SUSTAINABLE PRACTICES OF CONSTRUCTION PROJECTS IN KUNMING, THE PEOPLE'S REPUBLIC OF CHINA: AN INVESTIGATION

By

Miss Duan XIAOMENG

A Thesis Submitted in Partial Fulfillment of the Requirements

for Master of Engineering ENGINEERING MANAGEMENT

Department of INDUSTRIAL ENGINEERING AND MANAGEMENT

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Miss Duan XIAOMENG : SUSTAINABLE PRACTICES OF CONSTRUCTION PROJECTS IN KUNMING, THE PEOPLE'S REPUBLIC OF CHINA: AN INVESTIGATION Thesis advisor : Associate Professor Choosak Pornsing, Ph.D.

The practice of sustainability has been adopted in China's construction industry. This article examines the key factors influencing sustainable construction practice (SCP) in construction projects. A questionnaire is designed to collect data from construction projects in Kunming City, Yunan Province, the People's Republic of China. Six groups of determinant factors are Economic perspective, Awareness of sustainability, Stakeholder perspective, Policy and regulations, Operation management in SCP, and Project management perspective. The statistical analysis reveals that the critical factor is Policy and regulations, with a score of 4.48. Project management and Awareness of sustainability are the second and third ranks, respectively. The Policy and regulations factor significantly differs from the other two factors. This study can recommend to policymakers to promote sustainable construction practices rigorously.

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CHAPTER 1
INTRODUCTION

1.1 Motivation

The construction industry is the primary industry sector of every country. It contributes to high life quality. Nevertheless, it is unavoidable that the construction industry and its activities have a tremendous impact on the natural environment, human health, and the global economy (Liu et al., 2012). The construction industry is the most contributor to pollution such as air, water, waste, and noise pollution throughout its life cycle (Wu & Low, 2010)

Copenhagen Resource Institute (2014) reported that the construction industry generates approximately 40% of energy consumption, 30% of carbon dioxide emissions, and 40% of total solid waste worldwide. In the UK, the construction industry is responsible for 50% of the total UK energy consumption. It also consumes fresh water increasingly by 70% in the last three decades. Biodiversity is one of the environmental impacts rendered by construction projects. It is affected by the buildings' land used (Pitt et al., 2009).

As a result, the construction industry has been forced to practice sustainability and comply with the law and legislated government regulations to protect the environment (Forrozanfar et al., 2017). Nations develop sustainable practices to conserve their natural resources and competitive advantages (Petri et al., 2014). The difficulty is that implementing sustainability concepts in a construction project has high uncertainty and complexity (Pham & Kim, 2019). Green construction practices (GPC) are not just an internal affair of a company but also an intra-affairs among parties and stakeholders. Thus, the strategy to ensure practice is that eco-friendly agenda is being practiced at individual-firm-project levels (Wazari et al., 2015).

The Ministry of Construction (MOC) has launched China's Green Building Evaluation System. It defined green building as 'the practice of creating structures to provide a healthy, applicable, and effective environment; furthermore, to save resources such as energy, land, water, and building materials.' In addition, the green construction practice must protect the environment and decrease pollution as much as possible throughout the life cycle of a building (Liu et al., 2012).

It is necessary that the negative affects that building operations have be reduced as much as possible. According to Akadiri and Fadiya (2013), this mandate compels construction companies to use environmentally responsible and environmentally responsible strategies and activities during the design and construction process. On the subject of putting sustainable building practices (SCP), many bodies of writing have been produced. According to Qi et al. (2010), it is impacted, amongst other things, by ecologically sustainable development-based requirements. These requirements might take the shape of government legislation, pressure from stakeholders, environmental groups, financial institutions, and top management commitment.

However, there are arguments that the different SCP implementations are discovered related to managerial renditions and firms' ability to launch strategies for tackling varied sustainability problems. As a result, sustainable construction practices are implemented in innovative construction firms with vague and partly explained by the managerial sustainable commitment (Gan et al., 2015). To our knowledge, more literature needs to discover and portray the understanding of key factors of the adoption of sustainable construction practices. Additionally, research reports provide little systematic work linking the drivers to actual adoption at the organization level (Elmualim et al., 2012).

Accordingly, this study aims to investigate the significant factors and their role and ability as determinants of sustainable construction practices in Kunming, the People's Republic of China.

1.2 Research Questions

As mentioned above, this study raises the issue to be examined. The determinant factors are needed to be discovered and their role and capability of the adoption to SCP is quantified. Their liking are also in our intention. This study will answered two research questions:

Research Question 1: What are the factors forces developers to deploy sustainable construction practices in their construction operations?

Research Question 2: What are the function and capability of the factors in the implementation to sustainable construction practices?

1.3 Research Objectives

Straightforwardly, the research objectives are interpreted from the research questions.

1. To identify the determinant factors of SCP adoption in Kunming, the People's Republic of China.

2. To examine the role and capability of the discovered determinant factors.

1.4 Research Contributions

1. The indentified factors which are discovered by this study helps developers and stakeholders practically deploy green construction practice.

2. A construction firms can dedicates scarce resources to the dominant factors and understand their ability.

3. The research procedure and tools used in this thesis can be applied to other engineering management problems.

1.5 Scopes and Limitations

1. This study is a survey research using a questionnaire as a research tool.

2. The data is collected between October 2023 to January 2024

3. The study area is Kunmig, Yunnan Province, the People's Republic of China.

1.6 Abbreviations

BREEAM	BRE et al. Method
CF	Critical Factor
EMS	Environmental Management System
GB	Green Building
GGBS	(The) Green & Gracious Building Scheme
ISO	International Standard Organization
KMO	(The) Kaiser-Meyer-Olkin
KPI	Key Perfromance Index
LEED	Leadership in Energy and Environmental Design
LCA	Life Cycle Assessment

LCC	Life Cycle Costing
MOC	(The) Ministry of Construction
RICS	(The) Royal Institute of Chartered Surveyors
SC	Sustainable Construction
SCP	Sustainable Construction Practice
UNEP	United Nations Environment Programme
VM	Value Management

CHAPTER 2
LITERATURE REVIEW

2.1 Sustainability

According to Pham et al. (2021), a holistic perspective on sustainability considers notions of economic performance and social and environmental performance. The corpus of study that has been dedicated to the topic of sustainability is well established. According to Shurrab et al. (2019), the definition of sustainability is "the process that creates a community vision that respects the prudent use of natural resources to ensure that existing generations achieve a high level of economic security, achieve democracy, and participate in the control of their communities all while preserving the integrity of ecological systems and life." In other words, sustainability is "the process that creates a community vision that respects the prudent use of natural resources to ensure that existing generations achieve a high level of economic security, To phrase it another way, sustainability might be seen as "the process that ensures existing generations achieve a high level of economic security, achieve democracy, and contribute to the control of their communities."

To broaden the environmentalist paradigm of those working in the field of sustainability and to allow for the incorporation of the social dimension, Bahadur and Waqqas (2013) developed the idea of sustainability as the triple bottom line. This idea was proposed by Bahadur and Waqqas. This concept served as the foundation for his book, "Cannibals with Forks," in which he outlines the triple-bottom-line vision, which has three components: economic success, environmental integrity, and social justice. The phrase "triple bottom line" was coined by him. According to Gimenez et al. (2012), environmental management, closed-loop supply chains, and an all-encompassing view on the triple bottom line are all necessary components of a sustainable business model. In spite of this, the culture of the organization, as well as its operations and strategy, includes considerations about profit, people, and the environment.

The core of sustainability may be captured by the triple-bottom-line viewpoint, which evaluates the operations of an organization in terms of their effect on the local, national, and global environments (Savitz, 2006). This viewpoint maintains that sustainability encompasses more than only a management tool for businesses and other

types of organizations. In addition, in order for organizations to continue their operations throughout the course of a longer period of time, they need to take measures that promote the sustainable management of human and natural resources and contribute to the general well-being of both the economy and society.

Every aspect of the economy is affected when there is a problem with sustainability. According to Dienes et al. (2016), businesses are required to comply with various directives and laws addressing CO_2 emissions, pollution, and noise emissions, component and product safety, product reusability, recyclability, and recoverability. The majority of the issues that are being addressed by this rule are technical in nature. In addition to the regulatory requirements, most businesses are also dealing with the effects of globalization, a prolonged economic crisis, and the push from labor unions to improve working conditions and salaries. In addition, corporations are shifting away from a conventional economic approach and toward one that incorporates environmental, social, and economic considerations. This transition is the result of managers realizing that sustainability has an influence on their operations, which represents new sources of competitive advantage and a proxy for quality management (Banihashemi et al., 2017).

2.2 Effects of Sustainability

2.2.1 Environmental effect

The Royal Institute of Chartered Surveyors (Ball, 2005) approximated that 40% of UK waste, solid and non-solid wastes, are generated by the construction industry. This figure is similar in other countries. Waste management is a primary department in construction sites that assists construction contractors in monitoring the wastes and debris from construction projects. The same report presented the ratio of energy used in buildings. It accounted for 50% of the total UK energy consumption. Of this number, 45% contributed to heat, light, and ventilation. UK government set a target to reach 60% energy consumption reduction by 2050 (Trutnevyte et al., 2016).

Edwards (2014) reported that about 4.1 million new households were needed in the UK by 2016. To this number, water consumption is skyrocketing by 70%, significantly increasing water pollution and impacting the freshwater supply. Consequently, sustainable construction practices are needed to implement water

conservation techniques. It is not only for new construction projects but also for refurbishment projects. Water-efficient technologies, such as less-water flush toilets, rain harvesting, and reused fresh water, can reduce water consumption by 20% approximately (Zhang et al., 2019).

Pollutions from construction projects are enormous and various. Some are temporal, such as vibration, noise, particles, and vaporous discharges, while some are permanent, such as water, debris, and solid waste. Besides, construction firms neglect the bio-diversity impact: all living things and their habitats receive negative impacts from construction projects. To date, there are obligations to monitor biodiversity in developments by deploying good design and landscaping (Nicholson & Kurucz, 2019).

2.2.2 Economic effect

Economic effect relates to the costs and benefits of building operations, such as the original investment, the use, and the time it takes to get a return (Gan et al., 2015). When new standards or technologies are brought into the construction sector, owners typically place the utmost importance on financial considerations as their priority. Sustainable construction approaches usually need a more significant initial financial commitment than conventional building projects.

For example, Liyin et al. (2006) note that the implementation of ISO 14000 and HKBEAM frequently results in an increase in the expenses of capital for equipment, staff training, human resources, and technology designed to preserve the environment (such as water treatment), as well as the use of noise-barrier materials. The advantages of sustainable construction are either long-term or intangible. Some examples of these benefits include reduced operation costs over the building's service life, improved environmental performance, enhanced corporate image, and increased employment. Sustainable construction also causes a more extended payback period for owners. Significant impediments to the adoption of sustainable construction exist for owners and financial institutions in the form of higher initial investments and a more extended payback period. According to Elmualim et al. (2012), the absence of assistance from financial institutions immediately results in budgetary restrictions, which in turn prohibits connected organizations from efficiently managing their duties related to sustainability.

2.2.3 Social effect

The quality of life, the promotion of healthy living, and the cohesion of society can be directly impacted by the performance, quality, and design of commercial and residential buildings and access to services and leisure. Everyone involved with a building stands to gain from more environmentally friendly methods. According to the research conducted by Walker (2000), "... stakeholders can provide tangible value, provide valuable feedback information about how they are affected and can cooperate in the delivery of the output."

According to Keeping & Shiers (1996), sustainable, "green" buildings have reduced energy costs and are seen to be "healthier," both of which can assist in minimizing absenteeism in the workplace. When a business has a pleasant atmosphere, it is easier to keep employees and acquire new ones, and it also has the potential to improve its entire image and brand. The delivery of this is not simple and is dependent on several elements.

2.3 Green Construction

Green construction principle is the responsibility of the construction industry in achieving *sustainability*. It is a coincidence with ‘sustaiable construction.’ There are three primary pillars of green construction: environmental conservation, social well-being, and economic growth (Shurrab et al., 2018). Precisely, green construction is a set of processes that delivers built properties such as building, structures, infrastructures, and surroudings, by meaning of firms’ profit and competitiveness. The benefits of green construction are not only for construction firms but also for clients, society, and animal wildlife.

There are factors undertaken at the construction level, most of them relates to energy-efficient consumption during the construction phase. It can reduce environmental impact and construction cost. Furthermore, a sustainable design affects to reduce environmental impacts during the post-occupancy stage (Fieldson et al., 2009). The related factors are described as follows.

1) Green practices

Green practices means the use of field operations to minimize the environmental impacts in construction projects. Partucularly, the practices are not only to project

owners and subcontractors, but also sites' waste management, prefabrication sites, and wastewater management.

2) Energy and water saving

Both water and energy are saved as a result of this action. This topic is of the highest significance for the industry as a whole, and it will have a significant impact on the environmental impact that the building will have over the course of its whole life cycle. For example, it is necessary to include the required technological systems into the design of the construction. Solar panels, systems for energy-efficient heating and lighting, air conditioning, and ventilation, as well as technology for recycling wastewater may be included in these technological systems. In addition to this, it is very necessary to reduce the quantity of embodied energy and the detrimental effects that the building has. Builders (also known as developers), architects, and consultants (both architects and consultants) are the key stakeholders in the design of environmentally friendly buildings. The methodology that corresponds to the supply of building materials is known as "green product design," and it includes selecting raw materials that have low embodied energy.

3) Facilitating green practices

In order to guarantee the successful execution of the "core green factors," it is important for all stakeholders to follow particular practices at the level of the organization. Facilitating and supporting practices are the names given to these types of activities. Because the stages of the building supply chain are more intricate than those in any other business, the processes that assist construction need to be more comprehensive than those in any other industry. These practices include certification to the international standard ISO 14001, governmental accreditation known as Estidama, and the implementation of an environmental management system, also known as an EMS. Internal policies, evaluations, plans, and actions to be carried out are the components that make up an EMS. Organizations that employ EMS figure out how their operations interact with the environment, the environmental ramifications that arise from diverse operations, and the alternative methods to prevent environmental pollution and the loss of natural resources. These are all important aspects of environmental stewardship. ISO 14001 is the standard for environmental management systems (EMS), despite the fact that there are other standards as well. It is the standard

that is most well known. There is a considerable body of evidence supporting the usefulness of ISO 14001 and EMS from an environmental and green point of view, and this data comes from a variety of industries, including the construction industry.

4) Environmental training

It is essential to provide employees with training on environmental concerns to improve their awareness, understanding, and overall level of competence. Employees at all levels of the business, including managers and onsite construction workers, must participate in these training sessions to get their benefits. According to Begum et al.'s (2009) research, for instance, contractors whose employees take part in training programs for trash management had more favorable opinions regarding waste management.

5) Green purchasing

This topic discusses the inclusion of environmental considerations into purchasing policies, strategies, and actions. These considerations include decisions about the procurement of materials as well as the selection of the company that will be awarded the contract. It is essential to pick products that are eco-friendly when making decisions about the acquisition of materials. Examples of products that are eco-friendly include those that are manufactured from recycled materials and those that do not include any potentially harmful chemicals. In a similar fashion, taking environmental factors into account throughout the bidding process necessitates the formulation of environmental standards at the pre-qualification phase. These environmental criteria could include requiring the tender participant to possess EMS and International Organization for Standardization (ISO) 14001 certification as well as technical knowledge, such as previous experience working on green projects or LEED-certified respondents on the payrolls. Additionally, these environmental criteria could include requiring the participant to have a LEED-certified respondent on the payrolls. During the stage of decision-making known as selection, the aspects of the project that are kind to the environment are accorded the appropriate amount of weight.

2.4 Sustainable Business Performance

2.4.1 Economic

This practice has been generally understood and long accepted as establishing a company's financial configuration and characteristics and evaluating a company against industry benchmarks. It is generally accepted that companies' business performance can be evaluated using financial ratios. The application of financial ratios as inputs into a financial risk analysis is another way in which they may be utilized to provide considerable and trustworthy information regarding a company's financial health. Even though there is a great deal of controversy around the importance of financial ratios and their capacity to influence share prices directly, it is easy to obtain them. Long-term investors, who are often more concerned with a company's continued survival, can benefit from the knowledge they help offer, thanks to these investors. In the area of financial analysis, appropriate ranges and criteria have been defined by analysts. Businesses that operate outside of specific ranges expose themselves to possible dangers. On the other hand, these ranges are subjective and are not universally recognized (Elyamany et al., 2007).

It is not necessarily true that a company's financial health could be better just because its share price is low. The ratios are calculated based on the firm's actual performance, but the market's sentiments and perspectives determine the share price. In addition, many investors realize that investing in the construction business includes danger, primarily with changeable economies. As a result, the disparity between share price and ratios may be significant for construction industry firms compared to other industries. It is because many investors recognize that investing in the construction business carries risk. The financial performance of companies may be enhanced by optimizing their use of available resources, boosting their efficiency and production, and cutting down on their operating expenses. Therefore, improved resource utilization will influence the firm's marketing edge, leading to more revenue, new market prospects, and a more significant market share. Therefore, businesses that work to enhance their processes and cut down on waste are better positioned to grow their customer base. However, it has yet to be determined whether these benefits directly influence companies' financial success (Hood et al., 2006).

In order to investigate the possible connection between the characteristics of green buildings and economic performance, it is necessary to incorporate many factors into the construct used to evaluate economic performance. The following are examples of these variables:

1) Possibilities available in the market
2) An increase in the cost of the item in question
3) A profit margin
4) An uptick in the total number of transactions
5) A rise in the proportion of the market share

2.4.2 Competitiveness

In addition to possessing the competencies of management and marketing, construction companies must guarantee that they are competitive and able to endure any problems that may arise in the highly competitive construction industry market. As a result, the competitive advantage factor has been incorporated into this investigation as one of the variables that is affected by the aspects of green building. According to Sabry (2015), the degree to which a business can create a defensible position over its rivals is considered its competitive advantage. Competitive advantage is the strategy businesses use to join the market to optimize their operations to obtain better outcomes for both short-term and long-term goals. As a result, the link between environmentally responsible building practices and economic viability will be investigated in this article. The factors that influence a company's level of competitiveness are as follows:

1) An increase in efficiency
2) An increase in quality
3) An increase in productivity
4) A cost reduction

2.5 China’s Environment Change

2.5.1 Sustainable development in construction industry

China is one of the primary producers of global carbon emissions, even though its emissions on a per capita basis are still lower than the world average. It is because China has a population of over 1.3 billion people. Billions of new building works required excessive land, and their development and operations accounted for roughly

30% of the total quantity of consumption in the entire society. According to Li et al. (2017), the building industry in China accounts for up to 40% of the world's use of cement and steel. Accordingly, new structures were responsible for 34% of the air, light, and electromagnetic pollution, and construction wastes accounted for 40% of the total trash society produces. Li et al. (2017) estimate that the total floor space required to accommodate the world's growing population will increase by 30 billion square meters by 2020. Because sustainable development in society is an essential component of green construction, which the government and scholars have backed, the building sector faces considerable challenges in achieving its goal of going green.

2.5.2 China's sustainable policy

The Chinese government began investing in environmentally friendly buildings as early as the 1980s; however, these initiatives need improvement due to a shortage of finance at the time as well as technical innovation. China does not have any publicly announced criteria that were important to sustainability before to the year 2005. However, there were some instruction manuals accessible, such as the ones listed below: 1) The Appraisal Handbook for Eco-housing in China was published in 2001, and it was the first eco-assessment framework; 2) The Construction Guidance for Green Olympic Buildings was published in 2003, and it assisted buildings associated with the Beijing Olympic Games in achieving the goal of having a "green Olympics" in 2008. 1) The Appraisal Handbook for Eco-housing in China was the first eco-assessment framework.

2005 was the year that saw the release of the Design Standard for Energy Efficiency of Public Buildings (GB 50189-2005), which was made accessible for public use. This standard requires ten different requirements to be met, and it addresses architectural features that apply to the inside as well as the outside of buildings. In 2009, 99% of firms were able to effectively apply this criterion, which is a significant increase from the 53% of organizations who could say the same in 2005.

The Ministry of Construction in China established the Chinese Green Building Evaluation System as the very first green building evaluation system in the history of the country in 2006. This standard begins by defining green buildings, then proceeds to explain their technical requirements, and then proceeds to outline the criteria for evaluating the impact that green buildings have on the surrounding environment. 2007

was the year that saw the publication of the MOC's Detailed Technical Rules for Green Building Evaluation as well as Administrative Measures for the Green Building Evaluation System. The Green Building Evaluation System is connected to these papers in some way. Prior to this, the standards that were used in the United States were called LEED (Leadership in Energy and Environmental Design), and the standards that were used in the United Kingdom were called BREEAM (BRE et al. Method). The green building certification system in China was comprised of a total of six essential subsystems. These subsystems were known as space savings and the outside environment, energy savings and the use of energy resources, water saving and the utilization of water resources, material savings and the utilization of material resources, indoor environmental quality, and operations management. The LEED rating system was utilized as a point of reference for China's green building rating system. The highest possible number of stars, three, can be given out for exceptional environmental performance. Although this evaluation system serves as an authority for certification, unlike the Building Code, the fundamental requirements for both are the same. These fundamental requirements are energy conservation and emissions reduction, and they are based on the "11th Five-year Plan (2005-2010)" and the government's "2010-20 percent" energy efficiency goal, in which savings on building energy account for the majority of the target. Both of these goals were established in accordance with the "11th Five-year Plan (2005-2010)."

The 14th announcement, titled "Policies and Plans of Integrated Utilization Techniques of Resources in China," was published on July 1st, 2010, and it was numbered 14. The purpose of this paper is to stimulate the adoption of the technical framework and innovations outlined within the document. The publication offers 257 environmentally friendly practices in 10 different industries, one of which is the construction industry. This will help improve resource efficiency and contribute to the development of a sustainable economy, both of which are necessary steps toward the creation of a society that has a smaller negative impact on the natural world.

Buildings in China are subject to a variety of rules and regulations, many of which contribute to the promotion of solutions that have a low cost but large impact in terms of decreasing their carbon footprint. In addition to the limitations that were discussed previously, the government of China has also made large financial

expenditures in the environmentally friendly construction sector. As part of a program that has been operating continuously in northern China since 2008, an incentive worth up to 642 million RMB has been granted. The restoration and retrofitting of heating systems was the goal of this incentive, which was designed to stimulate these activities. In 2008, the central government allocated 1.37 billion RMB to fund demonstration projects that supported the utilization of technologies that made use of renewable resource sources.

2.5.3 Progress of sustainable constructions in China

After signing the climate change accord in Copenhagen in December 2009, China has made it a persistent priority to promote the growth and expansion of the market for environmentally friendly buildings. It was anticipated that new constructions under the 11th Five-year Plan (2005-2010), will save 700 billion tons of standard coal. The leading role that China is already playing in generating the technology required to address the issue posed by climate change is not as generally recognized as it should be. For instance, China is not only the greatest customer but also the largest manufacturer of solar water heaters, accounting for 50% of the world's total output and 65% of all installations.

The eight-story office of the Ministry of Science and Technology in Beijing, which was finished in 2004, was the first building in China to earn the internationally renowned US LEED certification. This accreditation was awarded by the United States. In China, there have been a total of 213 accredited projects, winning a total of 17 silver awards, 23 gold awards, and one platinum medal. On the other hand, as of the end of 2010, The Chinese Green Building Evaluation System had awarded certification to more than one hundred different structures.

The construction costs of green buildings in China were on average 100 to 150 RMB per square meter more than the price of constructing a regular structure. The market potential for environmentally friendly buildings is projected to be equivalent to 1.5 trillion RMB if there is an increase in price of 100 RMB per square meter. The green construction industry has a large commercial potential for the entirety of the green supply chain, and it may be found here. To help minimize risks and assist in overcoming the gaps in technology, skills, and funding that the green sector still experiences,

participation from banks and financiers, as well as local and international enterprises in important sectors, was encouraged. This participation was encouraged in order to aid.

2.6 Related Studies

Liu et al. (2012) investigated green construction practices in the Chinese construction industry. They discovered threats and opportunities in the sustainable construction industry that can guide stakeholders to reduce environmental impacts. A survey study was conducted with 65 respondents. The authors reported that the government's subsidization significantly drives sustainable construction practices. The major obstacles are 'high fabrication cost' and 'lack of skilled-management and – operators levels.' Nevertheless, the number of respondents in this study was too low compared to the size of the industry in China. Furthermore, the data analysis was descriptive statistics. It could not deliver other implications than using inference statistics.

However, these projects need to be improved due to a lack of cash at the time as well as technical innovation. The Chinese government began investing in environmentally friendly buildings as early as the 1980s. Prior to the year 2005, China did not have any publicly acknowledged criteria that were significant to sustainable development. On the other hand, there were certain instruction manuals that were available, such as the ones that are listed below: 1) The Appraisal Handbook for Eco-housing in China was published in 2001, and it was the first eco-assessment framework; 2) The Construction Guidance for Green Olympic Buildings was published in 2003, and it assisted buildings associated with the Beijing Olympic Games in achieving the goal of having a "green Olympics" in 2008. 1) The Appraisal Handbook for Eco-housing in China was the first eco-assessment framework. 1) The first eco-assessment framework was called the Appraisal Handbook for Eco-housing in China.

In 2005, the Design Standard for Energy Efficiency of Public Buildings (GB 50189-2005) was published and made available for use by the general public for the first time. This standard is still in use today. This standard has ten separate requirements that must be satisfied before it can be considered met, and it discusses aspects of architecture that are applicable to both the interior and outside of buildings. This criteria was successfully used by 99% of companies in 2009, which is a substantial rise from

the 53% of businesses that could claim the same in 2005. In 2005, the percentage of companies who could effectively apply this criterion was 53%.

The Chinese Green Building Evaluation System was the very first green building evaluation system in the history of the country when it was developed in 2006 by the Ministry of Construction in China. This standard begins with defining green buildings, then continues on to define the technical requirements for green buildings, and then moves on to outline the criteria for evaluating the impact that green buildings have on the environment around them. The Detailed Technical Rules for Green Building Evaluation and Administrative Measures for the Green Building Evaluation System were both published by the MOC in the year 2007, the same year that both documents were made available for public consumption. There is a connection between the Green Building Evaluation System and these articles in some manner. Prior to this, the standards that were utilized in the United States were known as LEED (which stands for Leadership in Energy and Environmental Design), whilst the standards that were utilized in the United Kingdom were known as BREEAM (which is for BRE et al. Method). China's program for certifying environmentally friendly buildings included a total of six different but equally important subsystems. These subsystems included names like "space savings and the outside environment," "energy savings and the use of energy resources," "water savings and the utilization of water resources," "material savings and the utilization of material resources," "indoor environmental quality" and "operations management." The Green Building Rating System in China looked to the LEED rating system as a point of reference while developing its own rating system. In recognition of outstanding environmental performance, the maximum number of stars—three—that can be awarded is at your disposal. In contrast to the Building Code, this assessment system serves as an authority for certification, although despite this difference, the essential standards for both are the same. These basic criteria consist of energy conservation and a decrease in emissions, and they are based on the "11th Five-year Plan (2005-2010)" and the government's "2010-20 percent" energy efficiency objective, in which savings on building energy account for the bulk of the target. In addition, these fundamental requirements are based on the "11th Five-year Plan (2005-2010)" and the "11th Five-year Plan (2005-2010)." Both of these objectives were

determined in line with the "11th Five-year Plan (2005-2010)," which was implemented in 2005.

On July 1, 2010, the fourteenth announcement, which bore the title "Policies and Plans of Integrated Utilization Techniques of Resources in China," was made public. The announcement was given the number 14, and it was published. This article's goal is to encourage the implementation of the technological framework as well as the innovations described in the aforementioned document. One of the ten sectors covered by the paper that contains 257 ecologically responsible practices is the building sector. This will help enhance resource efficiency and contribute to the development of a sustainable economy, both of which are vital steps toward the construction of a society that has a less negative impact on the natural world. If we do this, we can get closer to our goal of creating a society that has a smaller negative impact on the natural world. Buildings in China are subject to a wide variety of rules and regulations, the majority of which contribute to the promotion of solutions that have a cheap cost but a substantial impact in terms of reducing their carbon footprint. In addition to the restrictions that were mentioned before, the government of China has also invested a significant amount of money in the development of ecologically friendly building practices. An incentive with a maximum value of 642 million RMB has been offered as part of a program that has been running without interruption in the northern region of China since 2008. This incentive, which was meant to drive operations like heating system maintenance and retrofitting, had the objective of restoring and upgrading existing heating systems as its primary focus. 1.37 billion RMB was allotted by the central government in the year 2008 for the purpose of financing demonstration projects that promoted the deployment of technologies that made use of renewable resource sources.

According to Yusof et al. (2017), business support, client pressure, and government laws are all examples of positive barriers to the implementation of environmentally responsible building techniques in Malaysia. The application of SCP has a beneficial impact, in addition, on the environmental and economic performance of the construction sector. These findings were reviewed based on the responses of 210 individuals, and the structural equation modeling approach (SEM) was utilized to conduct the analysis.

Shurrab et al. (2019) empirically investigated the distinctions between significant contributions and sustainable building. Additionally, the authors looked at applying the theory of planned behavior in building. In the study of the demand side, this idea is fundamental. The most significant barrier is the demand from customers. There were a total of 120 replies from construction companies collected. In order to analyze the data, conformance factor analysis models were utilized. It was discovered that applying environmentally responsible building procedures improved environmentally responsible performance. They demonstrated that construction businesses may enhance their sustainable competitiveness, their company's image, and their customers' expectations.

Savari et al. (2021) focused on the critical success factors of small and medium-sized construction companies in the Middle East. The study started by reviewing critical factors in the literature—seventy critical factors reviewed by experts. After three review stages, 63 factors were suitable to be analyzed. The researchers deployed various statistical analysis techniques such as the Kendall coefficient of concordance, Kolmogorov-Smirnov test, Single variable T-test, Friedman’s test, and factor analysis. The results showed that green technology is the most important for sustainable construction practices. The next is skilled workers, dynamic capability, and management, respectively.

Ohene et al. (2022) examined the barriers toward zero carbon emission building construction. The research used a systematic review to identify the barriers from the Scopus and WoS databases. The best and worst multi-criteria decision-making technique was the primary analysis tool. The authors reported that the highest degree barrier needed more rules, policies, and implementation efforts. The economic uncertainty and long payback period were essential factors—the collaboration among governments, developers, customers, and suppliers needed to be promoted to overcome these barriers.

2.7 Conclusion

Sustainability is not a trend but is a requirement of humankind. There are various definitions of it; notwithstanding, all of them has common statements. The sustainability is required because it affacts to environement, economic, and social. Thus, sustainable practices are studied in various industris especially in construction industry.

Sustainable construction practices consider many aspects to protect environment and improve firms' competitiveness. Green practices, energy and water saving, facilitating green practices, environmental training, and green purchasing are common factors in sustainable construction practices. In term of business performance, sustainable construction practices affect to economic, and competitiveness.

Presently, China has promoted sustainable development in construction industry because Chinese construction industry is the major part in Chinese economy. It also a primary consumer of energy, land, building materials. Accordingly, sustainable construction practices are required.

CHAPTER 3
RESEARCH METHOD

In this chapter, the research procedure is proposed. Section 3.1 explained the preliminary list of factors in literature. The questionnaire design is described in section 3.2. The population and sample in data collection is unfolded in section 3.3. Data analysis techniques are clarified in section 3.4. In conclusion, the research procedure and its schedule are illustrated in section 3.5.

3.1 Preliminary Factor Lists

The factors are listed from literature. Based on a content analysis of the relevant literature. Structured interviews will be conducted to explore the rational of the factors. The interviewees are the experienced management of construction projects in Kunming and the academic professors. The interviewees will review the factor in this study and give comments with some recommendations. The important is the interviewees are aksed to give their professional perspective on the rationality of the factors in the context of Kunming construction industry.

3.1.1 The determinant factors

The determinant factors are drawn from literature. There are many studies explored the knowledge about sustainable construction practice; however, a specific area such as Kunming is scarce. The factors are carefully review and selected in the context of Kunming. Table 3.1 details the selected factors and their related literature.

Table 3.1 The determinant factors of sustainable construction practice.

No.	Factors	References
1	Economic - Investment - Return on investment - Tangible benefits - Intangible benefits - Incentive	Gan et al. (2015), Oluwole et al. (2013)
2	Awareness - Market awareeness - Knowldege and information - Local culture	Shurrab et al. (2019), Gen et al. (2015), Pitt et al. (2009)
3	Stakeholders - Top-management support - Financial instution support - Local government support - Shareholder support	Yin et al. (2018), Pham and Kim (2019), Pham et al. (2021)
4	Policy and regulations - Sustaiable regulations - Local government monitoring - Gonvernment incentive	Gen et al. (2015), Liu et al. (2012), Baloi (2003)
5	Sustaiable construction operations - Guidance to sustainable construction - Operational standard - Key performance index	Waziri et al. (2015), Yin et al. (2018)
6	Project management - Organization - Procurement - Monitoring	Robichaud and Anantatmula (2011), Gen et al. (2015)

3.1.2 Experts' recommendations

Three experts in the construction industry, specifically in Kunming, are asked to give recommendations on the selected factors of this study. Two are professors at Kunming University of Science and Technology, and one is a professor at Silpakorn University. They have experience in construction projects and sustainable practices. The recommendations are descriptive and excerpted from the interview. Table 3.2 shows the details of recommendations and their modifications.

Table 3.2 Experts' recommendations.

No.	Factors	Recommendations
1	Economic - Investment - Return on investment - Tangible benefits - Intangible benefits - Incentive	The term of return on investment concerns the interest rate. The operational level uses the benefit-cost ratio. It is easy to calculate and apply. However, in sustainable construction, the benefits are related to tangible and intangible benefits. Thus, the benefit-cost ratio may be computed from tangible benefits and then remove tangible benefits from the factors. The incentive is mainly from the government. Thus, it may be moved to the number 4 policy and regulations.
2	Awareness - Market awareeness - Knowldege and information - Local culture	It is better to identify whose knowledge. It must be the knowledge of building buyers in this context. They must have information about the building they are about to buy. The local culture is critical. It reflects buyers' behavior. However, it relates to the knowledge and information the buyer has.
3	Stakeholders - Top-management support - Financial institution support - Local government support - Shareholder support	It is better to rank the importance of the factors from Shareholder support, Local government support, Financial institution support, and Top-management support.
4	Policy and regulations - Sustaiable regulations - Local government monitoring - Gonvernment incentive	Government regulations and law is the most important in green practices. It is not just the regulation but also law enforcement. The study uses the word 'monitoring'. It is okay, but it may be more specific if she uses law enforcement.

Table 3.2 continued

No.	Factors	Recommendations
5	Sustainable construction operations - Guidance to sustainable construction - Operational standard - Key performance index	Performance measurement is essential at the operational level. It is generally designed for conventional construction operations. It needs to have sustainable performance measurement. Thus, it is good to inquire about the appropriate performance index for sustainable practices in the open-ended questions.
6	Project management - Organization - Procurement - Monitoring	This dimension is okay because green procurement is the starting point of green practices. It must review the whole supply chain, called a green supply chain. However, practically, it is challenging to conduct.

3.2 Research Tool Design

A three-part questionnaire was designed. The objectives and definition of sustainable construction practices. Part 1 is about the respondent demographic information, e.g. company size, position, and experience of respondents. Part 2 asks the factors importance on a 5-point Likert scale: 1 is ‘strongly disagree’, 2 is ‘disagree’, 3 is ‘neutral’, 4 is ‘agree’, and 5 is ‘strongly agree’. Part 3 is the opened questions about sustainable construction practices and its impacts. Furthermore, the Item Objective Congruence (IOC) is employed to validate the questionnaire.

3.2.1 Questionnaire design

The questionnaire part 1 has 8 questions about the company and respondents’ information. Part 2 has 20 questions in 6 categories: economic perspective, awareness of sustainability, stakeholder perspective, policy and regulations, operation management in SCP, project management perspective. Part 3 has 3 openned questions. It asks about the opinion of implementing sustainable construction practices in respondent’s construction project. The benefits and risks are also investigated in this part. The details of the questionnaire are shown in Appendix A.

3.2.2 Index of item-objective congruence

The questionnaire is validated the content. It was developed by Rovini and Hambleton in 1977 (Turner & Carlson, 2003). It is a procedure used in test development for evaluating content validity at the item development stage. The formular of IOC is shown below.

$$IOC = \frac{\sum R}{N} \tag{3.x}$$

where IOC = indext of item-objective congruence

R = experts' opinion score

N = number of experts

The score that assigned by the expert has 3 choices as follows.

+1 = The question is congruent with the objective.

0 = It is not sure that the question is congruent with the objective.

-1 = The question is not congruent with the objective.

The criteria of IOC interpretation are as follow.

$IOC \geq 0.50$ is the question is congruent with the objective.

$IOC < 0.50$ is the question is not congruent with the objective.

Three experts are invited to review the questions and assign the score one by one. There are two professors from China institute and Thai institute. Another one expert is from a construction company in Kunming. The detailed score is shown in Appexdix B. The result show that twenty questions are validated. They are suitable to be used as the research tool.

3.3 Data Collection

The target respondents were the management of Kunming construction projects. Kunming is the capital and largest city in Yunan province with urban area about 4,013 km^2 and metro are about 2,622 km^2. The construction projects are various such as residents, commercial, and public buildings. The questionnaire was sent via e-mail and telephone call was required in case of delay response. The survey was conducted from October 2023 to December 2023 using snowball sampling method. Please note that snowball sampling is a non-probability sampling technique used in sociology and

statistics research. It involves existing study subjects recruiting future subjects from among their acquaintances. The sample group is said to grow like a rolling snowball.

3.4 Data Analysis

From the research objectives and questions, the research would like to propose three hypotheses as follows:

H₀: Top management commitments are not promising relate with sustainable construction practices in Kunming construction projects.

H₁: Top management commitments are promising relate with sustainable construction practices in Kunming construction projects.

First of all, the Cronbach's α coefficient will be used to assess the reliability of the returing questionnaires.

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k} \sigma_y^2}{\sigma_x^2}\right) \tag{3.3}$$

where k is the number of items in the measure, σ_y^2 is the variance associated with each item, and σ_x^2 is the variance associated of the total scores.

Then, the data is examined the normal distribution by using Kolmogorove-Smirnov test (K-S test) at 95% confidence. The empirical distribution function F_n for n independent and identically distributed (i.i.d.) ordered observatons X_i is defined as

$$F_n(x) = \frac{1}{n}\sum_{i=1}^{n} 1_{(-\infty,x]}(X_i) \tag{3.4}$$

where $1_{(-\infty,x]}(X_i)$ is the indicator function, equal to one if $X_i \leq x$ and equal to zero otherwise.

The Kolmogorov-Smirnov statistic for a given cumulative distribution function $F(x)$ is

$$D_n = \sup_x |F_n(x) - F(x)| \tag{3.5}$$

where $\sup_x$ is the supremum of the set of distance. Intuitively, the statistic takes the largest absolute difference between the two distribution functions across all x variables.

Then, the multivariable regression analysis modelling is constructed. Correlation analysis and t-test are selected to test the hypotheses to achieve the research goals. In this research, a commercial software package, Minitab, is used. The results and analysis are dexcribed in the next chapter.

3.5 Research Procedure

Figure 3.1 shows the steps of this research project.

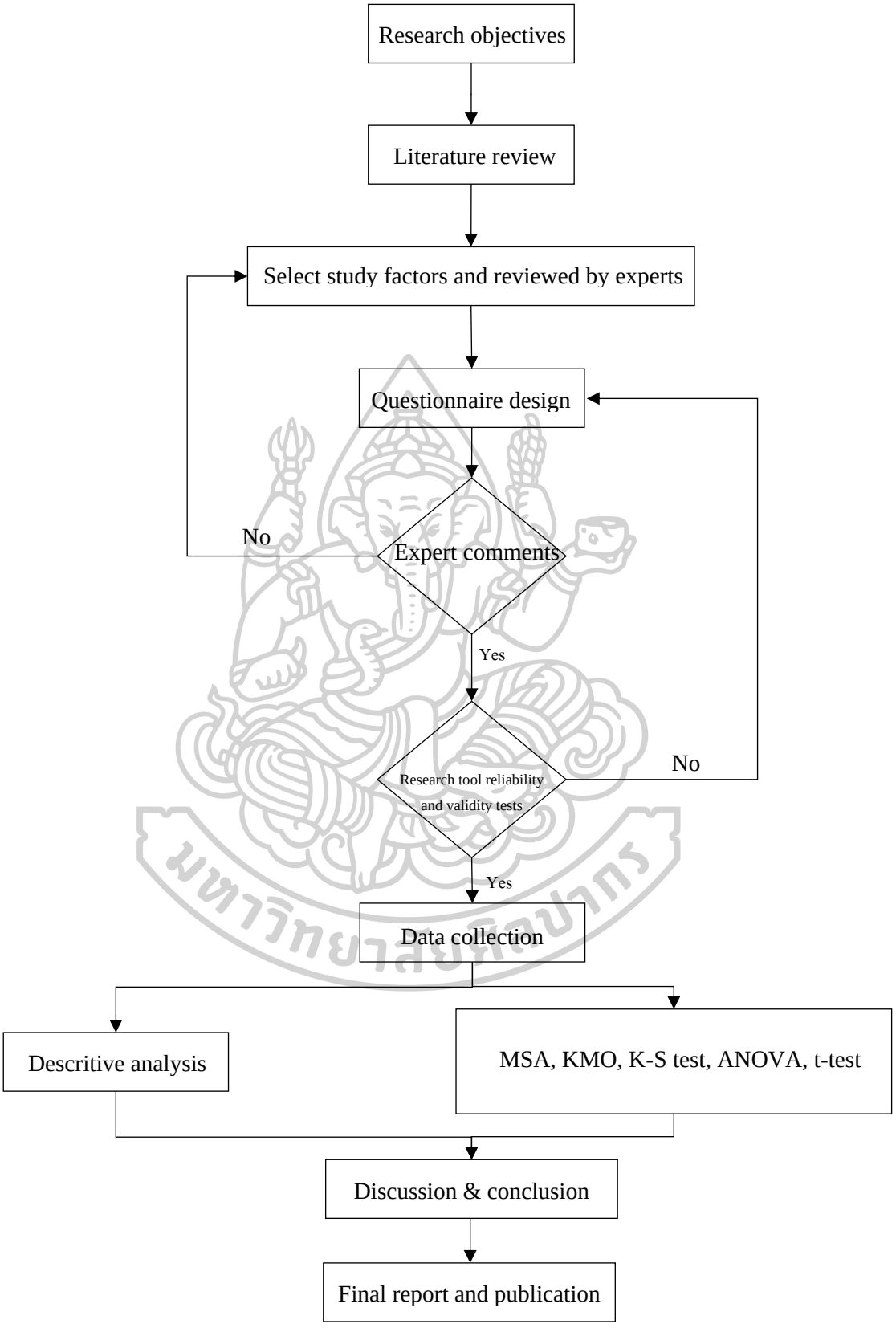

Figure 3.1 Research process flowchart

CHAPTER 4
RESULTS

4.1 Demographic Data

There were 387 respondents in the data collection. It accounts for a 96.8% return rate, which is satisfactory. Figure 1 shows the demographic data of the respondents. From Fig. 4.1, most respondents are construction project managers. It accounts for 35.4% of all respondents. Engineers are the second number of respondents, 29.7%. The least respondents in this study were CEOs. It accounts for 3.4% or 13 respondents. Figure 4.2 illustrates the respondents' experience in the construction industry. Most of them have 1-3 years of experience. It accounts for 35.4%. The next is a group of 3-5 years. It accounts for 29.7% of all respondents. Interestingly, the 5-10 years of experience accounts for 20.4% of all respondents. It was 79 respondents for this study. That means the data tends to have a high reliability. Finally, Fig. 4.3 shows that most respondents hold an undergraduate degree, meaning they are highly educated employees, and the collected data are reliable.

In part 2 of the questionnaire, the respondents' opinions were collected. I need to test the data's reliability and validity. There are twenty variables within six categories affecting practitioner's sustainability practices. Normal distribution was tested through Kolmogorov-Smirnov (K-S) test at 95% confidence. The Kolmogorov-Smirnov statistics are non-significant (significance is > 0.05 in all variables), which indicates that they are normally distributed, see Table 4.1.

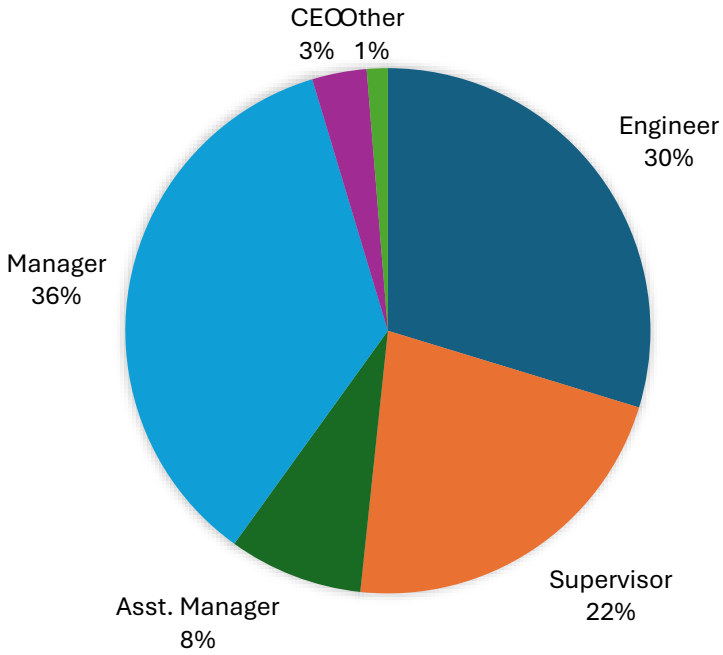

Figure 4.1 Respondents' job position.

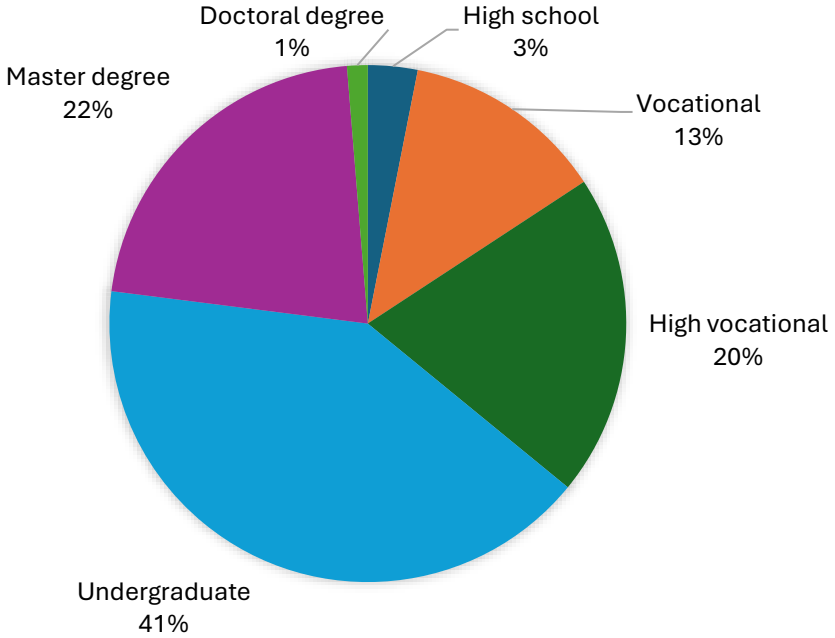

Figure 4.2 Respondents' education level.

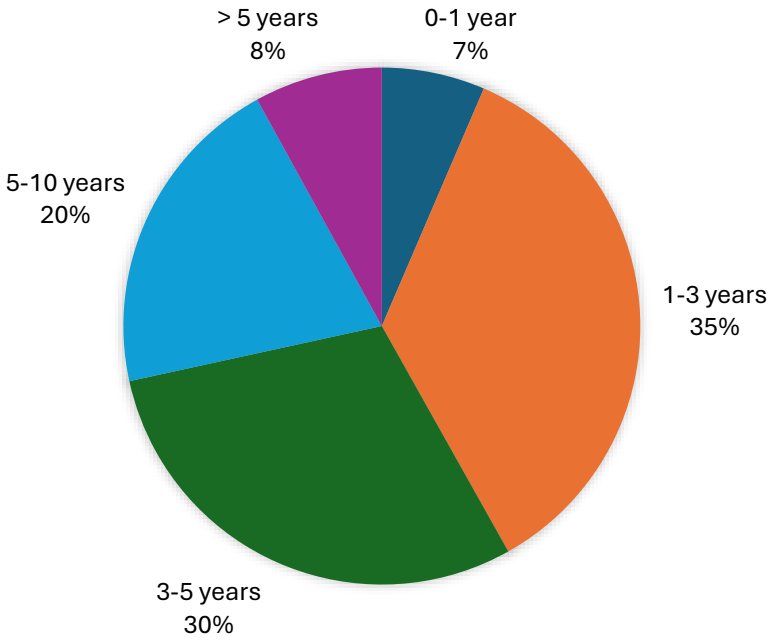

Figure 4.3 Respondents' experience.

4.2 Data Analysis

Table 4.1 shows the statistical data of the returned questionnaire. The questions are calculated as the mean and standard deviation. Furthermore, each category's mean and standard deviation are also determined.

Table 4.1 Test of normal distribution.

	The Kolmogorive-Smirnov test		
	Statistic	df	Sig.
Economic perspective	0.047	387	0.1
Awareness of sustainability	0.063	387	0.1
Stakeholder perspective	0.056	387	0.1
Policy and regulations	0.066	387	0.1
Operation management in SCP	0.083	387	0.1
Project management perspective	0.068	387	0.1

Table 4.2 Results and analysis of the collected data.

No.	Content	$\bar{x}$	Std.	No.	Content	$\bar{x}$	Std.
	Economic perspective	2.63	0.67		Policy and regulations	4.48	0.86
1	Sustainable construction investment is reasonable.	2.71	0.68	11	Sustainable regulations are necessary and guide the company's SCP.	4.35	0.92
2	The benefit-cost ratio of SCP is good.	2.43	0.45	12	Law enforcement of the local government is vital to SCP.	4.46	0.74
3	There are intangible benefits from SCP, such as the gain of goodwill.	2.76	0.23	13	Government incentive influences SCP.	4.63	0.58
	Awareness of sustainability	4.29	0.86		Operation management in SCP	3.48	0.96
4	Customers and the market are the most important to green building and sustainable construction.	4.23	1.07	14	Guidance, code, and standard from a third party is necessary for SCP.	3.91	0.79
5	The customers need to be educated in green and sustainable building.	4.41	0.54	15	An internal audit for SCP at the operational level is needed.	3.69	0.77
6	The green culture influences sustainable building and practice.	4.23	0.63	16	Current performance index is enough for SCP.	3.01	1.23

Table 4.4.2 Experts' recommendations.

No.	Content	$\bar{x}$	Std.	No.	Content	$\bar{x}$	Std.
Stakeholder perspective		3.91	0.94	17	The performance measurement needs to be improved for SCP.	3.32	0.88
7	Shareholder or state (in case state-owned company) support is important for SCP.	4.56	0.89	Project management perspective		4.36	0.84
8	Local government support is important for SCP.	4.21	0.39	18	The company need to be modified its organization to implement SCP.	4.76	0.54
9	Financial institution support is important for SCP.	3.69	1.02	19	The procurement must be reviewed rigorously to implement SCP.	4.12	0.67
10	Top-management support is important for SCP.	3.17	1.23	20	The self-monitoring about SCP needs to be created.	4.21	0.88

From Table 4.2, the most critical factor is the policy and regulations. Specifically, the government incentive has the highest score in this category. It means that the initiative of Kunming's sustainable construction practice is the government incentive in terms of tax and benefits for sustainable construction projects. The second tier is project management. It implies that the management level significantly impacts sustainable practice construction. A factor that should be ignored in this study is the awareness of the customers. Sustainable construction projects usually have a higher cost than conventional construction projects. Customers and the market are one of the drivers in this phenomenon; without the support of customers, the green building and sustainable construction project could not be successful. To this point, the researcher needs to ensure that the scores regarding statistics are significantly different. Thus, a two-way ANOVA is deployed to test it.

Table 4.3 Analysis of variance (two-way)

Source	SS	df	MS	F	p
Between	959.41	5	191.88	292.54	0.0000
Error	1519.10	2316	0.66		
Total	2478.51	2321			

From Table 4.3, it makes sure that the factors are significantly different. That means a factor dominates other factors significantly. Accordingly, Policy and regulations, Project management, and Awareness of sustainability are in our attention. By considering the score of this factor, Policy and regulations are the most critical factors for adopting sustainable construction practices in a construction project in Kunming, with a score of 4.48. The next factor is Project management, which has a score of 4.36, and the last one is Awareness of sustainability, which has a score of 4.29.

However, it has yet to be made clear that the three factors are significantly different. Thus, the researcher would like to conduct a t-test between two samples. That is, it compares Policy and regulations, project management, and Awareness of sustainability.

Table 4.4 Two-sample t-test for Policy and regulations versus Project management.

	N	Mean	StDev	SE Mean
Policy and regulations	387	4.4800	0.8600	0.0437
Project management	387	4.3600	0.8400	0.0427
Estimate error for difference:	0.061			
95% CI for difference:	(-0.0001, 0.2401)			
T-test of difference = 1	T-value = 1.9637	P-value = 0.049	DF = 772	

Table 4.5 Two-sample t-test for Awareness of sustainability versus Project management.

	N	Mean	StDev	SE Mean
Awareness of sustainability	387	4.2900	0.8600	0.0437
Project management	387	4.3600	0.8400	0.0427
Estimate error for difference:	0.061			
95% CI for difference:	(-0.1901, 0.0501)			
T-test of difference = 0	T-value = 1.1455	P-value = 0.2524	DF = 772	

From Table 4.4, the Policy and regulations factor significantly differs from Project management with a p-value of 0.049 ($\alpha = 0.05$). However, the Project management factor is not significantly different from the Awareness of sustainability factor, with a p-value of 0.2524 ($\alpha = 0.05$), see Table 4.5.

4.2 Hypothesis Testing

The first hypothesis is about the opinion of respondents who are the level of CEO and managers which are grouped to Top management. There are 150 respondents.

H_0: Top management commitments are not promising relate with sustainable construction practices in Kunming construction projects.

H_1: Top management commitments are promising relate with sustainable construction practices in Kunming construction projects.

The score of twenty questions from Top management and other employees are shown in Table 4.6. The result of hypothesis testing is shown in Table 4.7.

Table 4.6 The score of Top management and other employees.

Group	*N*	Average	St.Dev.
Top management	150	3.99	0.342
Other employees	237	3.76	0.283

Table 4.7 Hypothesis 1 testing

Source	SS	df	MS	F	p
Between	4.45	1	4.45	47.91	0.0000
Error	35.73	385	0.09		
Total	40.17	386			

Table 4.7 shows that the Top management promising with the sustainable construction practice different from other employees significantly.

4.3 Research Questions

There are two research questions in this study.

Research Question 1: What are the factors forces developers to deploy sustainable construction practices in their construction operations?

Research Question 2: What are the function and capability of the factors in the implementation to sustainable construction practices?

By reviewing and analyzing parts II and III of the questionnaires, the researcher would like to conclude the opinions of 387 respondents. They are willing to implement sustainable construction practices in their construction projects. However, the most important factor is policy and regulations. This factor can make a difference to developers. Tax incentives can increase the return on investment in sustainable practices existing.

Furthermore, market trends and customer needs are vital factors that force developers to implement the SCP. However, policy and regulation are also risks for construction projects. The policy must be particular and stable, and the regulations must be transparent and reviewable. The regulations must consent to practice, and local government is the most critical factor.

Nevertheless, the developers need to be careful about customers' perceptions. Marketing and public communication must be cleared. Customers' education about green building must be promoted. The demand side plays a vital role in business and the economy. It is inevitable.

CHAPTER 5
CONCLUSION

This report has shown the research objectives and procedure that developed carefully in order to receive a meaningful result. This chapter conclude the result corresponding to this research

5.1 Conclusion

This study investigated the determinant factors of adopting sustainable construction practices in Kunming. There were 378 returned questionnaires out of 400 distributed questionnaires. It accounted for a 96.8% return rate, which was satisfied. Considering the demographics of the collected data made us confident with the data because of the thoughtful answers from qualified respondents. The analysis showed that Policy and regulations are the most critical factors influencing the adoption of sustainable construction practices. Additionally, Project management and Awareness of sustainability support sustainable construction practice. By considering the questions in Policy and regulations, the government incentive is the most substantial factor for adopting sustainable construction practice

5.2 Future Research

The researcher is interested in the economic perspective of sustainable construction practices. It is bold in terms of business. If the study quantifies the money term of sustainable construction practices in a construction project, promoting the sustainable construction industry is essential.

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APPENDIX

Appendix A

Questionnaire

Questionnaire

This form is the questionnaire for a research project of Ms. Duan Xiaomeng, a student in the Master Degree of Engineering Program in Engineering Management at Silpakorn University. The topic is "Sustainable practices of construction projects in Kunming, the People's Republic of China: an investigation."

There are three parts. The first part asks about the respondent's background in the construction industry. The second part asks the opinion about the factors that influence sustainable practice in the Kunming construction industry. It is a five-point Likert scale:

Score 1 means 'strongly disagree',

Score 2 means 'disagree',

Score 3 means 'neutral',

Score 4 means 'agree', and

A score of 5 means' strongly agree'.

The last part is an open question and the recommendation from the respondent about sustainable construction practices in Kunming.

Thank you very much for your cooperation. The data are kept secret and unopened to a third-party organization. The purpose of this study is academic only.

Part I:

No.	Question	Answer
Q1.1	Do your construction project is in Kunming?	□ Yes □ No
Q1.2	Do your construction project is practicing in sustainable construction?	□ Yes □ No
Q1.3	How many employees in your construction site?	…….employees
Q1.4	Is your construction project state-owned?	□ Yes □ No
Q1.5	What is your position in the construction project?	□ Engineer □ Supervisor □ Asst. Manager □ Manager □ CEO □ Other……
Q1.6	How long you have been working in construction industry?	□ 0-1 year □ 1-3 years □ 3-5 years □ 5-10 years □ More than 10 years
Q1.7	What is your education level?	□ High school □ Vocational □ Higher vocational □ Undergraduate □ Master degree □ Doctoral degree
Q1.8	What is your education major?	…….

Part II: Please read the questions carefully and then select the score based on your opinion. Note that SCP means sustainable construction practice.

No.	Question	Score				
		1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Economic perspective						
Q2.1	Sustainable construction investment is reasonable.					
Q2.2	The benefit-cost ratio of SCP is good.					
Q2.3	There are intangible benefits from SCP, such as the gain of goodwill.					
Awareness of sustainability						
Q2.4	Customers and the market are the most important to green building and sustainable construction.					
Q2.5	The customers need to be educated in green and sustainable building.					
Q2.6	The green culture influences sustainable building and practice.					
Stakeholder perspective						
Q2.7	Shareholder or state (in case state-owned company) support is important for SCP.					

No.	Question	Score				
		1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Q2.8	Local government support is important for SCP.					
Q2.9	Financial institution support is important for SCP.					
Q2.10	Top-management support is important for SCP.					
Policy and regulations						
Q2.11	Sustainable regulations are necessary and guide the company's SCP.					
Q2.12	Law enforcement of the local government is vital to SCP.					
Q2.13	Government incentive influences SCP.					
Operation management in SCP						
Q2.14	Guidance, code, and standard from a third party is necessary for SCP.					
Q2.15	An internal audit for SCP at the operational level is needed.					
Q2.16	Current performance index is enough for SCP.					

No.	Question	Score				
		1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Q2.17	The performance measurement needs to be improved for SCP.					
Project management perspective						
Q2.18	The company need to be modified its organization to implement SCP.					
Q2.19	The procurement must be reviewed rigorously to implement SCP.					
Q2.20	The self-monitoring about SCP need to be created.					

Part III:

Q3.1 Do you think you can implement SCP in your construction project?

……

……

……

Q3.2 What benefits will your company receive from SCP?

……

……

……

Q3.3 Are there risk to implement SCP in your construction project?

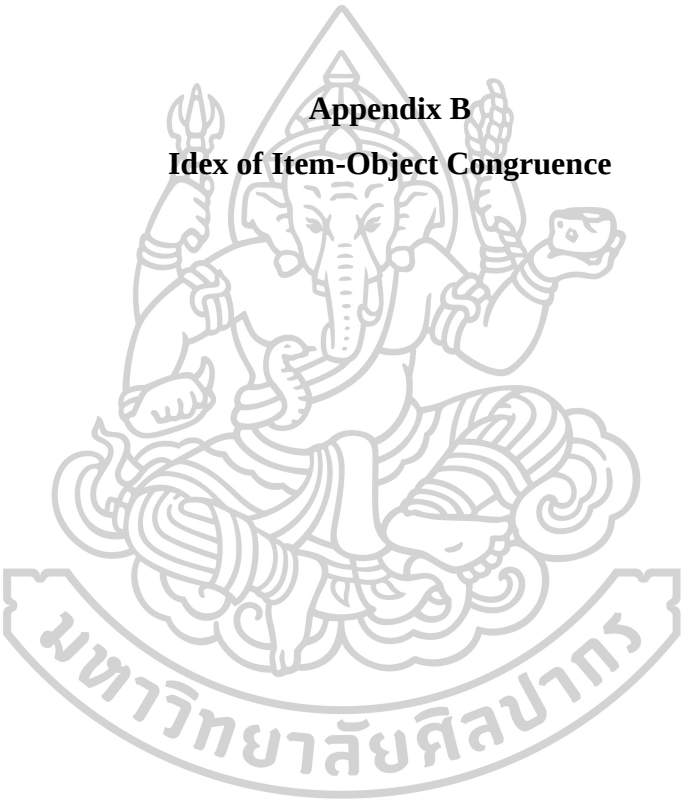
……

……

……

Appendix B

Idex of Item-Object Congruence



No.	Question	-1	0	+1	Total	IOC	Result
Q2.1	Sustainable construction investment is reasonable.	0	0	3	3	1.00	OK
Q2.2	The benefit-cost ratio of SCP is good.	0	1	2	2	0.67	OK
Q2.3	There are intangible benefits from SCP, such as the gain of goodwill.	0	0	3	3	1.00	OK
Q2.4	Customers and the market are the most important to green building and sustainable construction.	0	0	3	3	1.00	OK
Q2.5	The customers need to be educated in green and sustainable building.	0	0	3	3	1.00	OK
Q2.6	The green culture influences sustainable building and practice.	0	0	3	3	1.00	OK
Q2.7	Shareholder or state (in case state-owned company) support is important for SCP.	0	0	3	3	1.00	OK
Q2.8	Local government support is important for SCP.	0	1	2	2	0.67	OK
Q2.9	Financial institution support is important for SCP.	0	0	3	3	1.00	OK
Q2.10	Top-management support is important for SCP.	0	0	3	3	1.00	OK
Q2.11	Sustainable regulations are necessary and guide the company's SCP.	0	0	3	3	1.00	OK
Q2.12	Law enforcement of the local government is vital to SCP.	0	0	3	3	1.00	OK
Q2.13	Government incentive influences SCP.	0	1	2	2	0.67	OK

No.	Question	-1	0	+1	Total	IOC	Result
Q2.14	Guidance, code, and standard from a third party is necessary for SCP.	0	0	3	3	1.00	OK
Q2.15	An internal audit for SCP at the operational level is needed.	0	0	3	3	1.00	OK
Q2.16	Current performance index is enough for SCP.	0	0	3	3	1.00	OK
Q2.17	The performance measurement needs to be improved for SCP.	0	1	2	2	0.67	OK
Q2.18	The company need to be modified its organization to implement SCP.	0	0	3	3	1.00	OK
Q2.19	The procurement must be reviewed rigorously to implement SCP.	0	1	2	2	0.67	OK
Q2.20	The self-monitoring about SCP needs to be created.	0	1	2	2	0.67	OK

VITA

NAME Duan XIAOMENG