allowing the researcher to fully understand and analyze the interrelationships of these views and the patterns of thinking behind them. In addition Q methodology usually involves a smaller sample size in the study compared to traditional survey research. Its methodology focuses more on gaining a deeper understanding of the complex structure of the views of a few individuals rather than conducting extensive surveys and generalizations on large samples (McKeown & Thomas, 2013). The advantage of this methodology is that it is able to explore the nuances and diversity among different individuals under a specific topic.

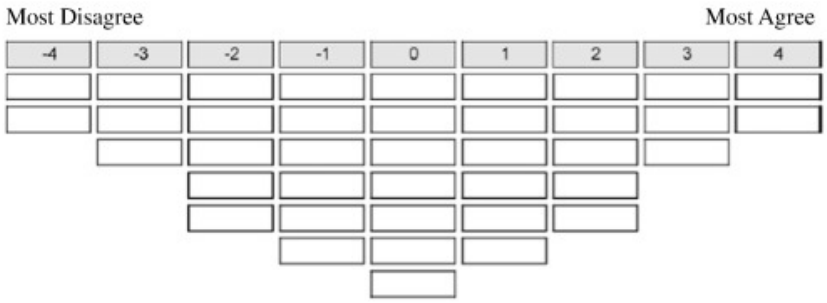

Figure 07. Sample score sheet (Silvius et al., 2017)

In this study, Q methodology was chosen as the primary research methodology because it provides an in-depth and detailed understanding of how construction project managers incorporate a subjective view of sustainability in their decision-making process(Silvius et al., 2017). In the decision-making process of construction project management, managers need to integrate multiple factors, such as environmental impacts, social responsibility, and economic benefits. The application of Q methodology enables us to gain insight into the subjective views of project managers when considering sustainability, and how these views are formed and developed (Watts & Stenner, 2005).

Furthermore, as sustainability itself is a multidimensional and complex concept, the flexibility and depth of the Q methodology makes it an ideal tool for understanding this complex topic (Cross, 2004). The method allows us to identify key perspectives or factors in sustainability decision-making and also reveals how these perspectives are influenced by individual experiences, values and contexts. By analyzing how project managers balance and incorporate sustainability considerations, we can provide deeper insight into the construction industry and provide an academic basis for developing more effective project management strategies.

In the Q-analysis after completing data collection the participants' results are categorized into different factors or types, with each type representing a unique perspective. This phase of Q-methodology is particularly important in the study because different approaches to sustainable integration by project managers will be identified and described during the analysis phase (Goel, 2022). These factors not only provide perspectives on the different

ways in which sustainability is considered, but also highlight possible areas of improvement or directions for further exploration (Tanga et al., 2022).

3.2 Design of the Q set

In this study, the design of the Q-set is a critical step that directly affects the accuracy and depth of the study. The Q-set consists of a series of statements that reflect different aspects of the research topic (Cuppen et al., 2016). In our study, these statements mainly focus on the consideration of various factors for incorporation decision making in construction project management.

3.2.1 Statement Generation

In order to generate the Q-set, a series of key categories first needed to be defined, as shown in Table 03. These categories are based on a conceptual model proposed by Dubois and Silvius in 2020 that systematically explores the relationship between sustainable project management and project success (Dubois & Silvius, 2020). Project success is often seen as the ultimate goal of project management, and sustainable project management provides a key way to achieve this goal.

In the context of sustainable project management, the project decision-making process becomes central to ensuring project success (Barendsen et al., 2021). The purpose of project decision-making is to ensure project success(Silvius et al., 2017), while project decision-making is not only about project time, cost and quality, but also about environmental protection, social responsibility and economic sustainability. The combination of these factors is the key to project success. Therefore, Dubois and Silvius' model provides a powerful tool to help us understand the various considerations in project decision-making, especially in the context of sustainable management. So we defined six factors that play a key role in project decision making.

Table 03. Important Factors(Dubois & Silvius, 2020)

Six Important Factors in Project Decision Making		
Time	Quality	Customer benefits
Cost	Stakeholder satisfaction	Sustainability

Based on this model, we categorized statements into six categories: sustainability, project time, project cost, project quality, stakeholder satisfaction, and customer benefits. Statements under each category are crafted to address their specific aspects to ensure that all aspects of project management are fully captured. Also for the statements under the sustainability category, they are generated according to the different principles of sustainability, which makes them more comprehensive and specific (shown in Table 04).

Table 04. Statements of sustainability

Principle of sustainability	Statements of Sustainability
Technology-Driven and Ecological Innovation	1.Prioritize the adoption of digital technologies to enhance sustainability
	4.Modular integrated construction (MiC) promotes fast construction and supports sustainable development.
	12.Renewable resources are vital
Comprehensiveness and	2. Emphasize the sustainability of the project life cycle, from

Systems Thinking	resource extraction to eventual decommissioning
	5. The ecological sustainability of the site should be assessed, ensuring minimal disruption to local ecosystems
	7. The sustainability of the project life cycle is important
	8. When making decisions, it's imperative to assess the potential long-term impacts of construction projects on the environment
Community Participation and Cultural Adaptability	10. Stakeholder engagement is essential
	14.Consider the social and cultural aspects of the project's impact on local communities
	15. Integrate nature-based solutions within decision-making
Risk Management and Health Safety	3. Potential environmental impacts should be assessed and mitigated
	16.Risk management is fundamental
	17. Health and safety issues are checked
Balancing and Harmonizing Social, Environmental, and	6. The amount of energy used in the project is essential to take into consideration
	9.Responsible waste management and reduction strategies

Economic Interests	should be a pivotal part in construction projects
	11.Should consider the potential for long-term economic benefits
	13.The economic, social and environmental consequences are crucial

In generating specific statements, we relied on extensive literature research and analysis of statements used in previous Q methodology investigations. This process not only ensured the comprehensiveness and accuracy of the statements, but also enhanced the depth and utility of the research by combining the results of the prior research with the purpose of the current study. Through this approach, we were able to ensure that the Q-set comprehensively reflected the key considerations in the project management decision-making process, particularly with regard to sustainability.

In summary, by creating the Q-sets, the aim is to provide an in-depth exploration of the various factors that need to be considered in the management of a construction project, and in particular, how they affect project decision-making and project success. This comprehensive and in-depth exploration will not only provide insights into project management practices, but also help to promote the wider application of sustainability in construction projects.

3.2.2 Choice of Declaration

When generating statements for the Q-set, we paid particular attention to incorporating multiple factors to ensure that the statements comprehensively cover the key factors in the

project's decision-making. To achieve this, we first identified different categories or principles on which to base the generation of the corresponding statements.

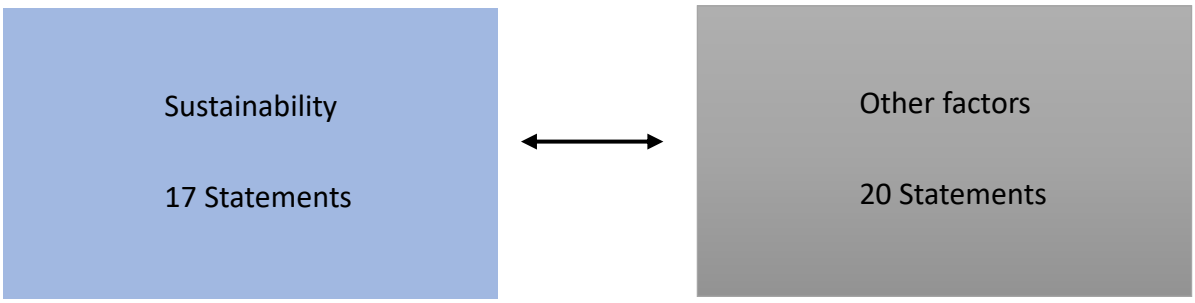

Figure 08. Comparison of sustainability and other factors

There is no fixed requirement for the number of statements in a Q set but it is usually between 20 and 50 (Exel & Graaf, 2005). So to maintain the balance of categories in a Q set, we make sure that each category or principle contains a similar number of statements, about four to five. This approach is intended to prevent any one category from bearing undue weight in the analysis, according to the principles of the Q methodology. As opposed to the absolute score of each statement individually, the Q methodology places more emphasis on the statements' relative importance to one another during the ranking process(McKeown & Thomas, 2013). Thus, ensuring that the number of statements in each category or principle is balanced helps to avoid bias in the ranking and analysis process and improves the fairness and accuracy of the study. In particular, for sustainability, the core investigated factor, we deliberately made the number of sustainability statements roughly equal to the total number of statements for the other factors. This was designed to ensure that the relative weights of sustainability and the other factors in the analysis remained consistent. In the Q methodology, this balanced approach helped us to more accurately capture and reflect participants' perceptions and preferences for each factor, especially when considering the importance of sustainability in construction project management. By having roughly equal numbers of statements in each category, we are able to more effectively assess and compare the relative importance of different categories to each other.（shown in Figure 08）. After synthesizing our analysis, we finalized 37 statements. These statements not only comprehensively cover a number of key aspects of construction project management, such as project time, cost, and quality, but also delve into multi-dimensional

content such as stakeholder satisfaction and client benefits. This design allows the Q-set to comprehensively reflect the complexity and diversity in project management and provides a solid foundation for the study.

The statements are designed to reflect key factors in construction project management. For example, the statements include "Project time ensures that the project is completed on time" and "Project cost ensures that the project is completed within the approved budget", which are key factors for project success. The statement also includes "Sustainability should be emphasized in the project life cycle" and "It is important to assess the potential long-term environmental impacts of construction projects when making decisions," reflecting the importance of sustainability in construction projects(Hussain & Hussaın, 2023). This design allows the Q-set to reflect the full range of considerations in project management.

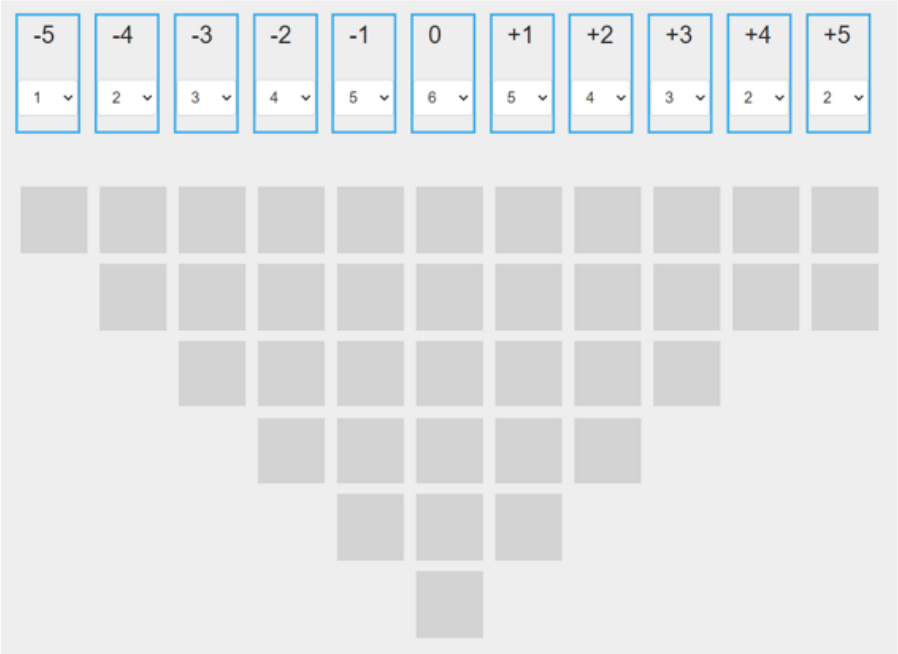

Figure 09. Score sheet for 37 statements

During the Q-sorting process, respondents ranked the statements according to their personal opinions, thus revealing their subjective views. The highest score a statement can receive is +5 and the lowest score is -5, as shown in Figure 09. This distribution makes the results more reflective of the respondents' views and preferences. By designing the Q-set in

this way, we were able to not only capture the multiple perspectives of the participants, but also explore the complexity and diversity in construction project management decisions.

3.2.3 Presentation of statements

Table 05. Statements （Q set）

No	Category	Statements (Within decision-making in construction projects…)	Source
1	Sustainability	Prioritize the adoption of digital technologies to enhance sustainability	(Kineber et al., 2023)
2	Sustainability	Emphasize the sustainability of the project life cycle, from resource extraction to eventual decommissioning	(Kineber et al., 2022; Silvius et al., 2017)
3	Sustainability	Potential environmental impacts should be assessed and mitigated	(Mallick et al., 2022)
4	Sustainability	Utilizing modular integrated construction (MIC) promotes fast construction and supports sustainable development;	(Wuni & Shen, 2019)

5	Sustainability	The ecological sustainability of the site should be assessed, ensuring minimal disruption to local ecosystems	(Olatunde& Odeyinka, 2021)
6	Sustainability	The amount of energy used in the project is essential to take into consideration	(Azzi et al., 2015; Silvius et al., 2017)
7	Sustainability	The sustainability of the project life cycle is important	(Silvius et al., 2017)
8	Sustainability	It's imperative to assess the potential long-term impacts of construction projects on the environment;	(Silvius & Schipper, 2014)
9	Sustainability	Responsible waste management and reduction strategies should be a pivotal part in construction projects	(Gareis et al., 2013)
10	Sustainability	Stakeholder engagement is essential	(Eskerod & Huemann, 2013)

11	Sustainability	Should consider the potential for long-term economic benefits	(Chan et al., 2017)
12	Sustainability	Renewable resources are vital	(McDonough & Braungart, 2010; Silvius et al., 2017)
13	Sustainability	The economic, social and environmental consequences are crucial	(Silvius et al., 2017)
14	Sustainability	Consider the social and cultural aspects of the project's impact on local communities	(D. Walker & Rowlinson, 2007)
15	Sustainability	Integrate nature-based solutions within decision-making	(Colding & Barthel, 2013)
16	Sustainability	Risk management is fundamental	(Silvius et al., 2017)
17	Sustainability	Health and safety issues are checked	(Silvius et al., 2017)

18	Cost	Should seek to optimize resource allocation, balancing upfront expenses with long-term savings	(D. Walker & Rowlinson, 2007)
19	Cost	Cost is the most important factor to take into account	(Kerzner, 2017; Silvius et al., 2017)
20	Cost	Should prioritize resource conservation	(Isazade, 2021)
21	Cost	A cost/benefit analysis is considered	(Garvin, 2000)
22	Time	Time efficiency should be considered to meet project milestones and avoid delays	(Garvin, 2000)
23	Time	Time is the most important factor	(Kerzner, 2017; Silvius et al., 2017)
24	Time	Prioritize decision-making methods that enable efficient resource allocation, avoiding overallocation and optimizing project timelines	(Kerzner, 2017c)

25	Time	Prioritize timely stakeholder collaboration to prevent project delays	(Shahbaz, 2018)
26	TIme	Time management in construction projects should account for potential delays due to sustainable practices, ensuring that these practices are not compromised for speed.	(Silvius et al., 2017)
27	Time	Time estimates should consider potential delays caused by unforeseen circumstances such as weather conditions	(Lim & Mezghiche, 1999)
28	Quality	Maintaining high-quality standards is crucial to ensure project longevity and stakeholder satisfaction	(Cooke-Davies, 2002)
29	Quality	Sustainable choices should align with quality objectives	(Silvius & Schipper, 2014b)
30	Quality	A quality review session is necessary	(Commerce, 2009; Silvius et al., 2017)

31	Quality	Prioritize the use of certified and standardized materials during decision-making to uphold quality and safety standards	(Eastman et al., 2011)
32	Stakeholder Satisfaction	Stakeholder satisfaction should be a central consideration, fostering positive relationships and community acceptance	(D. Walker & Rowlinson, 2007)
33	Stakeholder Satisfaction	Decision-making processes should incorporate stakeholder feedback and engagement	(Gareis et al., 2013)
34	Stakeholder Satisfaction	Prioritize open and transparent communication with stakeholders	(Mitchell et al., 1997)
35	Customer Benefits	Consider the long-term benefits and operational efficiencies that end-users will gain from the completed construction project	(Kerzner, 2017)
36	Customer Benefits	Within decision-making in construction projects, the identification of customer needs and preferences should guide the selection of project features	(Kerzner, 2017)
37	Customer	Construction projects that prioritize sustainability	(Olatunde &

	Benefits	offer long-term benefits to customers, including healthier living environments and reduced maintenance costs	Odeyinka, 2021)

3.3 Data collection

Data collection was a key aspect of this study, aiming to gain insights into respondents' perceptions and decision-making processes regarding sustainability in construction project management. This process involved conducting meticulous interviews with the respondents to ensure that the information collected was accurate and comprehensive, as shown in Figure 10.

Before formally commencing the Q-sort, I first conducted a series of initial questioning with the interviewees to better understand their professional backgrounds and perceptions of sustainability. These questions were designed to reveal how well the respondents understood and applied sustainability in their actual work. For example, I asked them about their specific responsibilities, the content of their work, and whether they were involved in sustainability-related decisions in their daily work. Through these questions, I was able to assess the interviewees' level of awareness of the concept of sustainability and its application in project management practices. Then, I further explored the factors that they usually need to consider in the project decision-making process, such as time, cost, quality, and sustainability. I asked them to rank the six key factors I identified in order of importance, which helped to understand their priorities in project management and how to strike a balance between various project management elements.

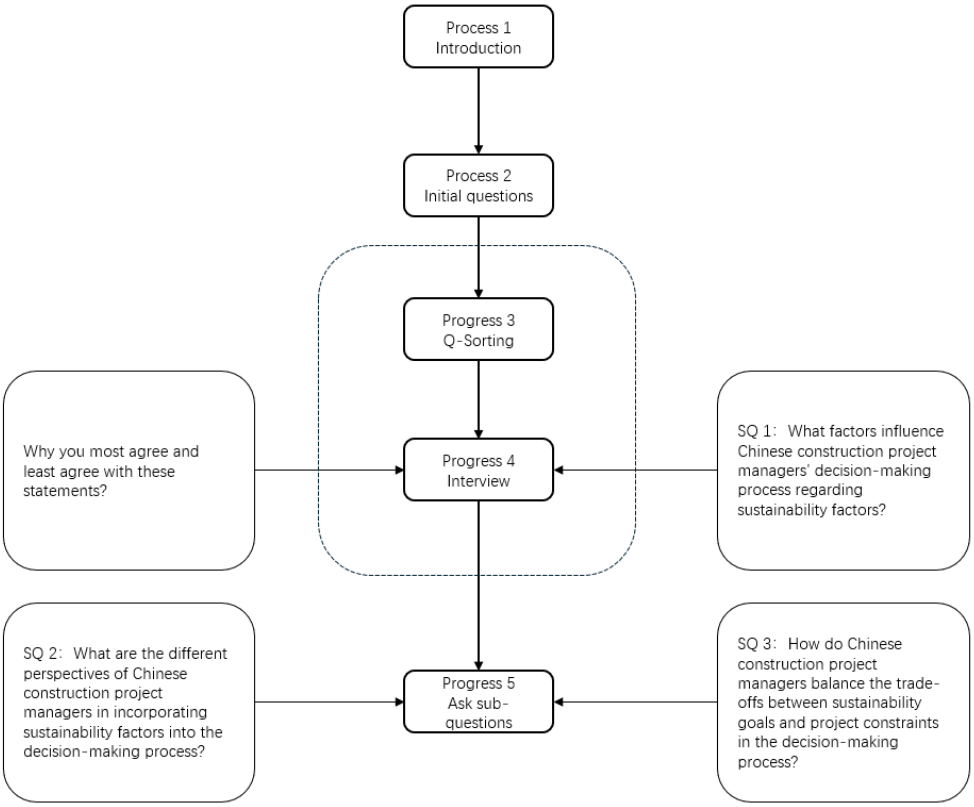

Figure 10. Processes of data collection

After answering the initial questions, the interviewees were guided through the Q-ranking process, which is the core aspect of the Q methodology. In this process, respondents were asked to rank a series of pre-prepared statements based on their personal opinions and judgments. These statements address various aspects of project management, especially sustainability considerations. The ranking results reveal the respondents' attitudes and preferences for each statement, reflecting their personal views and value judgments in project management decisions.

For the results of the Q-sorting, I paid special attention to those statements that respondents specifically agreed or specifically disagreed with, and asked them why they chose such a sort, with a view to gaining a deeper understanding of the logic behind their thinking. After respondents completed their ranking of the statements, I further asked them my sub-questions, such as how they viewed the integration of sustainability into the project's decision-making process and what trade-offs they would make when sustainability conflicted with other elements of the project. The purpose of these questions was to probe

respondents' decision-making logics and strategies when faced with sustainability challenges.

3.4 P set design

In this study, the selection criteria for the respondents (P-set) were carefully designed to ensure the validity and reliability of the findings. These respondents were from the construction industry with backgrounds in civil engineering construction work, and their experience and knowledge were crucial to the study.

To ensure the quality of the respondent pool, we conducted extensive recruitment on the Internet and set strict criteria for selection. First, respondents had to come from large, state-run engineering companies that are well known in China. This condition ensures that they are representative and influential in the industry and thus able to provide insights into sustainability considerations in construction project management. Second, interviewees should have many years of relevant work experience in construction project engineering. This range of experience helps us to gather diverse perspectives from project managers at different levels, thus giving the results of the study more breadth and depth. In addition, they need to have experience in exposure to and practice of sustainability, which helps to assess their knowledge of sustainability concepts and their application in practice. Finally, experience in participating in project decision-making is critical to understanding their decision-making approach and considerations in the project management process. These criteria not only ensured that the interviewees had sufficient expertise and experience, but also that they were able to provide insights and high-quality feedback on construction project management and sustainability.

Through these criteria, we were able to ensure the reliability and utility of the findings, providing valuable insights into sustainability decision-making in construction project management.

3.5 Q analysis

Q-analysis is a unique research methodology that combines quantitative and qualitative analytical tools focused on exploring the subjective perspectives of different individuals. Q-analysis in this study is a series of analytical steps to gain an in-depth understanding of the subjective considerations of construction project managers in sustainability decision-making(Watts, 2012). The key strength of the approach is its ability to capture and analyse participants' individual perspectives, providing a multidimensional perspective for understanding and evaluating sustainability decisions in construction projects(Watts, 2012).

3.5.1 Analysis Preparation and Data Entry

Preparation for data entry and analysis was a critical first step in this study. All data obtained through Q-sorting needed to be converted into a format suitable for analysis. This process includes data cleaning and preprocessing to ensure data consistency and accuracy. In this study, the data were analyzed using Ken-Q Analysis, a software designed for the Q method. When using Ken-Q Analysis software for data analysis, the first thing that needs to be ensured is the correct data format and accurate entry(Brown, 1993).

3.5.2 Construction of correlation matrix

The construction of the correlation matrix is an important step in Q analysis that involves comparing the results of ranking statements by different participants (Li & Suen, 2013). This step helps the researcher to understand the similarities and differences between participants by identifying patterns and trends in the data. In constructing the correlation matrix, each respondent's Q ranking was meticulously compared and analyzed to reveal their consensus and disagreement on sustainability issues.

3.5.3 Implementation factor analysis

Implementation factor analysis is the core part of the Q methodology. In this step, the data was analysed for principal components using Ken-Q Analysis software. This analysis helps in

identifying the key factors in the data and deciding which factors should be retained based on the eigenvalue. Eigenvalue is a statistical measure used to assess the amount of variance of each factor in factor analysis, i.e., the amount of variation in the data explained by the factor. In factor analysis and principal component analysis, the eigenvalue reflects the contribution of each factor in explaining the variation in the data. In factor analysis, especially in Q-method studies, the rule of eigenvalues greater than 1 is often used to select factors to retain, which is called the "Kaiser criterion"(Kaiser, 1960). This criterion suggests that only those factors with eigenvalues greater than 1 should be retained because they represent substantial contributions that are at least equal to the average amount of variation in a variable. In this study, when the number of factors extracted was more than four, we found that only three factors had eigenvalues greater than 1.

In this study, when the settings for the number of factors extracted were more than four, we found that only three factors had eigenvalues greater than 1. This suggests that these factors play a significant role in explaining the data, and were therefore identified as the main focus of the study. According to the Figure 11, these factors with eigenvalues significantly greater than 1 can significantly explain the variability in the data and therefore become the focus of the study. It is significant to remember that the number of factors chosen for retention depends on the study's objectives and practical significance in addition to the eigenvalues' magnitude. In this study, we first considered the number of factors extracted. This is because in factor analysis, the choice of the number of factors is critical to the interpretability and validity of the overall analysis. We decided on the number of factors to be retained based on the Kaiser criteria and the interpretability of the factors to ensure that the results of the analysis met the statistical criteria and were reasonable at the same time. Therefore, in this study, we chose to retain the top three factors with eigenvalues greater than 1 based on their statistical significance and importance in explaining the sustainability decision-making process in construction project management. By retaining these key factors, we were able to

understand and explain the respondents' views in greater depth, thus providing valuable insights for the study.

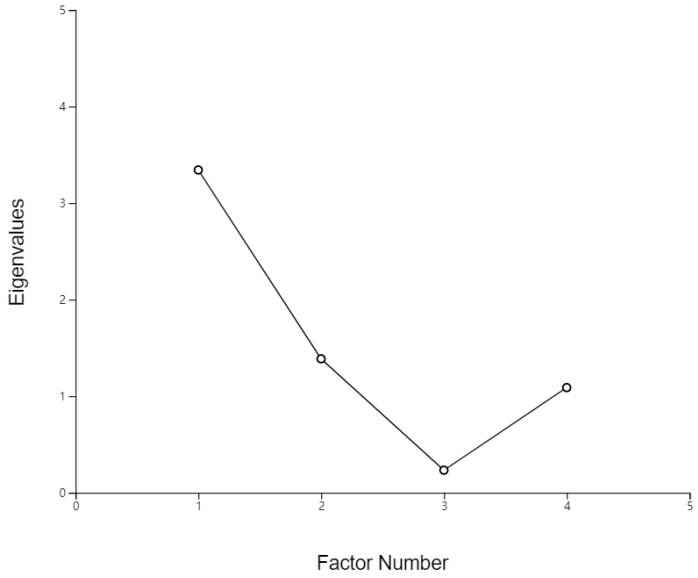

Figure 11. Eigenvalue of each factor

3.5.4 Factor Interpretation and Validation

In Q-analysis, factor interpretation is a step that requires in-depth understanding and qualitative analysis. A detailed explanation of each factor was needed in this step, and the explanation included the themes and perspectives represented by the factors and their representation in the data. We also referred to relevant literature and theories to validate the plausibility and consistency of the factors (Watts, 2012). This step ensured that our analysis was both data-based and consistent with existing research and theory.

3.5.5 Calculating and Interpreting Factor Scores

Calculating and interpreting factor scores is a critical step in Q-analysis. There will be different statement scores in each factor, and different scores prove that the importance of individual statements is different. We calculated scores for each factor based on its loadings and used these scores to further analyse and understand each factor in relation to each

interviewer's subjective perspective. These scores can be used to measure the relative importance of each factor in different subjective perspectives(Brown, 1993).

4. Results and discussion

4.1 General overview

After recruiting and interviewing program participants, this study eventually collected 14 participants from construction project management professionals with diverse work experiences and positions. These participants had a wide range of work experience, covering from two to ten years, and possessed diverse experience and knowledge in the field of construction project management, as shown in Table 06.

Table 06. Overview of P set

Job type	**Numbers of respondents**	**Respondents**
Safety management manager	4	3,4,8,12
Quality supervision manager	3	1,7,11
Technical general engineer	7	2,5,6,9,10,13,14

In terms of specific positions, the participants' positions ranged from safety management manager, quality supervision manager, and technical general engineer. These positions had important role in the management and execution of construction projects, and the scope of work involves a number of key areas such as safety, quality, and technology in construction

projects. Therefore, the perspectives and experiences of these participants were valuable in understanding sustainability considerations in construction project management.

In terms of sustainability exposure and practice, most interviewees indicated that they did have exposure to sustainability-related topics in their projects. However, when delving into the actual operation and implementation of sustainability measures in their specific work, they generally reflected that there are certain challenges and difficulties in practical application. This reflects the fact that although sustainability is widely recognized at the theoretical level, there are still many barriers and challenges in the actual project management and implementation process at present. The analysis of these initial situations provides a practical context for the study, reveals the complexity of sustainability implementation in construction project management, and lays the foundation for subsequent data analysis and interpretation of results.

4.2. Different perspectives

This study identified three salient factors through principal component analysis that represented the participants' different perspectives on sustainability considerations in construction project management. The Q-sort results for the 14 valid samples revealed these three distinct perspectives, which collectively comprised the participants' group (P-set) comprehensive view of sustainability considerations. These three perspectives collectively comprise 100% of the P-set, as shown in Figure 12.

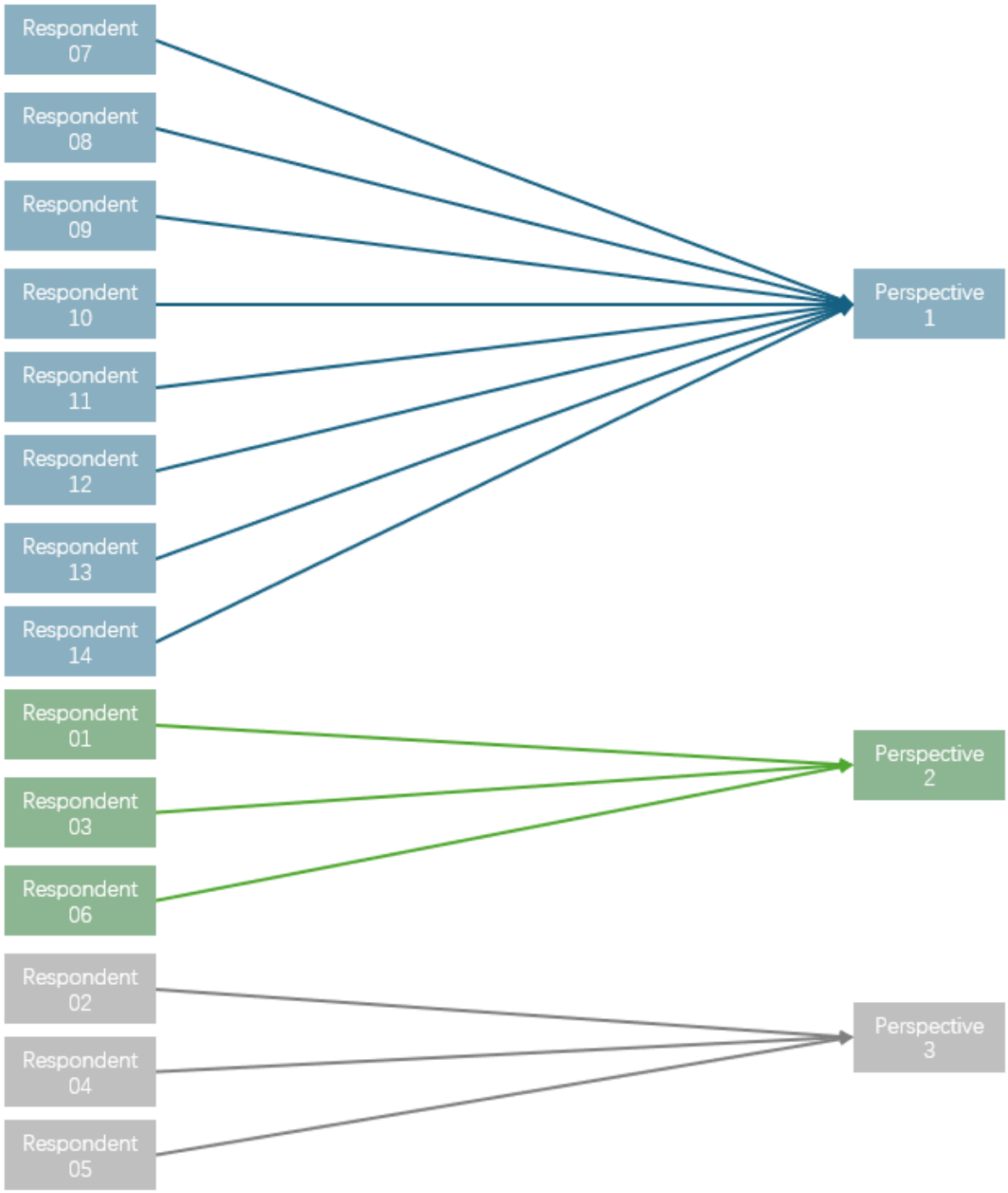

Figure 12. Perspective for respondents

The grey cells in the Table 07 identify a defining ranking of each perspective, which helps us understand the core elements and priorities of each perspective. Comparative analysis allows us to gain a deeper understanding of the specific application and impact of these perspectives in project management practice. Perspectives are expressed by further analyzing the factor scores for each perspective versus the consensus in the Q-sorted group.

Perspective one is characterized as cost and sustainability. Perspective two is characterized as people and sustainability. Perspective three is characterized as cost and quality.

Perspective one is named 'Cost and Sustainability' because the statements in this perspective focus primarily on controlling costs and achieving sustainability. In this perspective, the participants consider cost and sustainability as the first factor to be considered in project decision-making, emphasizing the importance of employee safety and health while maintaining the cost-effectiveness of the project, reflecting the importance of the relationship between risk health management and financial costs. Perspective two is called 'People and Sustainability', and this perspective emphasizes technology to achieve sustainability with employee and community involvement in the project. In this perspective, respondents focused on how to achieve the sustainability goals of the project while ensuring employee engagement and community benefits, showing a balance between sustainable technical practices and high levels of people involvement in the project. Perspective three was named 'Cost and Quality' because the statements in the perspective focused on two factors, project cost and quality. Respondents identified cost and quality as the most important factors to consider in project decision making. This perspective statement focuses on achieving a high standard of project quality within a sensible cost, and emphasizes the balance between cost-effectiveness and quality.

Through this naming approach, the characteristics and focus of each perspective become more apparent. This contributes to a fuller understanding of the different perspectives of construction project managers on sustainability in construction project management and their specific application.

Table 07. Identification of perspectives

	Perspective 1	Perspective 2	Perspective 3
Respondent 1	0.2649	0.5970	-0.1395

Respondent 2	-0.0669	0.0095	0.4303
Respondent 3	-0.0205	0.4137	0.0566
Respondent 4	0.2505	0.0139	0.5567
Respondent 5	0.0746	0.2844	0.5001
Respondent 6	0.0891	0.4513	0.2560
Respondent 7	0.7947	0.0534	0.0369
Respondent 8	0.1759	0.0694	0.0615
Respondent 9	0.5513	-0.2599	0.5275
Respondent 10	0.6507	-0.0328	0.0357
Respondent 11	0.4601	-0.2202	0.1851
Respondent 12	0.3637	-0.3024	0.0828
Respondent 13	0.8361	0.1170	0.010
Respondent 14	0.7078	0.2305	0.0648
Percentage	58%	21%	21%

4.3 Top Ranking Statements

In the Q-method analysis of this study, the individual statements ranked by the respondents were carefully counted and analyzed. In order to gain a deeper understanding of the factors prioritized in the different perspectives, the top ten ranked statements in each perspective were summarized and compared. Within each viewpoint, the top ten ranked statements reflect respondents' perceptions of the importance of each factor in construction project management. In the Table 08, sustainability statements are labelled with a grey background, while statements for other factors are displayed with a white background. This visual distinction helps to quickly identify which factors are valued more highly in different views.

Table 08. Top 10 statements per perspectives

	Perspective 1 （Cost and Sustainability）	Perspective 2 （People and Sustainability）	Perspective 3 （Quality and Cost）
1	17. Health and safety issues are checked；	1.Prioritize the adoption of digital technologies to enhance sustainability；	21.A cost/benefit analysis is considered；
2	21. A cost/benefit analysis is considered；	10.Stakeholder engagement is essential；	31.Prioritize the use of certified and standardized materials during decision-making to uphold quality and safety standards；

3	16. Risk management is fundamental;	21.A cost/benefit analysis is considered;	18.should seek to optimize resource allocation, balancing upfront expenses with long-term savings;
4	30. A quality review session is necessary;	13.The economic, social, and environmental consequences are crucial;	29.Sustainable choices should align with quality objectives;
5	19. Cost is the most important factor to take into account;	14.Consider the social and cultural aspects of the project's impact on local communities;	3.Potential environmental impacts should be assessed and mitigated ;
6	22.Time efficiency should be considered to meet project milestones and avoid delays;	29.Sustainable choices should align with quality objectives;	35.Consider the long-term benefits and operational efficiencies that end-users will gain from the completed construction project;
7	28.Maintaining high-quality standards is crucial to ensure project longevity and stakeholder	2.Should emphasize the sustainability of the project life cycle, from resource extraction to eventual	17.Health and safety issues are checked;

	satisfaction;	decommissioning;	
8	24. Prioritize decision-making methods that enable efficient resource allocation, avoiding overallocation and optimizing project timelines;	11.Should consider the potential for long-term economic benefits;	16.Risk management is fundamental;
9	31. Prioritize the use of certified and standardized materials during decision-making to uphold quality and safety standards;	30.A quality review session is necessary;	8.It's imperative to assess the potential long-term impacts of construction projects on the environment;
10	29.Sustainable choices should align with quality objectives;	4.Utilizing modular integrated construction (MiC) promotes fast construction and supports sustainable development;	5.The ecological sustainability of the site should be assessed, ensuring minimal disruption to local ecosystems;

In the Table 08, sustainability statements accounted for 47% of the total coverage, while statements of other factors accounted for 53% of the total coverage. This means that sustainability-related statements and statements related to other factors are roughly considered equally important across all viewpoints. However, when we analyse each

perspective further, we find that these levels of importance vary across perspectives. The level of importance attached to sustainability statements varied across the three different perspectives. In the second perspective (people and sustainability), sustainability factors are valued more, as evidenced by the higher percentage of sustainability in the top-ranked statements of this perspective. In contrast, sustainability was considered relatively less in the first perspective (cost and sustainability) and the third perspective (cost and quality), indicating that in these perspectives, respondents tended to focus more on traditional project management factors such as cost, time, and quality.

Table 09. Percentage of statements in all perspectives

	Perspective 1 (58%)	Perspective 2 (21%)	Perspective 3 (21%)	Percentage
Sustainability statements	20%	70%	50%	37%
Other statements	80%	30%	50%	63%

While the importance of sustainability statements varied across perspectives, overall sustainability was a relatively small proportion of decision-making considerations for all respondents. This is because each perspective is not represented by the same number of people. The charts represent the relative proportion of each category in the top ten rankings among the different perspectives. The Table 09 shows that the overall share of sustainability statements is 37%, while the share of other factors reaches 63%. This indicates that while sustainability is an important consideration in the actual decision-making process of construction project management, it is relatively less influential than other he factors such as cost, time and quality of the project.

4.3.1 Considerations for sustainability

By looking at the top ten statements for each perspectives, 12 sustainability statements existed.

- 17.Health and safety issues are checked;
- 16.Risk management is fundamental;
- 1.Prioritize the adoption of digital technologies to enhance sustainability；
- 10.Stakeholder engagement is essential；
- 13.The economic, social, and environmental consequences are crucial；
- 14.Consider the social and cultural aspects of the project's impact on local communities;
- 2.Emphasize the sustainability of the project life cycle, from resource extraction to eventual decommissioning；
- 11.Should consider the potential for long-term economic benefits；
- 4.Utilizing modular integrated construction (MIC) promotes fast construction and supports sustainable development；
- 3.Potential environmental impacts should be assessed and mitigated ；
- 8.It's imperative to assess the potential long-term impacts of construction projects on the environment；
- 5.The ecological sustainability of the site should be assessed, ensuring minimal disruption to local ecosystems；

By analyzing the important sustainability statements mentioned, the principle of Risk Management and Health Safety is the most considered by construction project managers. It can also be seen that there are two statements in sustainability that are mentioned in both perspectives. For 17. health and safety issues are checked; this statement was mentioned by many during the interviews. Interviewee 11 emphasized the importance of safety issues by mentioning, "Safety issues need to be taken care of all the time because sometimes construction projects represent the image and reputation of the whole company. If there is a serious safety issue, it will have an impact on the reputation of the whole company." This

reflects the importance that project managers place on health and safety considerations in their decision-making process. Respondent 1, on the other hand, suggested the wider implications of safety issues, "Safety is the most important issue in the actual construction project because it is related to many factors at the same time it can lead to many problems." This suggests that health and safety are key factors that cannot be ignored by project managers when assessing project risks.

For another frequently mentioned sustainability statement 16.Risk management is fundamental; Interviewee 4 said in the interview that risk management is the basis of all business activities, so projects need to be undertaken with their risks in mind. Risks cover many aspects, such as project risks, quality risks, cost budget risks, and so on. Each type of limitation needs to be evaluated and predicted when considering its risks.

Technology-driven and eco-innovation appear relatively low on the project manager's list of considerations compared to risk management and health and safety. Although digital technology has a place in construction projects, it faces multiple challenges in the implementation phase. Interviewee 13 pointed out the difficulty in applying digital technology, "Although computer technology has a role in construction projects, it is more difficult to coordinate because of the inconsistencies in the education and skill levels of construction personnel." This reflects the need for project managers to take into account the skills and training needs of their staff when considering the adoption of new technologies.

An analysis of the top-ranked sustainability statements reveals the principle of Risk Management and Health Safety. The emphasis on these principles reflects the role of the project manager in protecting worker safety, safeguarding the company's reputation and managing project risks. Technology-driven and eco-innovation, while recognized as important, may face more implementation challenges in practice. These insights reveal the complexity and diversity of sustainability considerations in current construction project management practices, and point to future areas of focus in promoting sustainable building practices.

4.4 Lower-ranking statements

In the process of analyzing the factors considered in construction project management, the statements that ranked low in each viewpoint were examined. These statements reflect factors that project managers pay less attention to or consider less important in their decision making.

The Table 10 illustrates the bottom-ranked statements across the three different perspectives, with sustainability statements accounting for 43% of the overall coverage. This percentage relative to the top-ranked statements (at 47%) shows a slight increase in sustainability concerns in overall decision-making considerations, but still maintains a modest weight.

In comparison to the sustainability statements, the other factors statements accounted for 57% of the bottom ranked section. This suggests that while sustainability is an important consideration in the decision-making process of construction project management, traditional factors such as project time, cost, quality, stakeholder satisfaction, and client benefits still dominate. This result reveals that sustainability, although generally recognized as important in construction project management decision-making, may not always be a primary consideration in practice. This may be related to project-specific requirements, financial constraints, technical feasibility, or other practical considerations. The lower prioritized sustainability statements may reflect the challenges and dilemmas faced by project managers in balancing project objectives with sustainability goals.

These observations suggest that although sustainability is widely recognized and valued in construction project management, its importance may be influenced by other project management factors in the actual decision-making process. This is a reminder of the need to consider project management complexity and seek a balance between sustainability and other key project management factors when promoting sustainability practices.

Table 10. Bottom ranked statements per perspectives

	Perspective 1 (Cost and Sustainability)	Perspective 2 （People and Sustainability）	Perspective 3 （Quality and Cost）
28	14.Consider the social and cultural aspects of the project's impact on local communities；	5.The ecological sustainability of the site should be assessed, ensuring minimal disruption to local ecosystems；	9.Responsible waste management and reduction strategies should be a pivotal part in construction projects；
29	12.Renewable resources are vital；	6.The amount of energy used in the project is essential to take into consideration；	22.Time efficiency should be considered to meet project milestones and avoid delays；
30	6.The amount of energy used in the project is essential to take into consideration；	34.Prioritize open and transparent communication with stakeholders；	30.A quality review session is necessary；
31	5.The ecological sustainability of the site should be assessed, ensuring minimal	35.Consider the long-term benefits and operational efficiencies that end-users will gain	4.Utilizing modular integrated construction (MiC) promotes fast construction and

	disruption to local ecosystems;	from the completed construction project;	supports sustainable development;
32	2.Emphasize the sustainability of the project life cycle, from resource extraction to eventual decommissioning;	9.Responsible waste management and reduction strategies should be a pivotal part in construction projects;	10.Stakeholder engagement is essential;
33	35.Consider the long-term benefits and operational efficiencies that end-users will gain from the completed construction project;	23.Time is the most important factor;	34.Prioritize open and transparent communication with stakeholders;
34	9.Responsible waste management and reduction strategies should be a pivotal part in construction projects;	24.Prioritize decision-making methods that enable efficient resource allocation, avoiding overallocation and optimizing project timelines;	20.Should prioritize resource conservation;
35	37.Prioritize the long-term benefits of construction projects for customers, including	26.Time management in construction projects should account for potential delays due to	23.Time is the most important factor;

	a healthier living environment and lower maintenance costs;	sustainable practices, ensuring that these practices are not compromised for speed;	
36	36.Within decision-making in construction projects, the identification of customer needs and preferences should guide the selection of project features;	36.Within decision-making in construction projects, the identification of customer needs and preferences should guide the selection of project features;	36.Within decision-making in construction projects, the identification of customer needs and preferences should guide the selection of project features;
37	1.Prioritize the adoption of digital technologies to enhance sustainability;	37.Prioritize the long-term benefits of construction projects for customers, including a healthier living environment and lower maintenance costs;	19.Cost is the most important factor to take into account;

4.5 Different perspectives

4.5.1 Perspective One: Cost and Sustainability

This perspective scored higher in terms of cost and sustainability. Although the sustainability statement also scored high, it was in 20% of the top ten statements. The defining statement for this perspective is 21. A cost/benefit analysis is considered , 16. Risk management is fundamental and 17. Health and safety issues are checked, as shown in Table 11. In this perspective, cost are viewed as the primary factor in construction project management because costs are directly related to revenue, and revenue generation is considered the most important objective in any business activity.

Respondents in Perspective 1 emphasized the importance of ensuring that revenue could be generated first and foremost in the decision-making process of a project. For example, Respondent 8 suggested that it is always important to focus on the cost aspect in a project, as this can motivate business activity. He gave an example from personal experience of a company that may not be able to achieve an overall profitable outcome in certain construction projects, but still participates in the bidding process. This is because the company needs to maintain cash flow in order to move forward with multiple projects at the same time. If a company does not have cash flow, then its business activities will stop.

In addition, respondents in Perspective 1 focused on the sustainability of the project while considering costs. This includes assessing how the project contributes to social and environmental well-being as well as the management of project safety and risk. This consideration of sustainability is to a large extent done through cost-benefit analysis, which indicates that even though sustainability is considered important, it is only considered for integration if it does not affect the profits of the project. Respondent 12 indicated that there are not many sustainable technologies that can be applied at this time, so there is no guarantee that there will be a cost savings to the project during implementation, so sustainability is generally considered when costs allow.

Table 11. Important statements from Perspective One

Agree(+5)	17.Health and safety issues are checked
Agree(+4)	16.Risk management is fundamental
	21.A cost/benefit analysis is considered
Disagree(-5)	1.Prioritize the adoption of digital technologies to enhance sustainability
Disagree(-4)	36. Within decision-making in construction projects, the identification of customer needs and preferences should guide the selection of project features
	37. Prioritize the long-term benefits of construction projects for customers, including a healthier living environment and lower maintenance costs
Relevant quotes from the respondents	"In some cases, a company will bid on a project even though it may not be overall profitable, as maintaining cash flow is critical to the company's overall operations."

4.5.2 Perspective 2: People and Sustainability

This perspective scored high on sustainability, with sustainability statements making up 70% of the top ten statements so in this perspective sustainability is the most important. In this perspective, not only the adoption of digital technologies was emphasized, but also

stakeholder engagement was seen as important in the project. This suggests that respondents in this perspective see technological innovation and stakeholder engagement as key to achieving project sustainability goals.

The defining statements for this perspective are 1. Prioritize the adoption of digital technologies to enhance sustainability; 10. Stakeholder engagement is essential, as shown in Table 12. These statements emphasize how to maintain effective communication with stakeholders in achieving sustainability goals. Digital technologies, such as Building Information Modelling (BIM) and green technologies, are seen as key tools to enhance project sustainability. At the same time, by collaborating with stakeholders, projects can better meet the needs of environmental conservation, social well-being and economic benefits. With regard to the consideration of sustainability statements, the majority of interviewees in this perspective still put a lot of focus on safety and risk. Respondent 6 stated that: the state subsidizes some building projects in terms of sustainability, e.g. if some sustainability targets are met, then monetary subsidies will be given. On this basis, some projects prioritize sustainability related aspects.

In summary, perspective two emphasizes the importance of integrating people (stakeholders) and sustainability. Respondents in this perspective can achieve sustainability goals more effectively by prioritizing the adoption of digital technologies and enhancing engagement with stakeholders. This perspective provides a comprehensive approach to dealing with the complexity of construction projects while ensuring that projects achieve social, environmental, and economic sustainability goals.

Table 12. Important statements from Perspective Two

Agree(+5)	1.Prioritize the adoption of digital technologies to enhance sustainability
	10.Stakeholder engagement is essential

Agree(+4)	13.The economic, social, and environmental consequences are crucial
Disagree(-5)	37. Prioritize the long-term benefits of construction projects for customers, including a healthier living environment and lower maintenance costs
Disagree(-4)	36. Within decision-making in construction projects, the identification of customer needs and preferences should guide the selection of project features
	26. Time management in construction projects should account for potential delays due to sustainable practices, ensuring that these practices are not compromised for speed
Relevant quotes from the respondents	"The Government provides subsidies for certain construction projects in terms of sustainability, and monetary subsidies are given if specific sustainability targets are met."

4.5.3 Perspective 3: Cost and Quality

This perspective scores high on cost and quality. In this perspective, cost and quality are placed as important in project decision making. The defining statements for this perspective are 21. A cost/benefit analysis is considered 31. Prioritize the use of certified and standardized materials during decision-making to uphold quality and safety standards, as shown in Table 13. This suggests that in this perspective, project management not only focuses on cost-effectiveness, but also prioritizes the use of high standards of materials to ensure the quality and safety of the project.

While this perspective and perspective one (cost and sustainability) overlap in their emphasis on cost factor, perspective three emphasizes the importance of quality even more. Respondent 3 stated that: for construction projects, quality is the first position because quality is the only way to ensure that the project can be used. If the project is not even usable then all the previous work will be in vain. In addition, respondents in Perspective 3 also seek to optimize resource allocation between up-front investment and long-term saving when considering costs. This balanced view provides a comprehensive project management strategy that focuses not only on immediate costs, but also considers the economics of running the project in the long term.

Overall, perspective three reveals the strong connection between cost and quality in construction project management. Respondents in this perspective emphasized the importance of considering both cost-effectiveness and high standards of quality in the decision-making process, and this perspective provides a comprehensive approach to dealing with the complexity of construction projects while ensuring their long-term availability. This approach requires project managers to maintain cost-effectiveness without neglecting the pursuit of quality, which is a key factor in project success and sustainability.

Table 13. Important statements from Perspective Three

Agree(+5)	21.A cost/benefit analysis is considered
	31.Prioritize the use of certified and standardized materials during decision-making to uphold quality and safety standards
Agree(+4)	18.should seek to optimize resource allocation, balancing upfront expenses with long-term savings
Disagree(-5)	19. Cost is the most important factor to take into account
	36. Within decision-making in construction projects, the identification

Disagree(-4)	of customer needs and preferences should guide the selection of project features
	23. Time is the most important factor
Relevant quotes from the respondents	"In some projects, the use of higher cost but better quality materials is chosen to improve the building's durability and performance, thereby achieving cost savings in the long term."

5.Conclusion and discussion

5.1 Answers to research questions

5.1.1 Answer to Sub-question 1

What factors influence Chinese construction project managers' decision-making process regarding sustainability factors?

The decision-making process for sustainability considerations in construction project management is influenced by a variety of factors. Our study has identified six key factors as time, cost, quality, sustainability, stakeholder satisfaction and customer benefits in the design of the Q-set (shown in Table 14). However, in the in-depth interviews with the project managers, safety was frequently mentioned, which can show its prominence in the decision-making process. Most of the interviewees emphasized that safety is not only an important consideration, but in some cases it is even more important than other traditional project management dimensions.

Table 14. All important factors

Important Factors in Project Decision Making		
Time	Quality	Customer benefits
Cost	Stakeholder satisfaction	Sustainability
Safety		

For example, interviewees 1 and 7 clearly stated that security management of projects is essential to safeguard the well-being of staff and the smooth running of the project. They emphasized that the handling of safety issues has a direct impact on the project's reputation and client trust, and therefore must be at the forefront of decision-making. In the Chinese construction market, safety management has become particularly complex and challenging due to the rapid increase in project size and complexity, and its issues require special attention and strategies.

In addition, interviewees 4 and 11 pointed out that safety management is not only about legal compliance and preventing accidents, but is also closely related to the overall sustainability of a project. For example, the occurrence of safety incidents can lead to project delays, cost increases, and even long-term environmental and social impacts. Therefore, considering safety as part of sustainability decision-making is not only a responsibility to employees and the community, but also key to achieving long-term project success.

These findings highlight the importance of the need to consider safety more fully in sustainability decision-making. Safety should not be viewed as just one component of sustainability principles, but as a separate and central consideration, alongside factors such as time, cost, and quality. Such a shift in perspective would help project managers to consider the multifaceted impacts of their projects more comprehensively, leading to more holistic and effective decision-making.

5.1.2 Answer to Sub-question 2

What are the different perspectives of Chinese construction project managers in incorporating sustainability factors into the decision-making process?

In exploring how construction project managers incorporate sustainability considerations into their decision-making processes, an analysis of the 14 existing Q categories yielded three different perspective. The Table 15 shows these perspectives, with grey cells indicating the ordering of the definitions. These perspectives reveal the diversity of views and approaches that program managers have when considering sustainability.

Table 15. Most defining statements

Statement	Category	Perspective 1	Perspective 2	Perspective 3
17Health and safety issues are checked;	Sustainability	5	0	3
16.Risk management is fundamental;	Sustainability	4	0	2
21.A cost/benefit analysis is considered;	Cost	4	2	5
1.Prioritize the adoption of digital technologies to enhance sustainability;	Sustainability	1	5	-1

10.Stakeholder engagement is essential；	Sustainability	2	5	-3
13.The economic, social, and environmental consequences are crucial；	Sustainability	1	4	1
31.Prioritize the use of certified and standardized materials during decision-making to uphold quality and safety standards；	Quality	2	0	5
18.should seek to optimize resource allocation, balancing upfront expenses with long-term savings；	Cost	1	2	4
3.Potential environmental impacts should be assessed and mitigated ；	Sustainability	1	-1	3

Perspective 1: Cost and Sustainability

In perspective one, respondents showed how they value cost-benefit analysis while considering sustainability. In this perspective, respondents acknowledged that costs are directly linked to revenue creation, which is vital in any business activity, especially in construction project management. The respondents expressed their attention to cost in the project decision-making process and stressed the importance of revenue. At the same time, respondents in Perspective 1 also recognized the importance of sustainability. While showing concern for long-term sustainability, they also focused on managing risk and safety. However, respondents expressed that this focus on sustainability is often done without impacting the project's profitability. This shows that although sustainability is a very good goal, financial factors are still dominant in actual project management. For example, respondent 5 mentioned that while they would like to implement more environmentally friendly measures, this needs to be done without significantly increasing project costs.

Perspective 1 exposes a key challenge faced by construction project managers in the management of construction projects: how to ensure that the project is economically beneficial while at the same time taking into account the sustainability of the project. This perspective reflects a pragmatic approach in which project managers consider short-term economic gains without losing sight of the long-term environmental and social impacts of the project. By achieving this balance, project managers can more effectively achieve outcomes between business and the environment.

Perspective 2: People and Sustainability

In Perspective 2, sustainability is placed at the centre of decision-making. This is apparent from the fact that sustainability statements accounted for 70% of the top ten statements in this perspective. Respondents in this perspective usually express a strong interest in sustainability and try to take environmental and social impacts into account during project implementation. For example, Respondent 9 emphasized that in their projects they try to minimize negative environmental impacts and utilize renewable resources whenever possible. At the same time, they recognize that technological innovation can be a key

instrument for enhancing project sustainability, and that stakeholder engagement can help to better meet the demands of environmental protection, social well-being, and economic efficiency.

Overall, Perspective 2 reflects a more comprehensive and forward-thinking approach in which sustainability is seen as equally important as project success. By prioritizing the adoption of digital technologies and enhancing communication with stakeholders, this perspective shows ways to achieve sustainability goals more effectively. This integrated approach provides the opportunity to deal with the complexity of a construction project while ensuring that the project meets its social, environmental, and economic sustainability goals.

Perspective 3: Cost and Quality

This perspective represents an approach to finding the right balance between project cost and quality. Interviewees in this perspective focused more on how to ensure that project quality is not compromised while maintaining project cost-effectiveness. For example, Interviewee 12 discussed how to use high-quality materials to ensure the durability of the building while also considering cost-effectiveness. Overall, perspective three shows how project managers can find a balance between cost and quality in the management of construction projects. This perspective provides a way to ensure the economic efficiency of a project while also considering the long-term availability and quality of the project. This balancing act is critical to the success of a construction project and requires project managers to consider costs while also taking into account the quality and safety standards of the project. Through this comprehensive approach, the complexity of construction projects can be managed more effectively, ensuring that the project meets expectations both economically and in terms of quality.

Together, these three perspectives reflect the complexity of considering individual factors and sustainability in the decision-making of construction project managers. Although all respondents agreed on the importance of sustainability, there were significant differences in their perspectives on how to achieve this and how to treat sustainability. All respondents

indicated that it is good to integrate sustainability into project decision making because it is the way of the future. However, some respondents said that sustainability is still less considered in the current social environment. More project managers still consider safety, quality, time and cost of the project. However, all were positive about sustainability.

5.1.3 Answer to sub-question 3

How do Chinese construction project managers balance the trade-offs between sustainability goals and project constraints in the decision-making process?

Balancing sustainability goals and project constraints in construction project management is a complex and multi-faceted issue. According to the respondents of this study, they showed different strategies and perspectives in dealing with this balance, which mainly divided into two categories, as shown in Figure13.

Some respondents held a more integrated perspective, believing that sustainability goals and other project constraints, such as cost and time, need not be in opposition to each other. They see the potential for collaboration between sustainability and other objectives of the project. For example, Respondent 4 emphasized that measures on achieving sustainability, such as the use of efficient materials and technologies can reduce the environmental impacts of a project while also reducing costs and increasing efficiency. They believe that, through careful planning and innovative methods, sustainability measures can compliment other objectives, creating a win-win situation for all.

Whereas other respondents expressed a more realistic approach, they saw a potential conflict between sustainability objectives and other constraints of the project. Decisions under this perspective are usually made based on the main objectives and priorities of the project. For example, respondent 12 mentioned that sustainability may not be a primary consideration when the focus of the project is on controlling costs and ensuring quality. Where resources are limited, sustainability goals may need to be adjusted to ensure that the

core objectives of the project are met. This perspective emphasizes the trade-offs and choices made in actual project management.

These different perspectives expose the complexity of decision-making about sustainability in construction project management. On the one hand, there are project managers who see the possibility of integrating sustainability with other project goals and try to find innovative ways to achieve this. On the other hand, there are project managers who are more focused on how to make effective trade-offs between sustainability and other project constraints given limited resources and tight time frames. This variety reflected the different challenges and chances that project managers faced in realizing sustainability goals in practice.

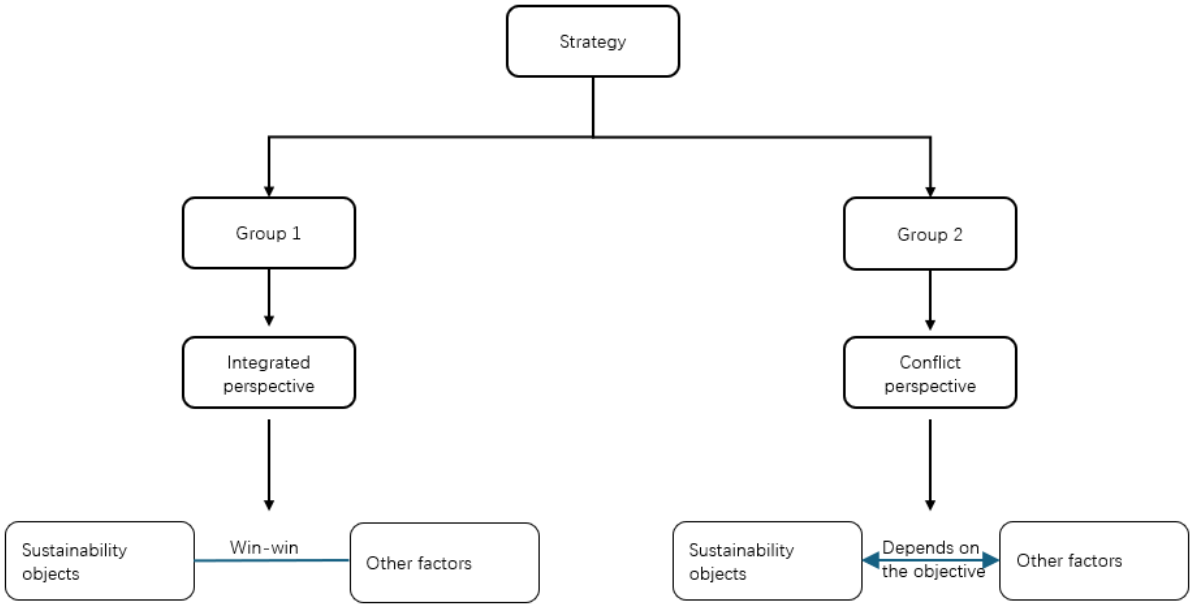

Figure 13. trade-off strategy

5.1.4 Answer to Main question

How do construction project managers in China integrate sustainability into their decision-making processes?

In exploring how Chinese construction project managers integrate sustainability into their decision-making process, we found that they presented various strategies and different

perspectives when facing sustainability goals and project constraints. Based on interviews with 14 respondents, this study shows the key factors they consider in their project decision-making, including time, cost, quality, safety, sustainability, stakeholder satisfaction, and client benefits. Safety was seen as a core element in project managers' decision-making. Respondents agreed that ensuring the safety of staff and the project is vital. They expressed that security management has a direct impact on the project's reputation and client trust, and therefore must be a primary factor in decision-making.

Second, through interviews and Q-method , we recognized three perspectives: Cost and Sustainability, People and Sustainability, and Cost and Quality. In the "cost and sustainability" perspective, project managers stressed the important of considering sustainability while keeping costs efficient. In the People and Sustainability perspective, project managers put sustainability at the center of decision-making, emphasizing the importance of considering environmental and social impacts during project execution. In the "cost and quality" perspective, emphasized by most project managers, they focus on finding the appropriate balance between project cost and quality.

In addition, respondents were interviewed about trade-offs between sustainability goals and other project constraints. Some project managers preferred to think that sustainability and other project goals (e.g., time and cost) are not in conflict with each other, but rather can complement each other. However, some project managers also expressed a more realistic perspective that, with limited resources, there may be a need for trade-offs between sustainability goals and the core objectives of the project.

In summary, these results show the complexity of Chinese construction project managers' decision-making in construction projects involving sustainability. They consider long-term environmental and social impacts, project financial benefits, safety, and quality while achieving project goals. This holistic approach to decision-making enables them to manage the complexity of construction projects more effectively while ensuring that the project achieves the expected goals.

5.2 limitations

In assessing the limitations of this study, we first need to be explicit about the characteristics of the Q-methodology itself, which allows us to explore the subjective views of the interviewees. Therefore, if the study sample changes, the conclusions may be different for project managers in different geographic regions or different project types. Although the Q methodology is effective in capturing and analyzing respondents' subjective perspectives, it may not be able to fully capture all the complexities and details of the decision-making process. This study mainly focuses on project managers in a specific region, so the results of this study cannot fully represent the perspectives of other project managers in the construction industry in different areas. Therefore the results of the study should be re-evaluated for their usefulness when applying them to different backgrounds or different areas.

Secondly the study is concerned with the construction project manager's perspectives and strategies on sustainability in project decision making can be affected by local laws, regulations and socio-economic developments. Because construction project management is a dynamic field, this field is influenced by external factors such as regulatory changes, technological advances, and economic regulations. As these factors change, the project manager's decision-making process and considerations may change as well. This dynamic character indicates the possibility that the accuracy of their findings may decrease with time and changes in the external context. In addition, the scope of the study is limited to a specific demographic and geographic area, which may limit the generalizability of the findings. The perspectives and experiences of construction project managers in different regions or in different areas of the construction industry may vary significantly. Therefore, caution should be exercised when attempting to apply the findings of the study to a broader or different context.

Finally, the limitations of the content of the study should also be considered. This study focuses on the integrating of sustainability factors into the decision-making process, but may not fully consider other relevant factors, like the influence of business market conditions and

organizational structure. In addition, the content of the study may also not provide insight into the differences in sustainability practices in different types of construction projects.

In summary this study provides important perspectives and strategies on the decision-making processes of Chinese construction project managers with regard to sustainability, but there are limitations in the results that should be taken into account when interpreting the results that are inherent to the study. These limitations relate to the subjectivity of the data, the influence of local conditions and external factors, and the extent of the study. Understanding these limitations is important to assess the results of the study and provide directions for improvement in future research.

5.3 Future research

This study's investigation into the sustainability factors in the decision-making of construction project managers in China provides an important opportunity for research in this field on a global level. The field of sustainable construction project management is rapidly developing, with different countries and locations facing different practices and challenges. Such differences provide many directions and possibilities for future research, so it is possible to build on the results of this study to explore the differences in sustainability in construction project management across different regions and cultures.

One potential way forward for future research is to analyze sustainability factors in the management of construction projects. Such research could explore how different cultural, economic, regulatory, and environmental factors influence sustainability strategies for construction projects in different locations. Such a comparison approach would not only deepen the understanding of the universal principles of sustainable construction, but also expose unique challenges and solutions for local conditions.

In addition, it can provide valuable insights into the evolution of sustainability considerations in construction project management over time through longitudinal research methods. As regulations, technology, and societal attitudes toward sustainability continue to evolve, such

research can track the progress and impact of sustainability in construction in response to policy changes and technological advances.

In summary, there are numerous opportunities for future research in the field of sustainable construction project management. Expanding the geographic scope of research, exploring the dynamic nature of sustainability factors, and adopting different research methodologies are all areas that deserve further exploration. These different attempts could advance the knowledge and practice of sustainable construction project management on a global scale.

References

Ahmad, A., Sajid, M., Khan, Z., & Iqbal, M. (2022). Influence of construction project performance indicators on project success moderating role of pandemic COVID-19 and project evaluation management. *Journal of Business and Social Review in Emerging Economies*, *8*(1), 183–196. https://doi.org/10.26710/jbsee.v8i1.2189

Ajayi, S. O., Oyedele, L. O., Bilal, M., Akinadé, O. O., Alaka, H., & Kadiri, K. O. (2015). Waste effectiveness of the construction industry: Understanding the impediments and requisites for improvements. *Resources, Conservation and Recycling*, *102*, 101–112. https://doi.org/10.1016/j.resconrec.2015.06.001

Ali, K. N., Alhajlah, H. H., & Kassem, M. A. (2022). Collaboration and Risk in Building Information Modelling (BIM): A systematic literature review. *Buildings*, *12*(5), 571. https://doi.org/10.3390/buildings12050571

Arabpour, S., & Silvius, G. (2023). Sustainability Interventions of Construction Project Managers—Establishing a minimum baseline. *Sustainability*, *15*(12), 9795. https://doi.org/10.3390/su15129795

Armenia, S., Dangelico, R. M., Nonino, F., & Pompei, A. (2019). Sustainable Project Management: A Conceptualization-Oriented Review and a Framework Proposal for Future Studies. *Sustainability*, *11*(9), 2664. https://doi.org/10.3390/su11092664

Ashkezari, A. B., Zokaee, M., Aghsami, A., Jolai, F., & Yazdani, M. (2022). Selecting an Appropriate Configuration in a Construction Project Using a Hybrid Multiple

Attribute Decision Making and Failure Analysis Methods. *Buildings*, *12*(5), 643. https://doi.org/10.3390/buildings12050643

Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International Journal of Project Management*, *17*(6), 337–342. https://doi.org/10.1016/s0263-7863(98)00069-6

Azzi, M., H, D., & Ha, Q. (2015). Toward sustainable energy usage in the power generation and construction sectors—a case study of Australia. *Automation in Construction*, *59*, 122–127. https://doi.org/10.1016/j.autcon.2015.08.001

Babatunde, Y., & Low, S. P. (2015). *Cross-Cultural management and quality performance: Chinese Construction Firms in Nigeria*. Springer.

Banihashemi, S. A., Khalilzadeh, M., Zavadskas, E. K., & Antuchevičienė, J. (2021). Investigating the Environmental Impacts of Construction Projects in Time-Cost Trade-Off Project Scheduling Problems with CoCoSo Multi-Criteria Decision-Making Method. *Sustainability*, *13*(19), 10922. https://doi.org/10.3390/su131910922

Barendsen, W., Muß, A. C., & Silvius, G. (2021a). Exploring team members' perceptions of internal sustainability communication in sustainable project management. *Project Leadership and Society*, *2*, 100015. https://doi.org/10.1016/j.plas.2021.100015

Barendsen, W., Muß, A. C., & Silvius, G. (2021b). Exploring team members' perceptions of internal sustainability communication in sustainable project management. *Project Leadership and Society*, *2*, 100015. https://doi.org/10.1016/j.plas.2021.100015

Bhagwat, R., & Sharma, M. K. (2007). Performance measurement of supply chain management: A balanced scorecard approach. *Computers & Industrial Engineering*, *53*(1), 43–62. https://doi.org/10.1016/j.cie.2007.04.001

Brady, T., & Davies, A. (2014). Managing Structural and Dynamic Complexity: A Tale of Two Projects. *Project Management Journal*, *45*(4), 21–38. https://doi.org/10.1002/pmj.21434

Bragança, L., Vieira, S. a. M., & Andrade, J. B. (2014). Early Stage Design Decisions: The Way to Achieve Sustainable Buildings at Lower Costs. *The Scientific World Journal*, *2014*, 1–8. https://doi.org/10.1155/2014/365364

Brown, A. W., & Adams, J. (2000). Measuring the effect of project management on construction outputs: a new approach. *International Journal of Project Management*, *18*(5), 327–335. https://doi.org/10.1016/s0263-7863(99)00026-5

Brown, S. R. (1982). Political Subjectivity: Applications of Q methodology in political science. *Journal of Marketing Research*, *19*(1), 162. https://doi.org/10.2307/3151542

Brown, S. R. (1993). A Primer on Q Methodology. *Operant Subjectivity*, *16*(3/4). https://doi.org/10.22488/okstate.93.100504

Cerezo-Narváez, A., Pastor-Fernández, A., Mateo, M. O., & Ballesteros-Pérez, P. (2021). The Relationship between Building Agents in the Context of Integrated Project Management: A Prospective Analysis. *Buildings*, *11*(5), 184. https://doi.org/10.3390/buildings11050184

Chan, K. M. A., Anderson, E. K., Chapman, M., Jespersen, K., & Olmsted, P. (2017). Payments for Ecosystem Services: Rife With Problems and Potential—For Transformation Towards Sustainability. *Ecological Economics*, *140*, 110–122. https://doi.org/10.1016/j.ecolecon.2017.04.029

Chang, R. (2017). Towards sustainability in the Chinese construction industry: a transition approach. *School of Architecture and Built Environment*. https://doi.org/10.4225/55/5b2090a798baf

Chang, R., Soebarto, V., Zhao, Z., & Zillante, G. (2016). Facilitating the transition to sustainable construction: China's policies. *Journal of Cleaner Production*, *131*, 534–544. https://doi.org/10.1016/j.jclepro.2016.04.147

Chang, Y., Ries, R., & Wang, Y. (2010). The embodied energy and environmental emissions of construction projects in China: An economic input–output LCA model. *Energy Policy*, *38*(11), 6597–6603. https://doi.org/10.1016/j.enpol.2010.06.030

Chawla, V. (2018). *The sustainable project management: A review and future possibilities*. https://m.growingscience.com/beta/jpm/2732-the-sustainable-project-management-a-review-and-future-possibilities.html

Cheah, C. Y. J., & Chew, D. a. S. (2005). Dynamics of strategic management in the Chinese construction industry. *Management Decision*, *43*(4), 551–567. https://doi.org/10.1108/00251740510593558

Chofreh, A. G., Goni, F. A., Malik, M. F., Khan, H. H., & Klemeš, J. J. (2019). The imperative and research directions of sustainable project management. *Journal of Cleaner Production*, *238*, 117810. https://doi.org/10.1016/j.jclepro.2019.117810

Colding, J., & Barthel, S. (2013). The potential of 'Urban Green Commons' in the resilience building of cities. *Ecological Economics*, *86*, 156–166. https://doi.org/10.1016/j.ecolecon.2012.10.016

Commerce, G. B. O. O. G. (2009). *Managing successful projects with PRINCE2*. The Stationery Office.

Cooke-Davies, T. (2002). The "real" success factors on projects. *International Journal of Project Management*, *20*(3), 185–190. https://doi.org/10.1016/s0263-7863(01)00067-9

Correa, J. a. G., Castañeda, S., Quintero, D. a. V., & Giraldo, G. E. (2018). Identification and Analysis of Project Management Success Factors in Information Technology SMEs. *International Journal of Information Technology Project Management*, *9*(4), 73–90. https://doi.org/10.4018/ijitpm.2018100105

Crawley, D. B., & Aho, I. (1999). Building environmental assessment methods: applications and development trends. *Building Research and Information*, *27*(4–5), 300–308. https://doi.org/10.1080/096132199369417

Cross, R. (2004). Exploring attitudes: the case for Q methodology. *Health Education Research*, *20*(2), 206–213. https://doi.org/10.1093/her/cyg121

Cuppen, E., Bosch-Rekveldt, M., Pikaar, E., & Mehos, D. C. (2016). Stakeholder engagement in large-scale energy infrastructure projects: Revealing perspectives using Q methodology. *International Journal of Project Management*, *34*(7), 1347–1359. https://doi.org/10.1016/j.ijproman.2016.01.003

Dai, F., & Kang, Y. (2023). Methodology for risk assessment of engineering procurement construction project based on the probabilistic hesitant fuzzy multiple attributes group decision making. *Journal of Intelligent and Fuzzy Systems*, 1–12. https://doi.org/10.3233/jifs-231726

De Bakker, K., Boonstra, A., & Wortmann, H. (2010). Does risk management contribute to IT project success? A meta-analysis of empirical evidence. *International Journal of Project Management*, *28*(5), 493–503. https://doi.org/10.1016/j.ijproman.2009.07.002

Du, Q., Shao, L., Zhou, J., Huang, N., Bao, T., & Hao, C. (2019). Dynamics and scenarios of carbon emissions in China's construction industry. *Sustainable Cities and Society*, *48*, 101556. https://doi.org/10.1016/j.scs.2019.101556

Dubois, O., & Silvius, G. (2020). The relation between sustainable project management and project success. *International Journal of Management and Sustainability*, *9*(4), 218–238. https://doi.org/10.18488/journal.11.2020.94.218.238

Eastman, C. M., Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2011). *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors*. John Wiley & Sons.

Elkington, J. (1999). Cannibals with forks: the triple bottom line of 21st century business. *Choice Reviews Online*, *36*(07), 36–3997. https://doi.org/10.5860/choice.36-3997

Elmualim, A., & Alp, D. (2016). Perception and challenges for sustainable construction in developing countries: North Cyprus case. *Journal of Civil Engineering and Architecture*, *10*(4). https://doi.org/10.17265/1934-7359/2016.04.012

Esangbedo, O., & Ealefoh, D. E. (2021). Prospects for the adoption of Agile Project Management techniques in Nigerian construction industry. *Nigerian Journal of Technology*, *40*(3), 357–362. https://doi.org/10.4314/njt.v40i3.1

Eskerod, P., & Huemann, M. (2013). Sustainable development and project stakeholder management: what standards say. *International Journal of Managing Projects in Business*, *6*(1), 36–50. https://doi.org/10.1108/17538371311291017

Exel, N. J. A., & Graaf, G. (2005). *Q methodology: A sneak preview*.

Fathalizadeh, A., Hosseini, M. R., Silvius, G., Rahimian, A., Martek, I., & Edwards, D. J. (2021). Barriers impeding sustainable project management: A Social Network Analysis of the Iranian construction sector. *Journal of Cleaner Production*, *318*, 128405. https://doi.org/10.1016/j.jclepro.2021.128405

Fathalizadeh, A., Hosseini, M. R., Vaez-Zadeh, S., Edwards, D. J., Martek, I., & Shooshtarian, S. (2021). Barriers to sustainable construction project management: the case of Iran. *Smart and Sustainable Built Environment*, *11*(3), 717–739. https://doi.org/10.1108/sasbe-09-2020-0132

Fernández, J. (2007). Resource Consumption of New Urban Construction in China. *Journal of Industrial Ecology*, *11*(2), 99–115. https://doi.org/10.1162/jie.2007.1199

Gain, H., Mishra, A. K., & Aithal, P. S. (2022). Risk management practice adopted in road construction project. *International Journal of Management, Technology, and Social Science*, 21–36. https://doi.org/10.47992/ijmts.2581.6012.0175

Gao, C. (2022). Risk Assessment and Analysis of Biomass Energy Engineering Project Management under the Concept of Sustainable Development. *Adsorption Science & Technology*, *2022*, 1–11. https://doi.org/10.1155/2022/5323021

Gareis, R., Huemann, M., Martinuzzi, A., Weninger, C., & Sedlacko, M. (2013). *Project management and sustainable development principles*. Project Management Institute.

Ghufran, M., Khan, K. I. A., Ullah, F., Alaloul, W. S., & Musarat, M. A. (2022). Key Enablers of Resilient and Sustainable Construction Supply Chains: A systems Thinking approach. *Sustainability*, *14*(19), 11815. https://doi.org/10.3390/su141911815

Goel, A. (2022). Using secondary data in research on social sustainability in construction project management: a transition from “interview society” to “project-as-practice.” *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/ecam-10-2021-0905

Górecki, J., & Utrilla, P. N. (2022). Decision-Making Problems in Construction Projects Executed under the Principles of Sustainable Development—Bridge Construction Case. *Applied Sciences*, *12*(12), 6132. https://doi.org/10.3390/app12126132

Hariram, N. P., Mekha, K. B., Suganthan, V., & Sudhakar, K. (2023). Sustainalism: an integrated Socio-Economic-Environmental model to address sustainable development and sustainability. *Sustainability*, *15*(13), 10682. https://doi.org/10.3390/su151310682

Hasana, U. (2022, January 1). *Management of Ecological Resources for Sustainable Tourism: A Systematic Review on Community Participation in Ecotourism Literature*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3948162

Hill, R., & Bowen, P. (1997). Sustainable construction: principles and a framework for attainment. *Construction Management and Economics*, *15*(3), 223–239. https://doi.org/10.1080/014461997372971

Hillebrandt, P. M. (2000). The Construction Industry and the Economy. In *Palgrave Macmillan UK eBooks* (pp. 19–28). https://doi.org/10.1057/9780230372481_3

Hou, H., Bai, H., Ji, Y., Wang, Y., & He, X. (2020). A historical time series for inter-industrial embodied carbon transfers within China. *Journal of Cleaner Production*, *264*, 121738. https://doi.org/10.1016/j.jclepro.2020.121738

Hoyos-Gómez, L. S., Ruiz, B., & López, P. (2021). A multicriteria methodology for prioritisation of social projects and community participation: Nariño study case. *International Journal of Sustainable Energy*, *40*(9), 869–888. https://doi.org/10.1080/14786451.2021.1883612

Hu, A., Yuan, X., Fan, S., & Wang, S. (2023). The Impact and Mechanism of Corporate ESG construction on the efficiency of Regional green Economy: An empirical analysis

based on signal transmission Theory and Stakeholder Theory. *Sustainability*, *15*(17), 13236. https://doi.org/10.3390/su151713236

Hussain, A., & Hussaın, I. (2023). Sustainability assessment for construction projects: A cost-sustainability tradeoff approach. *Journal of Cleaner Production*, *423*, 138727. https://doi.org/10.1016/j.jclepro.2023.138727

Hussin, J. M., Rahman, I. A., & Memon, A. H. (2013). The Way Forward in Sustainable Construction: Issues and challenges. *International Journal of Advances in Applied Sciences*, *2*(1). https://doi.org/10.11591/ijaas.v2i1.1321

Ika, L. A. (2009). Project Success as a Topic in Project Management Journals. *Project Management Journal*, *40*(4), 6–19. https://doi.org/10.1002/pmj.20137

Josa, I., & Aguado, A. (2019). Infrastructures and society: from a literature review to a conceptual framework. *Journal of Cleaner Production*, *238*, 117741. https://doi.org/10.1016/j.jclepro.2019.117741

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement*, *20*(1), 141–151. https://doi.org/10.1177/001316446002000116

Kerzner, H. (2017). *Project management: A Systems Approach to Planning, Scheduling, and Controlling*. John Wiley & Sons.

Khalim, S. M. A., & Lee, C. K. (2020). IMPLEMENTATION OF ENVIRONMENTAL MANAGEMENT SYSTEM (EMS) IN CONSTRUCTION INDUSTRY:

INVESTIGATION OF SUCCESS FACTORS. *Journal of Governance and Integrity*. https://doi.org/10.15282/jgi.4.1.2020.5611

Khanaum, M. M., & Hossain, T. (2023). Sustainability Assessment of Economic and Environmental Impacts: A critical systems thinking approach to tackle complex environmental challenges. *International Journal of Multidisciplinary Research and Analysis*, *06*(09). https://doi.org/10.47191/ijmra/v6-i9-42

Kibert, C. J. (1994). *Sustainable construction: Proceedings of the First International Conference of CIB TG 16, November 6-9, 1994, Tampa, Florida, U.S.A*. University of Florida, Center for Construction & Environment.

Kibert, C. J. (2016). *Sustainable construction: Green Building Design and Delivery*. John Wiley & Sons.

Kineber, A. F., Oke, A. E., Aliu, J., Hamed, M. M., & Oputu, E. (2023). Exploring the Adoption of Cyber (Digital) Technology for Sustainable Construction: A Structural Equation Modeling of Critical Success Factors. *Sustainability*, *15*(6), 5043. https://doi.org/10.3390/su15065043

Labuschagne, C., & Brent, A. C. (2005). Sustainable Project Life Cycle Management: the need to integrate life cycles in the manufacturing sector. *International Journal of Project Management*, *23*(2), 159–168. https://doi.org/10.1016/j.ijproman.2004.06.003

Li, H., & Suen, H. K. (2013). Constructing and Validating a Q-Matrix for Cognitive Diagnostic Analyses of a Reading Test. *Educational Assessment*, *18*(1), 1–25. https://doi.org/10.1080/10627197.2013.761522

Lim, C., & Mezghiche, M. (1999). Criteria of project success: an exploratory re-examination. *International Journal of Project Management*, *17*(4), 243–248. https://doi.org/10.1016/s0263-7863(98)00040-4

Lin, B., & Liu, H. (2015). CO2 mitigation potential in China's building construction industry: A comparison of energy performance. *Building and Environment*, *94*, 239–251. https://doi.org/10.1016/j.buildenv.2015.08.013

Liu, Z., Li, P., Wang, F., Osmani, M., & Demian, P. (2022). Building Information Modeling (BIM) Driven Carbon Emission Reduction Research: A 14-Year Bibliometric Analysis. *International Journal of Environmental Research and Public Health*, *19*(19), 12820. https://doi.org/10.3390/ijerph191912820

Lotfi, R., Yadegari, Z., Hosseini, S. H., Khameneh, A. H., Tirkolaee, E. B., & Weber, G. (2022). A robust time-cost-quality-energy-environment trade-off with resource-constrained in project management: A case study for a bridge construction project. *Journal of Industrial and Management Optimization*, *18*(1), 375. https://doi.org/10.3934/jimo.2020158

Low, S. (2003). Internationalization of Chinese construction enterprises. *CiNii Research*. https://cir.nii.ac.jp/crid/1370290617842564228

Ma, L., Le, Y., Li, H., Jin, R., Piroozfar, P., & Liu, M. (2018). Regional comparisons of contemporary construction industry sustainable concepts in the Chinese context. *Sustainability*, *10*(11), 3831. https://doi.org/10.3390/su10113831

Makeev, V. (2021). The basic concepts of social responsibility in the construction sector. *Obŝestvo I Èkonomika*. https://doi.org/10.31857/s020736760017489-6

Mallick, J., Ibnatiq, A. A., Kahla, N. B., Alqadhi, S., Singh, V. P., Hoa, P. V., Hang, H. T., Van Hong, N., & Le, H. A. (2022). GIS-Based Decision Support System for Safe and Sustainable Building Construction Site in a Mountainous Region. *Sustainability*, *14*(2), 888. https://doi.org/10.3390/su14020888

Maqbool, R., & Jowett, E. (2022). Conserving a sustainable urban environment through energy security and project management practices. *Environmental Science and Pollution Research*, *30*(34), 81858–81880. https://doi.org/10.1007/s11356-022-21721-w

Marquès, G., Gourc, D., & Lauras, M. (2011). Multi-criteria performance analysis for decision making in project management. *International Journal of Project Management*, *29*(8), 1057–1069. https://doi.org/10.1016/j.ijproman.2010.10.002

McAuley, B., Behan, A., McCormack, P., Hamilton, A., Rebelo, E., & Lynch, S. (2020). Improving the Sustainability of the Built Environment by Upskilling SMEs in Building Information Modelling Through the Horizon 2020 BIMcert Project. *Jounal of Sustainable Design & Applied Research*, *8*(1), 6. https://doi.org/10.21427/g444-m486

McDonough, W., & Braungart, M. (2010). *Cradle to cradle: Remaking the Way We Make Things*. North Point Press.

McKeown, B., & Thomas, D. B. (2013). *Q Methodology*. SAGE Publications.

Mitchell, R. H., Agle, B. R., & Wood, D. J. (1997). Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of who and What Really Counts. *Academy of Management Review*, *22*(4), 853–886. https://doi.org/10.5465/amr.1997.9711022105

Mussinelli, E. (2021). Editorial. *TECHNE, Journal of Technology for Architecture and Environment*, 10–15. https://doi.org/10.36253/techne-11533

Nawi, M. N. M., Baluch, N. H., & Bahauddin, A. Y. (2014). Impact of Fragmentation Issue in Construction Industry: An Overview. *MATEC Web of Conferences*, *15*, 01009. https://doi.org/10.1051/matecconf/20141501009

Newton, S. (2022). Measuring the perceptual, physiological and environmental factors that impact stress in the construction industry. *Construction Innovation: Information, Process, Management*. https://doi.org/10.1108/ci-02-2022-0040

Ohiomah, I., Aigbavboa, C., Mogasho, B., Osunsanmi, T. O., & Thwala, W. D. (2019). Identifying the awareness level of the use of sustainable project management in the South African construction industry. *IOP Conference Series*, *640*(1), 012021. https://doi.org/10.1088/1757-899x/640/1/012021

Okitasari, M., Mishra, R., & Suzuki, M. (2022). Socio-Economic Drivers of Community Acceptance of Sustainable Social Housing: Evidence from Mumbai. *Sustainability*, *14*(15), 9321. https://doi.org/10.3390/su14159321

Olatunde, N. A., & Odeyinka, H. (2021). Factors influencing stakeholder management in building projects procured by private corporate organisations. *Journal of Engineering, Project, and Production Management*. https://doi.org/10.2478/jeppm-2021-0002

Oliveira, R., Lopes, J., & Abreu, M. I. (2021). Sustainability Perspective to Support Decision making in Structural retrofitting of Buildings: a case study. *Systems*, *9*(4), 78. https://doi.org/10.3390/systems9040078

Oliver, A. A., Leoto, R., Lizzaralde, G., Petter, A., & Roy, N. (2019). Design, decision-making and trade-offs in the Centre for Sustainable Development (La Maison du développement durable) in Canada. *IOP Conference Series*, *294*(1), 012055. https://doi.org/10.1088/1755-1315/294/1/012055

Paoletti, I., & Vettori, M. P. (2021). Heteronomy of architecture. Between hybridation and contamination of knowledge. *TECHNE, Journal of Technology for Architecture and Environment*, 16–20. https://doi.org/10.36253/techne-11015

Petrelli, M. Z., Júnior, A. C. P., De Arruda Ignácio, P. S., Rampasso, I. S., Anholon, R., & Bortolotto, W. W. (2023). Sustainable practices in construction project management: impacts on triple bottom line. *Proceedings of the Institution of Civil Engineers*, 1–12. https://doi.org/10.1680/jensu.21.00109

Pirotti, A., Keshavarzsaleh, A., Rahim, F. a. M., & Zakaria, N. (2020). Effective Factors on Project Success in Malaysian Construction Industry. *Journal of Engineering, Project, and Production Management*. https://doi.org/10.2478/jeppm-2020-0001

Qi, Y., & Xia, Y. (2022). Research on Accounting and Transfer Pathways of Embodied Carbon Emissions from Construction Industry in China. *Sustainability*, *14*(22), 15165. https://doi.org/10.3390/su142215165

Qu, Y., Li, M., Han, J., & Guo, L. (2015). Developing more insights on sustainable consumption in China based on Q methodology. *Sustainability*, *7*(10), 14211–14229. https://doi.org/10.3390/su71014211

Runa, A., Zhang, Z., & Zhang, H. (2021). Carbon Emission Peak and Carbon Neutrality under the New Target and Vision. *2021 International Conference on Advanced Electrical Equipment and Reliable Operation (AEERO)*. https://doi.org/10.1109/aeero52475.2021.9708209

Ryłko-Polak, I., Komala, W., & Białowiec, A. (2022). The reuse of biomass and industrial waste in biocomposite construction materials for decreasing natural resource use and mitigating the environmental impact of the construction industry: a review. *Materials*, *15*(12), 4078. https://doi.org/10.3390/ma15124078

Sari, E. M., Irawan, A. P., Wibowo, M. A., Siregar, J. P., Tamin, R. Z., Praja, A. K. A., & Dewi, M. P. (2023). Challenge and awareness for Implemented Integrated Project Delivery (IPD) in Indonesian projects. *Buildings*, *13*(1), 262. https://doi.org/10.3390/buildings13010262

Sassi, P. (2006). *Strategies for Sustainable architecture*. Routledge.

Sears, S. K., Segner, R. O., Rounds, J. L., Clough, R. H., & Sears, G. A. (2015). *Construction Project Management: A Practical Guide to Field Construction Management*.

Senaratne, S., & Sandanayake, Y. G. (2012). *World Construction Conference 2012: Global Challenges in Construction Industry : Proceedings*.

Shahbaz, M. S. (2018, December 27). *Stakeholders' Management Approaches in Construction Supply Chain: A New Perspective of Stakeholder's Theory*. https://penerbit.uthm.edu.my/ojs/index.php/IJSCET/article/view/3579

Shao, C., Guan, Y., Wan, Z., Guo, C., Chu, C., & Mei, J. (2014). Performance and decomposition analyses of carbon emissions from industrial energy consumption in Tianjin, China. *Journal of Cleaner Production*, *64*, 590–601. https://doi.org/10.1016/j.jclepro.2013.08.017

Silvius, G., Kampinga, M., Paniagua, S., & Mooi, H. (2017). Considering sustainability in project management decision making; An investigation using Q-methodology. *International Journal of Project Management*, *35*(6), 1133–1150. https://doi.org/10.1016/j.ijproman.2017.01.011

Silvius, G., & Schipper, R. (2014). Sustainability in project management: A literature review and impact analysis. *Social Business*, *4*(1), 63–96. https://doi.org/10.1362/204440814x13948909253866

Singh, A. K., Jyoti, B., Kumar, S., & Lenka, S. K. (2021). Assessment of Global Sustainable Development, environmental sustainability, Economic Development and Social Development Index in selected economies. *International Journal of Sustainable Development and Planning*, *16*(1), 123–138. https://doi.org/10.18280/ijsdp.160113

Sinxadi, L., & Awuzie, B. (2021). Eliciting project managers' perceptions regarding economic sustainability incorporation on construction projects: a Bloemfontein case study. *IOP Conference Series*, *654*(1), 012019. https://doi.org/10.1088/1755-1315/654/1/012019

Soltanzadeh, A., Mahdinia, M., Oskouei, A. O., Jafarinia, E., Zarei, E., & Sadeghi-Yarandi, M. (2022). Analyzing health, safety, and environmental risks of construction projects using the Fuzzy Analytic Hierarchy Process: a field study based on a project management body of knowledge. *Sustainability*, *14*(24), 16555. https://doi.org/10.3390/su142416555

Stephenson, W. (1968). *The study of behavior: Q-technique and Its Methodology*.

Tang, Y. (2013). China's Rapid Urbanization. *Science*, *342*(6156), 310. https://doi.org/10.1126/science.342.6156.310-a

Tanga, O., Akinradewo, O., Aigbavboa, C., Oke, A. E., & Adekunle, S. A. (2022). Data Management Risks: A Bane of Construction Project Performance. *Sustainability*, *14*(19), 12793. https://doi.org/10.3390/su141912793

Toljaga-Nikolić, D., Todorović, M., Dobrota, M., Obradović, T., & Obradović, V. (2020). Project Management and Sustainability: Playing Trick or Treat with the Planet. *Sustainability*, *12*(20), 8619. https://doi.org/10.3390/su12208619

Venegas-MartíNez, F., & Aali-Bujari, A. (2021). Impact of construction industry on Economic growth in Africa: Granger Causality and GMM Estimation of dynamic

panel models. *Review of Economics and Finance*, *19*, 292–299. https://doi.org/10.55365/1923.x2021.19.30

Walker, A. (2015). *Project management in construction*. John Wiley & Sons.

Walker, D., & Rowlinson, S. (2007). *Procurement systems: A Cross-Industry Project Management Perspective*. Routledge.

Wang, Y., Chen, D., & Tian, P. (2022). Research on the Impact Path of the Sustainable Development of Green Buildings: Evidence from China. *Sustainability*, *14*(20), 13628. https://doi.org/10.3390/su142013628

Wang, Y., Chong, D., & Liu, X. (2021). Evaluating the Critical Barriers to Green Construction Technologies Adoption in China. *Sustainability*, *13*(12), 6510. https://doi.org/10.3390/su13126510

Wang, Y., & Liang, S. (2013). Carbon dioxide mitigation target of China in 2020 and key economic sectors. *Energy Policy*, *58*, 90–96. https://doi.org/10.1016/j.enpol.2013.02.038

Watts, S. (2012). *Doing Q Methodological Research : Theory, Method & Interpretation*. Watts, Simon - Stenner, Paul - Sage - Torrossa. https://www.torrossa.com/en/resources/an/4913515

Watts, S., & Stenner, P. (2005). The subjective experience of partnership love: A Q Methodological study. *British Journal of Social Psychology*, *44*(1), 85–107. https://doi.org/10.1348/014466604x23473

Weerasinghe, U. G. D. (2022). SUSTAINABLE BUILDINGS: EVOLUTION BEYOND BUILDING ENVIRONMENTAL ASSESSMENT METHODS. *Journal of Green Building*, *17*(4), 199–217. https://doi.org/10.3992/jgb.17.4.199

Wei, L., Tam, V. W., Chen, H., & Du, L. (2020). A holistic review of research on carbon emissions of green building construction industry. *Engineering, Construction and Architectural Management*, *27*(5), 1065–1092. https://doi.org/10.1108/ecam-06-2019-0283

Wong, K. D., & Zhang, R. (2013). Implementation of web-based construction project management system in China projects by Hong Kong developers. *Construction Innovation: Information, Process, Management*, *13*(1), 26–49. https://doi.org/10.1108/14714171311296048

Wuni, I. Y., & Shen, G. Q. (2019). Critical success factors for modular integrated construction projects: a review. *Building Research and Information*, *48*(7), 763–784. https://doi.org/10.1080/09613218.2019.1669009

Yaman, K. M., & Ghadas, Z. a. A. (2022). SUSTAINABLE CONSTRUCTION IN THE DIGITAL AGE: SPECIAL REFERENCE TO THEORIES OF SUSTAINABILITY AND SDGS IN GREEN BUILDING. *IIUM Law Journal*, *30*(S1), 35–68. https://doi.org/10.31436/iiumlj.v30is1.698

Ying-Bin, Z., Lv, S., Wang, J., Tong, J., & Fang, Z. (2022). The impact of green taxes on the carbon emission efficiency of China's construction industry. *Sustainability*, *14*(9), 5402. https://doi.org/10.3390/su14095402

Yu, J., & Bell, J. (2007). BUILDING A SUSTAINABLE BUSINESS IN CHINA'S SMALL AND MEDIUM-SIZED ENTERPRISES (SMEs). *Journal of Environmental Assessment Policy and Management*, *09*(01), 19–43. https://doi.org/10.1142/s1464333207002718

Zhang, N., Ye, J., Zhong, Y., & Chen, Z. (2023). Digital transformation in the Chinese construction industry: status, barriers, and impact. *Buildings*, *13*(4), 1092. https://doi.org/10.3390/buildings13041092

Zhao, W. (2022). China's goal of achieving carbon neutrality before 2060: experts explain how. *National Science Review*, *9*(8). https://doi.org/10.1093/nsr/nwac115

Zhou, Y., & Pheng, L. S. (2014). Project communication management in complex environments. In *Springer eBooks*. https://doi.org/10.1007/978-981-4560-64-1

Zhu, X., Zhang, L., Ran, R., & Mol, A. (2015). Regional restrictions on environmental impact assessment approval in China: the legitimacy of environmental authoritarianism. *Journal of Cleaner Production*, *92*, 100–108. https://doi.org/10.1016/j.jclepro.2015.01.003

Ziraba, A., Akwene, G. C., Nkea, A. N. a. M., & Lwanga, S. C. (2020). THE ADOPTION AND USE OF MOODLE LEARNING MANAGEMENT SYSTEM IN HIGHER INSTITUTIONS OF LEARNING: A SYSTEMATIC LITERATURE REVIEW. *American Journal of Online and Distance Learning*, *2*(1), 1–21. https://doi.org/10.47672/ajodl.489

Zubko, K., Samus, H., Tsyhanenko, O., Троян, М. Ю., & Järvis, M. (2021). Economic and environmental assessment of environmental pollution by construction companies in Ukraine in the system of environmental management in the Post-Pandemic period. *SHS Web of Conferences*, *126*, 01004. https://doi.org/10.1051/shsconf/202112601004

Appendix

Appendix A： Q-Sorting of Respondents

Respondent 1

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
26	36	33	3	27	11	2	15	14	4	1
	35	6	9	28	12	7	19	16	13	10
		34	24	31	17	8	21	18		
			35	5	22	25	29			
				20	23	30				
					32					

Respondent 2

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
20	34	19	15	3	9	26	25	11	35	21
	36	23	16	4	14	28	32	12	37	18
		30	10	5	27	31	22	13		
			17	6	29	33	24			
				7	1	8				
					2					

Respondent 3

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
7	23	24	36	19	2	31	9	30	14	1
	37	8	4	18	33	12	29	6	21	11
		22	15	34	16	5	20	13		
			25	3	17	32	10			
				35	26	27				
					28					

Respondent 4

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
19	36	20	10	35	7	2	3	18	29	16
	23	12	25	9	22	8	5	24	31	21
		11	28	37	13	17	6	27		
			30	1	14	32	15			
				4	26	33				
					34					

Respondent 5

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
22	6	36	27	14	25	2	8	21	31	28
	19	23	4	26	20	18	15	11	3	17
		24	9	12	10	30	5	35		
			32	34	1	29	7			
				33	16	37				
					13					

Respondent 6

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
9	16	26	5	6	4	11	3	10	1	7
	23	36	14	12	15	22	8	28	2	21
		37	20	13	17	29	32	33		
			24	27	18	31	34			
				35	19	30				
					25					

Respondent 7

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
14	36	35	9	23	6	15	34	21	16	19
	5	37	11	4	13	18	29	22	30	17
		7	12	26	8	24	10	31		
			20	27	25	32	28			
				1	3	33				
					2					

Respondent 8

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
1	4	9	16	18	3	2	7	10	12	14
	19	25	26	28	6	17	20	21	22	23
		32	33	34	11	24	27	29		
			35	36	13	30	31			
				5	8	37				
					15					

Respondent 9

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
1	6	15	20	9	8	29	28	18	16	21
	12	14	13	23	19	3	31	17	24	22
		4	10	37	33	2	27	30		
			26	11	34	5	25			
				32	36	7				
					35					

Respondent 10

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
1	9	36	37	35	32	6	33	28	19	13
	12	25	4	5	31	10	34	16	23	18
		14	7	2	29	17	30	21		
			8	20	26	22	24			
				3	27	11				
					15					

Respondent 11

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
1	2	20	18	14	4	21	31	26	22	17
	11	34	19	35	6	5	28	27	24	16
		15	12	37	7	3	29	30		
			9	32	8	36	25			
				33	10	13				
					23					

Respondent 12

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
1	14	2	8	7	29	25	21	24	31	19
	12	4	10	5	9	6	16	18	35	17
		3	23	27	22	13	30	11		
			26	34	32	33	36			
				15	37	20				
					28					

Respondent 13

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
1	2	34	6	9	33	3	24	16	19	17
	36	35	20	18	7	4	29	22	21	30
		37	5	25	12	11	10	23		
			8	26	13	14	31			
				32	15	28				
					27					

Respondent 14

Disagree -5	-4	-3	-2	-1	0	1	2	3	4	Agree 5
6	9	2	37	15	12	34	3	29	16	21
	11	35	1	18	24	22	14	10	17	28
		36	7	26	30	23	19	13		
			8	32	31	27	20			
				33	4	25				
					5					