GREEN PROCUREMENT IN CONSTRUCTION PROJECTS: CONCEPTS, PRACTICES, AND EMPIRICAL STUDY IN KUNMING, THE PEOPLE'S REPUBLIC OF CHINA

By

Mrs. Tan Xiu XIU

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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This research investigates practical factors of green procurement of construction projects in Kunming. Green construction could only happen with good green procurement practices. Thus, an empirical study was initiated to investigate this knowledge. A questionnaire with 20 questions was designed and tested using the item-objective congruence (IOC) index. The twenty questions were divided into four-factor categories: cost, supply side, demand side, management and risk, and trend, regulations, and laws. There were 317 respondents out of 400 distributed questionnaires. It accounted for a 79.25% return rate. The results showed that cost and supply side are the most important for green procurement. Undoubtedly, abundant low-price green materials could make green procurement exist. The trends, regulations, and laws are essential, while the demand side, management, and risk factors are important. Five interview questions were also asked of thirty interviewees who are working on construction projects. Their answers shape the concept, definition, required technologies, and impacts of green procurement in construction projects interestingly.

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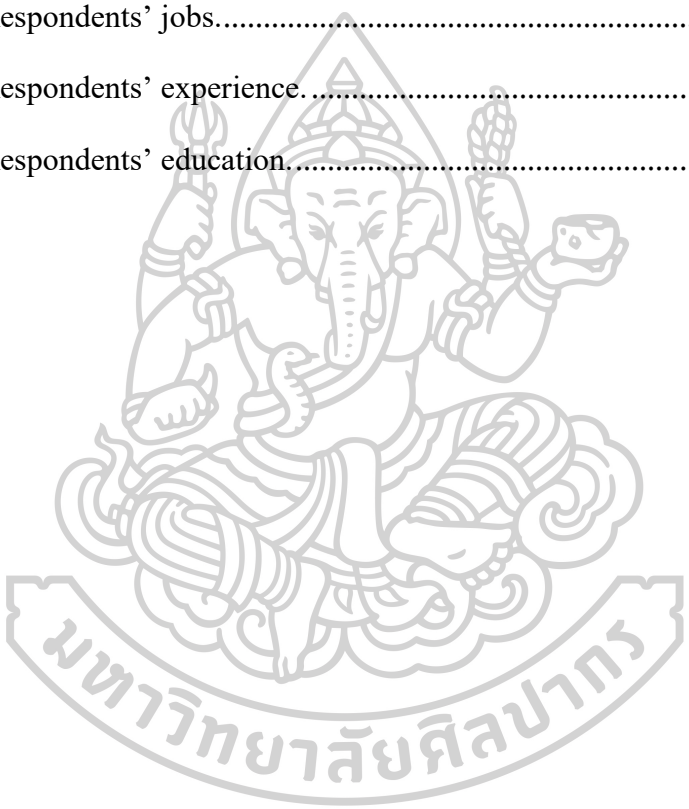

CHAPTER 1

INTRODUCTION

1.1 Motivation

With global warming reaching alarming levels, the imperative call for conserving scarce resources and sustaining a sustainable environment has compelled governments and corporations worldwide to implement environmentally promising practices and products (Khan & Qianli, 2017). With its consumption of vast quantities of non-renewable resources and materials, especially in new construction, the industry significantly affects the environment (Wong et al., 2016). This is because construction activities, which include manufacturing and transporting building materials, consume vast amounts of energy, resulting in the emission of large quantities of greenhouse gases (GHG). Consequently, it should be no surprise that the construction industry is crucial in realizing a low-carbon society.

Inevitably, the quality of living for individuals has been dramatically improved thanks to the construction sector. However, environmental issues affect the entire world as the building sector and its products grow (Shurrab et al., 2019). According to estimates from the Copenhagen Resource Institute (2014), the worldwide building sector is responsible for 40% of energy use, 30% of CO_2 emissions, and 40% of all solid production waste. Therefore, significant changes are required to do more with less to support the world population. Changes in construction are essential since the built environment is a crucial part of society. Utilizing highly renewable resources is the first step. A key area to adopt sustainable changes is the design and construction of buildings and other facilities because the construction sector frequently uses several types and large quantities of materials. Improvements in material design and building techniques are among the crucial success elements for construction projects.

One of the vital operations in construction projects is the procurement operation. It is the bridge phase in three main phases of construction projects: the engineering phase, the procurement phase, and the construction phase (EPC) (Habibi et al., 2018). Accordingly, putting the green concept into the procurement phase has a

positive environmental impact. This research aims to portray the green procurement of construction projects in Kunming, the People's Republic of China, and look into the green procurement factors in the same context.

1.2 Research Objectives

1 . To investigate the practical factors of green procurement of construction projects in Kunming, the People's Republic of China.

2 . To provide the concepts and the practices of green procurement of construction projects in Kunming, the People's Republic of China.

1.3 Research Contributions

1. Fulfilling the knowledge gap among concepts, frameworks, and practices of green procurement in the construction industry.

2 . Report the situation of green procurement in construction projects in Kunming, the People's Republic of China.

3. Illustrate the study model for other areas of green procurement.

1.4 Scope and Limitations

1. The study area is Kunming, the capital city of Yunnan province, the People's Republic of China.

2. The duration of data collection is between the last week of October 2023 to the last week of November 2023.

3. This study is the survey research and uses statistical tools for data analysis. There is no guarantee for other study areas.

1.5 Acronyms

CO_2	Carbon dioxide
CSR	Corporate social responsibility
ERO	Environmentally responsible operation
EMS	Environment management system
EPC	Engineering, procurement, and construction
GBI	Green building index
GGP	Government green procurement
GHG	Greenhouse gas
ISO	International organization for standardization
LCA	Life cycle analysis / Life cycle assessment
LPI	Lead performance indicator
NO_2	Nitrogen dioxide
PMBOK	Project management body of knowledge
RFP	Request for proposal
RFQ	Request for quote
RIV	Relative importance value
SCM	Supply chain management
SDV	Standard deviation value
UNEP	United Nations environment program

1.6 Glossary

Green building a structure and the application of environmentally responsible and resource-efficient processes throughout a building's lifecycle.

Green construction constructions focus on reducing water, energy, and materials after the building is built. It also uses intelligent energy-saving technology to build zero-energy homes with fewer greenhouse gases impacting the environment.

Green procurement purchasing products and services that cause minimal adverse environmental impacts. It incorporates human health and environmental concerns into the search for high-quality products and services at competitive prices.

Project management body of knowledge a set of standard terminology and guidelines for project management.

CHAPTER 2
LITERATURE REVIEW

This chapter details the fundamental theories and concepts of the construction industry's environmental impacts. The procurement of the construction industry is also described. The critical parts of this chapter are the details of green procurement in the construction industry and the factors that influence green procurement. The rest of this chapter is organized as follows. Section 2.1 introduces the relationship between the construction industry and the environment. The procurement operation in construction projects is explained in section 2.2. Then, section 2.3 explicates green procurement concepts and practices in the literature. Section 2.4 concludes the factors that persuade firms to implement the green procurement in construction projects. The conclusions of this chapter are drawn in Section 2.5.

2.1 Construction Industry and Environments

Any nation's social and economic values are enhanced through the construction sector. It encourages the fulfillment of basic demands for habitation, infrastructure development, and employment creation (Khahro et al., 2021). However, because of the numerous issues, this sector has created, critics express their unhappiness. The ecology and natural resources are reportedly impacted. The increased emissions of greenhouse gases (GHG) brought on by construction projects are one of the critical issues. Since the building sector relies on non-renewable resources, a various raw materials have a substantial environmental impact (Khan et al., 2018).

The worldwide construction industry is predicted to increase at a compound annual growth rate (CAGR) of 4.2% from 2018 to 2023, reaching an estimated $10.5 trillion, according to the study Growth Opportunities in the Worldwide Construction Industry (Markets, 2018). The global economy depends heavily on the building sector. According to studies conducted in developed nations, the building industry has used between 30 and 40 percent of its natural resources; 50 percent of the energy was used for heating and cooling buildings, and about 40 percent of the materials

consumed globally were adapted for the building environment, and 30 percent of the energy was consumed for operational needs (Isa et al., 2021).

Given that the building business contributes significantly to the depletion of non-renewable resources, the construction industry and sustainable development challenges are closely intertwined. Brundtland (1987) defined sustainable development as "development that satisfies present needs without compromising the ability of future generations to meet their own needs." According to the Brundtland Report's concept of sustainable development, many experts concur that construction procurement is crucial for addressing environmental challenges in the building sector. Buying products and services from a third party is referred to as procurement. Outsourcing and purchase are other phrases. One of the essential aspects in determining a project's success or failure is procurement management; according to the vast majority of people (87%), a successful project is inextricably linked to excellent procurement (Chartered Institute of Building, 2010).

According to the Willmott Dixon firm (2010), building is one of the least sustainable sectors in the world since it uses around half of all non-renewable resources that humans use. Nevertheless, since humankind has spent most of its time altering the natural environment to suit its needs better, our daily activities now occur in or on constructions of all shapes and sizes. For example, we live in houses, travel on roads, and work and socialize in various structures. Buildings and their contents are essential to modern human civilization, yet the resource consumption they now involve is beyond the capacity of our planet.

Cities and buildings have lengthy lifespans, and their effects will be felt far into the lives of many generations to come, and into a future with scarce resources, pollution, and uncertain climatic conditions. Something must change for the sake of the environment, the world’s survival, countless interconnected and interdependent ecosystems, and humankind. Construction businesses have a crucial role to play in this shift.

However, that tells a portion of the tale. We develop structures that produce riches. Buildings account for half of all fixed capital creation each year, and when combined with inherited building assets, they account for around 75% of all UK

wealth. A building's ability to meet human demands, adapt to changing environmental circumstances, and endure changing standards of architectural excellence all have a role in its long-term asset value.

Buildings that are naturally lit and well-ventilated, that use alternative energy sources, and that are intended to provide consumers with attractive whole-life performance are more likely to be sound wealth investments than those that rely too heavily on fossil fuels or fail to recognize the universal need for a healthy and stimulating environment. Fig. 2.1 displays the typical proportion of economic costs for a commercial structure over 50 years.

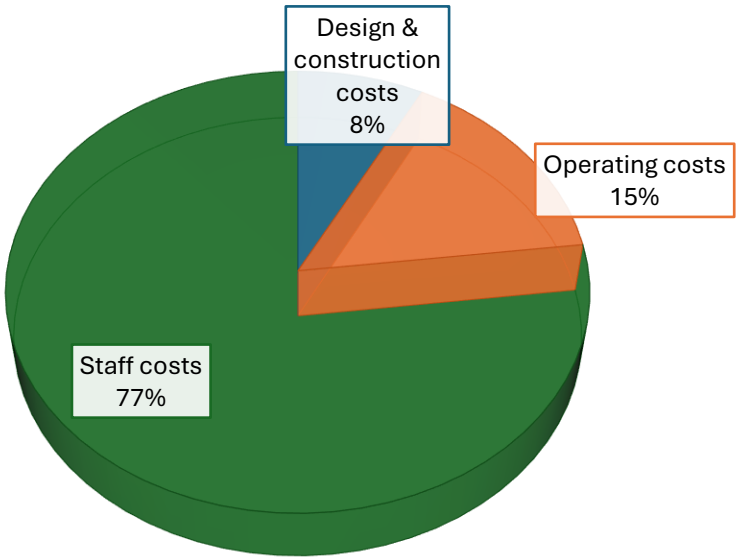

Figure 2.1 The typical proportion of economic costs of commercial building
Source: Willmott Dixon Company (2010)

Therefore, it is essential to address environmental concerns right away; else, our built-asset wealth will be seriously threatened. The following categories can be used to classify the primary effects of the creation and usage of our built environment:

2.1.1 Global resource used in construction

The earth has warmed by around $0.5^{O}C$ during the past 100 years (Lenzen & Treloar, 2002). There is compelling evidence that this results from rising levels of

specific trace greenhouse gases. Carbon dioxide is the main one, and it is created whenever fossil fuels are burned to produce energy. Over the past few decades, energy usage and the resulting carbon dioxide emissions have been proliferated globally. The industrialized nations are the primary clients since they enjoy living levels that are developing nations long. The results of the predicted continued expansion in energy use might be disastrous. The industrialized nations must increase their energy efficiency. About half of the energy used nationwide in the UK is tied to the construction industry. Carbon dioxide emissions from the manufacture of building materials, the building or structure's construction, and its occupants or users during its lifetime are all caused by energy supply from fossil fuels. Despite not being the most powerful, it is the one that is created the most considerable amounts of the so-called greenhouse gas variations in construction methods that may be necessary due to these climate variations.

The usage of resources by the building sector is evident. Materials come from various providers and sources, and reducing waste is a challenge. Although most sites utilize many of the same materials, the scattered development structure limits how much recycling can be done. Despite the extended product lives, their ultimate destruction or redevelopment might result in a substantial amount of garbage that must be disposed of on land if it is not reused.

Stone and primary aggregates comprise the most of the resources used in the construction industry in the UK. Sand and gravel extraction from these primary resources has a significant negative impact on the environment due to habitat and ecosystem loss, damage to the landscape, the possibility of subsidence issues, and the release of methane. Local authorities prohibit the issuance of extraction licenses due to noise, dust, and excessive traffic through inhabited areas. The same problems occur whether garbage is disposed of, processed, or recycled.

In addition to its direct energy use, construction also has a significant negative influence on the environment through the materials it utilizes. Transporting the substantial amount of materials utilized requires much energy. When both direct use and embodied energy are considered, the construction industry consumes about 4.5% of the nation's total energy. As a result of this energy consumption, construction

produces more than 40 million tonnes of carbon dioxide, which causes the greenhouse effect and contributes to global warming (Lenzen & Treloar, 2002). In addition, the creation of acid gases and nitrogen dioxides (NO_2) contributes to acid rain and photochemical smog formation.

The connections between water and energy are slowly coming into greater focus. Water is essential for the cooling process involved in energy production, and power outages have previously occurred when nuclear power plants had to be shut down due to droughts. The UK water sector is responsible for around 1% of the country's CO_2 emissions, and processing and pumping drinking and wastewater consume significant energy. Domestic water heating accounts for 25% of household energy costs and 5% of UK CO_2 emissions in our homes. Using various techniques, building a house uses roughly 6 million liters of water (McCormack et al., 2007).

Large amounts of garbage are created during construction, but notably at the conclusion of a building's useful life. The construction process itself also produces a substantial amount of garbage. Many of these losses may be prevented on-site. However, other factors, such as neglecting design details, using the wrong material or dimensions, making late changes, placing excessive orders, etc., can cause waste. The specific global resources employed in construction are detailed in Table 2.1.

Table 2.1 Estimate of global resources used in buildings

Resources	Percentage
Energy	45-50
Water	50
Materials for buildings and roads (by bulk)	60
Agricultural land loss to buildings	80
Timber products for construction	60 (90% of hardwoods)
Coral reef destruction	50 (indirect)
Rainforest destruction	25 (indirect)

Source: Willmott Dixon Company (2010).

2.1.2 Pollution generating

There are many different types of pollution, including those that result from the built environment (sewage, waste, etc.), pollution created during the production of materials and goods, hazards created during the handling and use of materials or on the construction site, and other operations and construction-related activities. The specification of materials and the utilization of equipment, systems, and methods, occur during the design and construction phases. Whether in undeveloped or already developed locations, the majority also involve significant environmental impacts.

Each of these actions runs the danger of contaminating the area, which might impact on the nearby community, the personnel at the site, or the surrounding ground, water, and air quality. Similar effects may manifest during the development's operational phase. These perturbations run the danger of introducing pollutants and upsetting the balance between the earth, water, and air.

Humans spend around 90% of their lives inside buildings in the developed world (Clements-Croome, 2006). They come into contact with a variety of chemicals from coatings and furniture. Their physiological and psychological responses are also impacted by other practices that take place in the building. Building layout and design are becoming essential factors in maintaining circumstances that assure its residents' health and general well-being.

Because the impacts of a flawed internal environment are long-lasting and, with a few notable exceptions, rarely instantly fatal, they frequently need to be addressed. Furthermore, the reasons have not yet been discovered with certainty, making it difficult to find remedies. One effect of this in the UK is the need for more time to take the problem seriously. Since musch study has been done, the causes are ambiguous, and there is not much quantitative information accessible. The construction industry's contribution to global pollution is estimated in Table 2.2.

Table 2.2 Estimate of global pollution attributed to buildings

Pollution	Percentage
Air quality (cities)	23
Climate change gases	50
Drinking water pollution	40
Landfill waste	50
Ozone depletion	50

Source: Willmott Dixon Company (2010).

2.1.3 Conclusion of constructions and environments

In this section, the construction industry inevitably affects the environment directly and indirectly. The habitat and other edifices of humankind are in the form of buildings. The buildings required both non-renewable resources and renewable resources. Additionally, construction activities yield significant adverse impacts on the earth: air, water, noise, and debris pollution. More negative impacts that cannot draw in this limited report, such as biodiversity, health control, and climate change. Thus, the construction industry must be carefully studied to finde how to make it sustainable for the next generations.

2.2 Procurement in Construction Industry

2.2.1 Construction management

Construction management professionals agree that a project is successful if it is finished on time, on budget, meets quality requirements, and has high customer satisfaction. Fulfilling these requirements has been linked to the issue of building procurement techniques more and more. In other words, the approach might influence the project's success (Naoum & Egbu, 2015).

The issues that the building process is currently facing can be grouped into seven categories: (1) separation of design and construction; (2) lack of integration; (3) ineffective communication; (4) uncertainty; (5) changing environmental conditions; (6) shifting client priorities and expectations; and (7) growing project complexity.

Construction professionals and the industry now provide alternate building procurement strategies such as design and build, managed-to-contract, and construction project management due to these, as well as economic developments (such as inflation and recession).

Barnes (1988) defined construction project management as "… is to produce a completed project which complies with the client's objectives." Generally, a client always focuses on three accurate dimensions, as shown in Fig. 2.2.

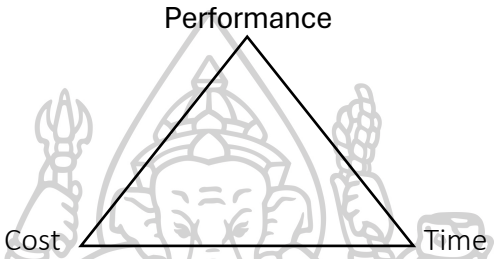

Figure 2.2 The client's objectives

Source: Barnes (1988)

The construction project management can be divided into three parts: 1) controlling performance cost and time, 2) the management task at the briefing, design, construction, and commissioning stages, and 3) organization to achieve control; the role of the contract. They are briefly described in this subsection.

Part 1) Controlling performance cost and time: It comprises cost control, cost recording, cost forecasting, early warning and early decision, time and quality control, float control, and quality management.

Part 2) The management task at the briefing, design, construction, and commissioning stages: It comprises design stage management, design control, financial control, and policy for dealing with new instructions and unexpected events.

Part 3) Organization to achieve control: The role of the contract: it is comprised of management strategy, project management organizing, contract management, and risk allocation.

Demirkesen and Ozorhon (2017) explained the main knowledge areas of the project management body of knowledge (PMBOK) guide, which are listed below.

1. Project Integration Management: the procedures and actions necessary to recognize, categorize, assemble, unify, and coordinate the numerous procedures and project management tasks inside the project management process groups.

2. Project Scope Management: the procedures to guarantee that the project contains all work necessary—and only that work—to effectively finish the project.

3. Project Schedule Management: the procedures necessary to ensure that the project is finished on schedule. The procedure was calles “Project Time Management” until the PMBK Guide’s 6th edition.

4. Project Cost Management: the procedures used to plan, estimate, budget, finance, fund, management, and control expenses to finish the project within the allocated budget.

5. Project Quality Management: the executing organization’s procedures and actions to establish quality standards, goals, and obligations for the project to meet the purposes for which it was undertaken.

6. Project Resource Management: it is the procedure for leading, organizing, and managing the project team. This procedure was referred to as "Project Human Resource Management" up to the PMBOK Guide's 6th edition.

7. Project Communications Management: the procedures necessary to guarantee that information about a project is planned, created, distributed, stored, retrieved, managed, controlled, monitored, and ultimately disposed of in a timely and suitable manner.

8. Project Risk Management is the process of identifying, analyzing, preparing for responses to risks, and controlling such risks on a project.

9. Project Procurement Management: the procedures required to get required goods, services, or outcomes from sources outside the project team. Procurement Planning, Solicitation Planning, Solicitation, Source Selection, Contract Administration, and Contract Closeout are processes in this domain.

10. Project Stakeholder Engagement: the procedures necessary to identify every individual or group affected by the project, to assess stakeholder expectations

and their influence on the project, and to develop the necessary management strategies for successfully involving stakeholders in project planning and execution.

One of the ten knowledge areas above is project procurement management. It manages and optimizes a project's budget for the goods, services, and resources needed to complete our project. Managing the procurement process is a crucial first step in developing a worthwhile project. The project manager sets up and arranges the infrastructure, tools, and supplies the team will require to complete the specified tasks during this project phase.

The simple procurement plan can be explained as 1) Choosing the best partnerships and contracting strategies for each purchased product or outsourced service, 2) Creating requests for quotations (RFQs) and requests for proposals (RFPs) and assessing partnership prospects, and 3) Choosing the right partnerships and contracting strategies. 3) Assessing requests for proposals, requests for proposals, and partnerships; 4) Awarding and signing contracts; 5) Managing quality and timely performance; 6) Managing contract amendments; and 7) Closing contracts.

Bower (2003) reported that any country's economic progress largely dependes on the building sector's development. For instance, construction is one of the foundations of the domestic economy in the UK. Murray (2008) estimated that the industry would likely contribute 10% of the nation's yearly gross domestic product (GDP) in 1998. Additionally, 6.4% of the labor force is employed there.

The construction business is a significant and highly diversified area of economic activity, encompassing anything from the construction of massive power plants to the construction of massive homes and other buildings to the small-scale refurbishment or repair of existing facilities. Construction companies make up 50% of all registered businesses in the UK, making it the most important industrial sector by a factor of three over agriculture. The UK construction sector employs some foreign labor and earns millions of pounds abroad.

A typical construction project goes through several stages, from conception to completion and commissioning. The project as a whole solely includes the building phase. Therefore, it is vital to acknowledge the networks of internal and external contacts when managing building projects.

The foundation of managing engineering is the project contracts. In order to achieve an appropriate distribution of risks and duties, the kind of contract strategy adopted must consider the project objectives and the characteristics of the parties to the contract. A contract's primary goal is to expressly lay out the risks connected to the project and how they will be distributed throughout the project's life, not only during the design and construction phases. The customer determines the contract strategy, taking into account the goals and responsibilities of the project team members. The accomplishment of the client's objectives should be the primary purpose of a contract strategy. It may be achieved by utilizing the following:

1) client participation

2) enabling for adjustments

3) contractors' inspiration

4) the ideal risk-sharing

5) the client's and the contractors' cash flow.

During the contract selection process, careful planning is crucial. The factors that have a role in the client's choice to hire a contractor for a project must be carefully considered. Then, these factors need to be ranked in terms of significance. Smith (2002) outlined a few criteria clients consider when hiring contractors for a project. The customer wants to utilize the contractors' abilities and persuade them to assume certain project risks. A project's best contract strategy must be determined after an organized, thorough, and practical review of all pertinent aspects (i.e., all accessible possibilities). The following factors influence the choice of a contract strategy:

1) the client's clearly stated project objectives

2) the contract's obligations, which must be clearly stated

3) the risk allocation between the parties

4) the payment mechanism

5) the incentive mechanism to ensure a competent performance from the contractor

6) the client's motivation to provide the necessary data and support to the contractor

7) the client's ability to make changes methodically

2.2.2 Procurement in construction projects

Contrary to other product procurement, construction procurement is distinct. According to Ruparathna & Hewage (2015), construction procurement is the "process of acquiring goods and services to realize a constructed facility in accordance with predefined requirements." Any infrastructure development will include central procurement since it will impact on the entire project's success (Love et al., 1998).

Dimitri et al. (2006) stated that procurement is a significant portion of all economic activities. In the EU, public procurement transactions account for around 16% of GDP, but in the US, they account for nearly 20%. Due to the trend of outsourcing all non-core corporate operations, transaction values in the private sector are considerably higher and growing constantly.

Therefore, effective procurement is essential for businesses to be profitable and survive, and for the public sector to be successfully get funds for social expenditures and reduce taxes. In the short and long terms, procurement design directly and significantly impacts how well firms and nations perform. In the short term, procurement design most obviously does this by immediately determining the costs and quality of inputs in the private or public supply chains; in the long term, procurement design most importantly does this by influencing suppliers' and, more broadly, firms', incentives to invest in R&D and to innovate generally.

Love et al. (1998) defined "a procurement system as an organizational system that assigns specific responsibilities and authorities to people and organizations and defines the relationships of the various elements in the construction of a project."

Naoum (2011) delineated "procurement is a mechanism for linking and coordinating members of the building team throughout the building process in a unique systematic structure, both functionally and contractually. Functionally via roles, authority, power, and contractually via responsibilities and risks. The main aim

is to deliver a project that meets its objectives and meets client criteria and expectations."

Masterman (2003) concluded, "the procurement process is a strategy to satisfy client's development and operational needs with respect to the provision of constructed facilities for a discrete life cycle." The author also presented that "a procurement system is an organizational structure adopted by the client for the implementation and, at times, eventual operation of a project."

Four conventional ways for categorizing the procurement system are as follows (Masterman, 2003).

1) Construction projects involve varying degrees of risk, some of which is covered by statutory liability, some of which is covered by insurance, and the remainder, which is frequently referred to as speculative risk, is apportioned within the pre-contract documentation to the most appropriate party. However, grouping things according to risk level—high, medium, or low—does little to educate the decision-maker on the critical distinctions between the various systems.

2) The amount of time needed between the completion of the design and the start of construction is determined by the level of information available or required at the time construction contracts are let. It always has interested clients, especially those eager to get to work on-site, because it directly affects how quickly the project can be physically started. However, any classifications using this standard is probably one-sided and deceptive to the decision-maker.

3) Due to the fact that many procurement systems let reimbursement be conducted in the same manner, basing the categorization on how the contractor gets paid is deemed incorrect because it would not help distinguish the various systems.

4) This method enables the fundamental problems of the relationship between the major project elements to be identified from the categorization while ensuring recognition of those procurement systems contained within each category. It is done by how the interaction between the design and construction, and occasionally the funding and operation of the project are managed.

2.3 Green Procurement

Green procurement refers to purchasing with an eye on environmental impacts. The word "green" refers to acknowledging, incorporating, and applying environmental practices, initiatives, or systems that aim to reduce environmental impacts throughout their lifecycles (Albino et al., 2009). When a company engages in green procurement for a construction project, it implies that it is accountable for reducing the environmental effect of its actions at all project phases.

Green purchasing is defined as the "affirmative selection and acquisition of products and services that most effectively minimize negative environmental impacts over their life cycle of manufacturing, transportation, use, and recycling or disposal" (Dubey et al., 2013). The attributes that products and services must possess are the ability to conserve energy and water, minimize refuse generation and pollutant emissions, and be recyclable.

In other words, when making procurement decisions, the environmental aspect is considered alongside other dimensions such as quality, cost, delivery, technology, service, and other variables of strategic importance (O'Connor et al., 2011). The ultimate objective is to reduce environmental impacts associated with procurement and improve resource efficiency.

2.3.1 Green procurement in construction projects

Bohari and Xia (2015) stated that in its simplest form, procurement refers to purchasing operations; nevertheless, procurement for buildings differs from procurement for items. The process of procuring commodities and services for the realization of a constructed facility in accordance with predetermined specifications is known as construction procurement. Any infrastructure development must include procurement since it affects the project’s success.

Construction procurement is a vital tool for managing environmental issues in construction projects. Green procurement refers to purchasing that considers environmental implications. According to Albino et al. (2009), the word "green" in this study refers to the recognition, integration, and application of environmental practices, initiatives, or systems intended to minimize environmental consequences throughout their lifespan. When an organization engages in green procurement for a

construction project, it makes a commitment to minimizing the environmental impact of its actions at all project stages.

It is well known that various organizations have varying perspectives on what it means to be green and sustainable (Shelbourn et al., 2006). All three authors—Mosgaard (2015), Fischer (2010), and Omran (2009)—agreed that these words have been used synonymously and promoted under many labels, including "energy-efficient" and "low carbon." However, regardless of the terminology, the objectives—which are to develop ecologically friendly goods and services—remain the same.

Khan et al. (2018) stated that “green procurement is the acquisition of “products or services which minimize or provide positive environmental impacts” through the factoring of “environmental concerns into major purchasing strategies, policies, and directives.” Green procurement combines economic and quality factors with environmental considerations in the purchase process. For instance, green procurement entails the acquisition of environmentally friendly equipment, supplies, and services for improved water, energy, waste, and material management in municipal structures, offices, workplaces, and fleets.

2.3.2 Benefits of green procurement implementation

Khan et al. (2018) also itemized the benefits of green procurement, as depicted below.

Environmental benefits: In comparison to other main polluting industries, the construction industry has the tremendous potential to reduce greenhouse gas emissions, according to the UNEP (2009). An environmental element is a means to choose more eco-friendly items or materials and to spread support for environmentally friendly design ideas like cradle-to-cradle. The construction sector may avoid any air pollution, water pollution, or even soil contamination by applying green procurement at the outset of a project. Understanding green procurement will enable stakeholders to manage chemicals and dangerous materials. This idea encourages the contractor to adhere to environmental rules and regulations while organizing raw materials; for example, it is crucial that purchases be made by buying lumber or timber products from lawfully harvested forests. It also considers how to manage forest operations sustainably to minimize any negative effects caused by

people. Due to the purchase of environmentally friendly materials like recycled steel and glass as well as renewable resources like rubber and bamboo, greenhouse gas emissions to the environment will be decreased. Additionally, by choosing more water-efficient fittings, water management has the benefit of reducing water use. Minimizing some emissions into the water, such as the chemical contamination of watercourses, also raises the water quality. Aside from that, a green building can use less energy than a typical structure does while also using less solid waste, drinkable water, and runoff into the sewage system. Installing energy-efficient windows and doors and a commercial solar panel system, which powers the building with renewable energy, are two methods to save energy.

Social benefits: Green purchasing is a technique to improve people's quality of life. Implementing green procurement decreases environmental harm, which lowers or minimizes the likelihood of accidents and thus lowers the cost of liability and safety and health insurance. For instance, it will result in a better and more comfortable working environment for the employees involved in green buildings, resulting in fewer incidences of headaches, asthma, and allergies. In order to provide a safer working environment, contractors should also cut back on using harmful chemicals. As a result, an organization can do away with the need for handling, storage, and disposal as well as the expense of reporting incidents. In addition, healthier communities and workplaces may result from improved air and water quality. Therefore, having good indoor air quality might increase employee productivity. In addition, using green procurement in building projects would encourage contractors to offer work of a higher caliber, and better performance to public authorities, eventually, the general public. Building green roof systems has several advantages, including managing rainwater, creating on-site gardens, and shielding the roof from the damaging effects of UV rays. It will offer a healthy lifestyle and environment. Additionally, boosting natural light can help customers reduce their long-term energy expenses. Suppliers' sustainability is essential to the construction sector. They can operate in a way that serves society by upholding moral standards, abiding by legal requirements, and taking steps to promote diversity, inclusivity, integration, equality, and regeneration. Last but not least, green procurement serves as a means of advancing the idea of environmental protection for people.

Economic benefits: Contractors have been able to conserve resources and money throughout the lifespan of their projects by implementing green procurement. The majority of money is saved on maintenance and utility bills by using green building techniques. It will encourage contractors to make better-informed purchasing decisions and to utilize environmentally friendly tools and raw materials. While using green procurement will save costs, such as those associated with waste and hazardous material management, it will also reduce the time and expense associated with reporting and follow-up. Contractors may, for instance, use less power during construction and materials that are simpler to recycle or reuse. Energy, water, fuel, and other resource conservation results in savings and, over time, can directly lower utility prices and project running expenses. Environmental procurement may also be advantageous to small and medium-sized businesses, giving them a chance to access new markets for their creative goods or solutions. In addition, using green procurement helps lower the cost of environmental technology. Green tendering requirements can change the market and open new opportunities for businesspeople to enter the environmental industry. As a result, it has the ability to increase market rivalry, innovation, and capacity while also enhancing supply chain efficiency. Additionally, being green may result in financial savings, mainly when new goods consume the least energy, produce less trash, and last longer. Even though certain items may cost more upfront, there will be more financial gain over the course of the product's whole existence.

Political benefits: The government is crucial in encouraging environmental protection and raising public awareness. The government was required to create a green building concept based on the 10th Malaysia Plan and Master Plan in order to protect natural resources and improve the quality of urban life for the populace. Private businesses use green procurement as a strategy to improve their standing for their social and environmental performance. It is because businesses have removed the harmful components from their goods. It immediately enhances supplier and contractor relationships' ability to work together to develop alternative goods. As a result, it will improve how the general public perceives the organizations. It will instantly raise consumer satisfaction levels and serve as a crucial element in maintaining client loyalty. Additionally, it will guide the contractor toward

sustainable resource usage. It is the duty of the government to convey to the populace the significance of green procurement in building projects. To create sustainable green procurement in the building industry, for instance, the government should offer incentives to builders, who are the significant beneficiaries of energy savings and worker productivity. The ideal strategy for the government to implement sustainability is, in summary, a mix of laws to force businesses and the market to practice sustainable development and an incentive package for construction firms who practice sustainability in their projects.

In conclusion, green procurement has many positive impacts from many perspectives. It promotes environmental sustainability, and quality of human life, saving costs and rising of public awareness. These are reasonable causes to implement green procurement in the construction industry.

2.4 Factors Influencing Green Procurement

Simion et al. (2019) proposed factors that empower green procurement in construction projects. There were 14 factors, and they can be grouped into five groups. The brief details are described as follows.

Group 1: There are three factors. First, the incentive from the government. Second, the legislation in the construction industry from the government. The last is the crushing from competitors and awareness of global trends.

Group 2: It is concerned with the efficiency of construction projects. The authors identified two factors for this. The higher energy efficiency in the stage of a construction project is the benefit of green procurement in construction projects. Another factor is the use of green building materials; it is also the benefit of green procurement because green material reduces waste and can be recycled.

Group 3: This group is about the internal forces and the international standards that a construction project must comply with. There are two factors. The first one is the internal pressures of management, and the second one is the ISO14000 certification which general construction projects must be certified.

Group 4: This group relates to the supply chain of building materials. It starts with the design phase regarding reuse, recycling, and recovery of materials and components. It also determines the supplier's willingness to participate in the construction green supply chain. Finally, these constituents affect construction waste reduction.

Group 5: This is the results of the first four groups above. It can reduce the life cycle cost of buildings and improve the company's image related to environmental protection.

Wong et al. (2016) conducted depth research on the factors that enable construction projects to implement green procurement. The authors divided respondents into four groups: developers, suppliers, consultants, and contractors. It is interesting. They should have called the customer's voice for this study since it is the most valuable group of stakeholders. Nevertheless, the rank of factors can show us the most important factors influencing green procurement in the construction industry. The report pointed out that the group of green principles and techniques to reduce environmental impacts is the most important group. It includes selecting green materials, adopting green procedures, performing assessments, and design on both products and services. The second group is the initiatives taken by industry and the community. It incorporates stakeholders such as companies, government, customer awareness, and global trends. The third group of factors is the commitments of management. This factor is the most important internal factor of a construction company. It comprises executive management commitments, corporate environment visions, internal-firm collaborations, and custermer needs tendering.

The fourth group is a mutual collaboration among stakeholders. It is abstract; however, it needs to be rendered factual for example, mutual understanding, mutual commitment, and mutual environmental policies on green procurement among construction firms, suppliers, contractors, government, and customers. The fifth group of factors relates to technical aspects. It is the structure of the database of green procurement. The stakeholders must adopt information sharing about green products and service specifications through the green supply chain. The government plays a major role in factors in the sixth group. It includes environmental regulation and

legislation, environmental standard establishment, and the standard of auditing, certifying, and tracking.

The seventh group focuses on the design phase. It must be thought about green the first time of EPC procedure. The design must specify reducing, reusing, and recycling recovering materials and energy of construction projects. The eighth group of factors identifies the excellent management practice in a company, such as organization, policy, training program, job descriptions, and incentive program. They must account for the green in their descriptions. The ninth group is about life-cycle assessment. The firm that wants to implement green procurement must understand the life-cycle of projects and their building. It guarantees not only the phase of construction but also the lifetime of the building. Finally, the tenth group is the support of mid-level management. It is essential to bridge between the operations and the management.

2.5 Conclusion

This chapter described the adverse impact of the construction industry on world environment. A construction project not only consumes non-renewable global resources but also releases pollution to the earth in various ways: air, water, land, debris, and noise. It also harmfully impacts the globe in other ways: climate change, biodiversity reduction, and human health deterioration. As a result, green thinking on construction projects is required.

Green procurement is upstream of a construction project by considering the EPC procedure. Procurement plays a vital role intermediate between the engineering and construction phases. Several studies have been devoted to exploring the knowledge of green procurement. They attempted to determine the factors influencing green procurement implementaion’s success. It is up to the country, context, and economic situation of that area of study. However, they all accept that green construction is a global trend.

The group of factors influencing green procurement is similar. They mentioned government regulation, customer awareness, and cost reduction. Other than that, the factors that make the green procurement implementation successful include understanding, commitments, management support, information sharing, and firms' collaboration with stakeholders.

CHAPTER 3

RESEARCH METHODOLOGY

In this chapter, the research design and its methods are introduced. The research design can be developed based on the research objectives.

3.1 Research Method

This qualitative research includes both professional interviews and survey research using a questionnaire. The literature assessment is also required to understand the practical framework and the factors supporting green procurement in the construction industry. The study starts with an in-depth literature review. The expected findings are the factors influencing the green procurement in construction projects. We are also interested in the obstacles that deteriorate green procurement implementation. The semi-structured questionnaire for in-depth interviews will be designed. This tool will focus on the current situation of green procurement implementation in Kunming's construction projects. The survey questionnaire is also prepared for conducting the data collection via email.

The research tools are tested by using the index of item objective congruence (IOC) by three experts. Then, the interview questions and the questionnaire will be revised as needed. After data collection, the researcher will analyze the data in qualitative analysis and quantitative analysis techniques. The findings will respond to the research objectives, and a conclusion will be drawn. This research project must be published, and the final report will be prepared. Figure 3.1 illustrates the research steps and their flow.

3.2 Population and Samples

There are a number of construction projects in Kunming. As the trends and government regulations, most of them are implementing green procurement for supporting green construction projects/buildings. To Yamane's formula, the sample is 400 for accepting a 5% error. By this number, we do not have to declare the population quantity.

The in-depth interview will be conducted with 30 professionals in the construction industry in Kunming. It is a reasonable number compared to the study of Varnäs et al. (2009) conducted with eight interviewees.

3.3 Research Tools

3.3.1 The semi-structured interview questions

It will comprise 5 questions about the implementation of green procurement. It will be a general implementation, benefits, and obstacles of green procurement in construction projects.

3.3.2 The survey questionnaire

There were three sections to the questionnaire. The survey's objectives and the notion of green procurement were introduced in Part 1. Part 2 asked for the responders' contact information. Part 3's questions focused on practical aspects of green procurement in the construction industry, and it asked respondents to rate the significance of elements that contribute to successful green procurement in a project. The respondents will score the criteria using a Likert scale with a maximum score of 5, with 1 being the least significant and 5 being the most important. The scale's middle point, 3, denoted a neutral reaction.

3.4 Data Analysis

The data collected were manipulated and analyzed using the Minitab software. The data collected were analyzed using various statistical approaches such as mean, standard deviation, cluster analysis, and hypothesis testing (if needed). However, these techniques are the ordinary way of survey research.

The in-depth interview will be analyzed by using the experience of the researcher. Thematic analysis technique will be used. Theoretically, thematic analysis is a technique for analyzing qualitative data in which a set of data is read through, and themes are discovered by looking for patterns in the meaning of the data. Making sense of the data is an active reflexive process where the researcher's personal experience is crucial.

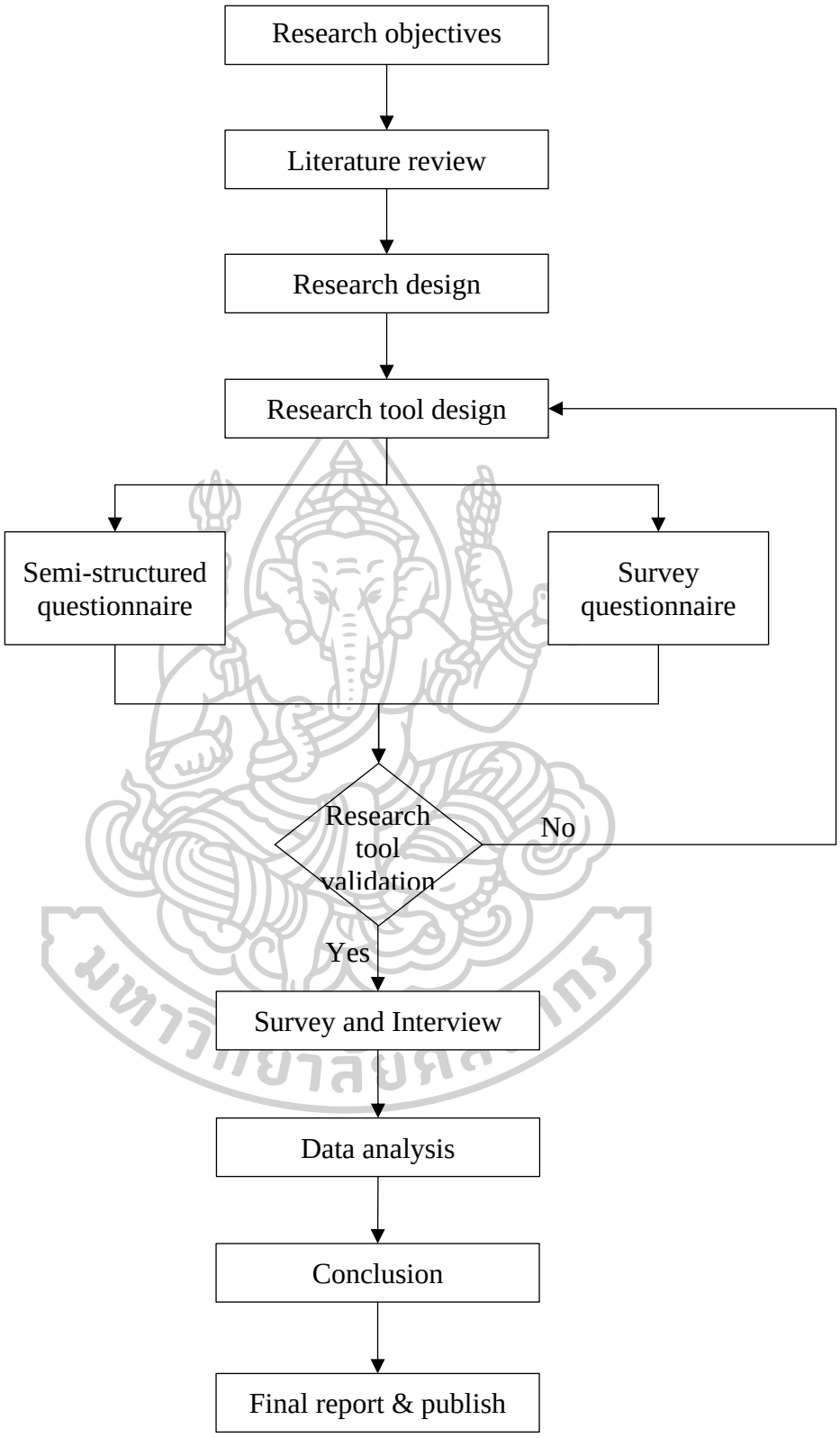

Figure 3.1 Research process flowchart

3.5 Research Mapping

The research questions are mapped with the research tool and the input data. It clarifies the research process and makes understanding of this study project. Table 3.1 shows the research mapping of this study.

Table 3.1 Research mapping.

Research objectives	Research question		Research tool	Input data
1. To investigate the practical factors of green procurement of construction projects in Kunming, the People's Republic of China.	RQ1	What are the factors/dimensions that formation green procurement of construction projects in Kunming?	Through literature assessment and interview	Green procurement enabler and barrier factors in literature and testimonial of professionals.
2. To provide the concepts and the practices of green procurement of construction projects in Kunming, the People's Republic of China.	RQ2	What are the concepts/frameworks of green procurement implementation of construction projects in Kunming?	Through literature assessment and survey	Green procurement implementation of construction projects in literature and professionals' opinions.

CHAPTER 4

RESULT AND ANALYSIS

In this chapter, the research results are explained concisely. Section 4.1 shows the questionnaire development and its congruent testing. Section 4.2 describes the data analysis on both survey and interview data. Nevertheless, in the interview, the statements corresponding to research objectives are drawn. Section 4.3 answers the research questions systematically.

4.1 Questionnaire Design

There are three sections to the questionnaire. Part 1 explains the respondents about the research such as objectives and the definition of terminologies. Part 2 asks for the respondents' contact information. Part 3's questions focused on practical aspects of green procurement in the construction industry, and it asked respondents to rate the significance of elements that contribute to successful green procurement in a project. The respondents will score the criteria using a Likert scale with a maximum score of 5, with 1 being the least significant and five being the most important. The scale's middle point, 3, denoted a neutral reaction. The survey questionnaire is shown in Appendix A. The questionnaire is evaluated using the item-objective congruence (IOC) index. The value less than 0.5 means the question needs to be congruent. On the other hand, the value between 0.5 and 1.0 means the question is congruent. The detailed question and analysis are shown in Table 4.1. Please note that three experts assess the IOC that are a professor from Thai university, a professor from China university, and a management of a construction company in Kunming.

Table 4.1 Survey questions and IOC analysis.

Based on your opinion, please select the important level of each factor contributing to the success of green procurement stated in each item.				
No.	Questions	Score	IOC	Result*
1	Incentive from government.	+3	1.0	1
2	Energy efficiency in construction site.	+2	0.7	1
3	Law enforcement to implement environmental protection.	+3	1.0	1
4	Top management enforcement to implement green construction.	+3	1.0	1
5	Save costs from waste management.	+2	0.7	1
6	Collaboration between designers, engineers, and other parties in construction site.	+3	1.0	1
7	Good design of construction products for reuse, recycling, and recovery.	+2	0.7	1
8	Reduce the cost of the life cycle by using green procurement.	+2	0.7	1
9	The readiness of suppliers for green procurement.	+3	1.0	1
10	Global trends, pressure from competitors, and customers.	+2	0.7	1
11	Company’s image for environmental protection.	+2	0.7	1
12	Scarce of green procurement knowledge.	+3	1.0	1
13	Green procurement raises the construction cost.	+2	0.7	1
14	Lack of practical strategies in green procurement.	+2	0.7	1
15	Unclear of organization structure for green procurement.	+2	0.7	1

Table 4.1 Survey questions and IOC analysis. (continued)

Based on your opinion, please select the important level of each factor contributing to the success of green procurement stated in each item.				
16	High accessibility for green materials.	+3	1.0	1
17	Low customer interest in green buildings.	+2	0.7	1
18	Risk raising due to using of green materials.	+2	0.7	1
19	Low supply of green materials in the local market.	+2	0.7	1
20	Suppliers need to be educated.	+2	0.7	1

*1 = a congruent question, 0 = not a congruent question.

The interview questionnaire is shown in Appendix B. The questionnaire is evaluated using the item-objective congruence (IOC) index. The value less than 0.5 means the question needs to be congruent. On the other hand, the value between 0.5 and 1.0 means the question is congruent. The detailed question and analysis are shown in Table 4.2. Please note that three experts assess the IOC: a professor from a Thai university, a professor from a Chinese university, and a management of a construction company in Kunming.

Table 4.2 Interview questions and IOC analysis.

In your opinion,				
No.	Questions	Score	IOC	Result*
1	What is the green procurement?	+3	1.0	1
2	What are the aims of green procurement?	+3	1.0	1
3	Can you explain the practices of green procurement in your construction project?	+3	1.0	1
4	What do you receive from green procurement in your construction project?	+3	1.0	1
5	What are the obstacles to implementing green procurement?	+3	1.0	1

*1 = a congruent question, 0 = not a congruent question.

As a result, the questionnaires both survey and interview questionnaire are accepted.

4.2 Data Analysis

4.2.1 Survey data

The returned questionnaire was 317 out of 400. It accounted for 79.25% return rate which was satisfied in this study. Figure 4.1 to 4.3 show the demographic information of this study. It shows that the collected data are reliable because most of respondents are experienced worker in construction industry of Kunming.

Figure 4.1 Respondents' jobs.

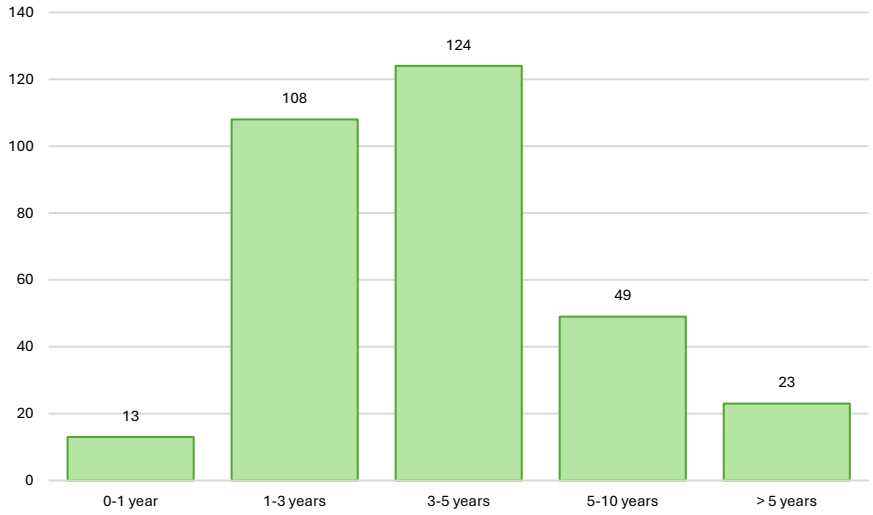

Figure 4.2 Respondents' experience.

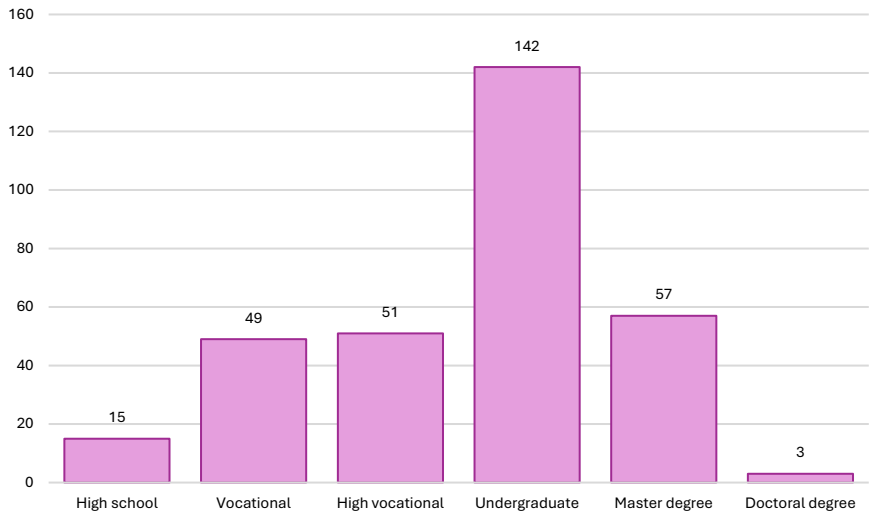

Figure 4.3 Respondents' education.

From Fig 4.1, most respondents are engineers and managers in construction projects. It accounts for 39.4% and 36.6%, respectively. Figure 4.2 shows that the respondents also hold one to five years of experience in this industry, around 73.2%. Most respondents graduated bachelor degree which accounts for 44.8%, see Fig. 4.3. This information helps us comfortably do further analysis.

The questions can be divided into five categories: 1) cost, 2) supply side, 3) demand side, 4) management and risk, and 5) trend, regulations and laws. Table 4.3 shows the result of the collected data in which the third column identifies the category by number. The average and standard deviation of 317 respondents is shown in the fourth and fifth columns, respectively.

Table 4.3 Survey result.

No.	Questions	Category	Average	Std.Dev.
1	Incentive from government.	5	3.72	0.45
2	Energy efficiency in construction site.	1	3.87	0.62
3	Law enforcement to implement environmental protection.	5	3.55	0.28
4	Top management enforcement to implement green construction.	4	2.91	0.47

Table 4.3 Survey result. (continued)

No.	Questions	Category	Average	Std.Dev.
5	Save costs from waste management.	1	4.28	0.12
6	Collaboration between designers, engineers, and other parties in construction site.	4	2.77	0.62
7	Good design of construction products for reuse, recycling, and recovery.	5	3.25	0.78
8	Reduce the cost of the life cycle by using green procurement.	1	4.13	0.31
9	The readiness of suppliers for green procurement.	2	4.59	0.44
10	Global trends, pressure from competitors, and customers.	3	3.28	0.27
11	Company's image for environmental protection.	3	3.43	0.19
12	Scarce of green procurement knowledge.	2	4.25	0.34
13	Green procurement raises the construction cost.	1	3.97	0.31
14	Lack of practical strategies in green procurement.	4	3.16	0.70
15	Unclear of organization structure for green procurement.	4	3.42	0.47
16	High accessibility for green materials.	2	4.29	0.43
17	Low customer interest in green buildings.	3	3.21	0.23
18	Risk raising due to using of green materials.	4	2.72	0.41
19	Low supply of green materials in the local market.	2	4.18	0.63
20	Suppliers need to be educated.	2	3.81	0.40

The questions are shuffled and randomly ask the sample by intention. Table 4.4 discloses the average and standard deviation of each category.

Table 4.4 Interpretation.

No.	Category	Number of questions	Average	Std.Dev.	CV	Interpretation
1	Cost	4	4.06	0.26	0.065	Most important
2	Supply-side	5	4.22	0.46	0.109	Most important
3	Demand side	3	3.31	0.23	0.070	Moderately important
4	Management and risk	5	3.00	0.54	0.182	Moderately important
5	Trends, regulations, and laws	3	3.51	0.54	0.155	Important

The number of questions in each category was different. It was occurred by intention. The coefficient of variation (CV), which is defined as the ratio of the standard deviation (σ) to the mean (μ) and is a standardized measure of dispersion of a probability distribution, is shown in column 6 of Table 4.4. Impressively, all CVs are lower than 1.0, meaning the data distribution is considered low-variance. Column 7 of Table 4.4 shows the interpretation of the data. I found that cost and supply are the most important factors in the practical green procurement of construction projects. They could support green procurement operations. The trends, regulations, and laws are important for this matter. Finally, the demand side and management and risk factors are moderately important

4.2.2 Interview data

Thirty interviewees accepted my interview session invitation. The questions were proposed randomly. It was up to the situation of each interview session. It is not helpful to report every single word of the questions and answers from the interview questions. As a result, I want to conclude the interview data in this report only. It is

worth rearranging the results corresponding to the research objectives. Please note that some interviews were conducted on-site and some online.

What is green procurement?

Green Procurement refers to the act of acquiring products and services that have the least negative effects on the environment. The search for high quality products and services at reasonable pricing is enhanced by considering both human health and environmental considerations.

In other word, green procurement is known as sustainable procurement refers to the systematic approach of choosing and acquiring goods and services that do the least amount of harm to the environment. The objective of green procurement is to diminish the overall ecological footprint of an organization's acquisitions.

Green procurement’s activities comprise of:

- Utilizing items with enhanced energy efficiency,
- Utilizing renewable energy sources or advanced technological solutions,
- Utilizing items that are either regulated in their usage or devoid of any harmful components,
- Utilizing items with enhanced recyclability,
- Utilizing items with low packing requirements,
- Utilizing items with prolonged longevity,
- Utilizing items that have minimized water and other natural resource usage.

The impacts of green procurement are:

- Minimize the use of resources, utilities, and energy.
- Minimize waste and emissions
- Ensure the protection and well-being of both human health and biodiversity.
- Improve the level of clarity and visibility about costs
- Promote the development of new ideas and practices Guarantee equitable compensation and labor conditions

- Generate employment opportunities focused on environmentally sustainable practices throughout the whole supply chain.

4.3 Research Questions and Answers

Table 4.5 Questions and answers.

Research objectives	Research question		Answers
1. To investigate the practical factors of green procurement of construction projects in Kunming, the People's Republic of China.	RQ1	What are the factors/dimensions that formation green procurement of construction projects in Kunming?	Cost and supply-side factors play a significant role in green procurement. The construction industry must develop suppliers who can supply green materials at reasonable prices for construction projects.
2. To provide the concepts and the practices of green procurement of construction projects in Kunming, the People's Republic of China.	RQ2	What are the concepts/frameworks of green procurement implementation of construction projects in Kunming?	Green procurement is the act of acquiring products and services that have the most minor adverse environmental effects. Human health and environmental considerations enhance the search for high-quality products and services at reasonable pricing. It consists of several technologies, such as utilizing materials and energy efficiently, avoiding harmful components, using minimal packaging, and using recyclable materials.

CHAPTER 5
CONCLUSION

5.1 Conclusion

Four hundred questionnaires were distributed to construction workers in Kunming, China, during the last quarter of 2023. Three hundred and seventy-one respondents sent back the questionnaires. The statistical analysis showed that cost and supply side, precisely, lower construction cost by green procurement operations and abundant green materials from suppliers, are most important. Furthermore, the benefits and law enforcement are essential level. Surprisingly, the demand side, such as customers' needs, is moderately important. Likewise, management and risk are also moderately important. The results can lead the construction industry, government, and stakeholders to plan a sustainable strategy to support construction projects implementing green procurement.

Furthermore, thirty interviewees attended the interview session in both onsite and online meetings. They helped this study shape the construction industry's concept and definition of green procurement. Furthermore, they also presented the required technologies and the impacts of green procurement to implement green procurement sustainably. This result could help stakeholders such as construction companies, supplier companies, government, and local administrations promote sustainable building efficiently.

5.2 Outlook and Recommendations

In the future, it is interesting to use more fancy decision techniques in multi-criteria decision-making tools such as the analytic hierarchy process, a technique for order preference by similarity to an ideal solution, and system dynamics. It can help us rank the factor quantitively. Please note that this study is survey research. The economic situation may affect the opinion of the respondents. Thus, the result may vary when the economic situation is changed.

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APPENDIX

APPENDIX A

Survey Questionnaire

Questionnaire

"Green Procurement in Construction Projects: Concepts, Practices, and Empirical Study in Kunming, the People's Republic of China"

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There are three parts. The first part illustrates the objectives and the notion of green procurement. Part 2 asks the demography of the respondent. Part 3 asks the opinion about the factors that contribute to the success of green procurement implementation in the Kunming construction industry. It is a five-point Likert scale:

Score 1 means 'most important',

Score 2 means 'important',

Score 3 means 'moderately important',

Score 4 means 'slightly important', and

A score of 5 means 'unimportant.

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: This part explain the research's objective and the definition of related terminologies for respondents.

1. The research objectives.

1.1) To investigate the practical factors of green procurement of construction projects in Kunming, the People's Republic of China.

1.2) To provide the concepts and the practices of green procurement of construction projects in Kunming, the People's Republic of China.

2. Notion of this study.

2.1) Green procurement means purchasing products and services that cause minimal adverse environmental impacts. It incorporates human health and environmental concerns into the search for high-quality products and services at competitive prices.

2.2) Green construction means constructions focus on reducing water, energy, and materials after the building is built. It also uses intelligent energy-saving technology to build zero-energy homes with fewer greenhouse gases impacting the environment.

2.3) Green building means a structure and the application of environmentally responsible and resource-efficient processes throughout a building's lifecycle

Part II: Please read the questions carefully and then select the score based on your opinion.

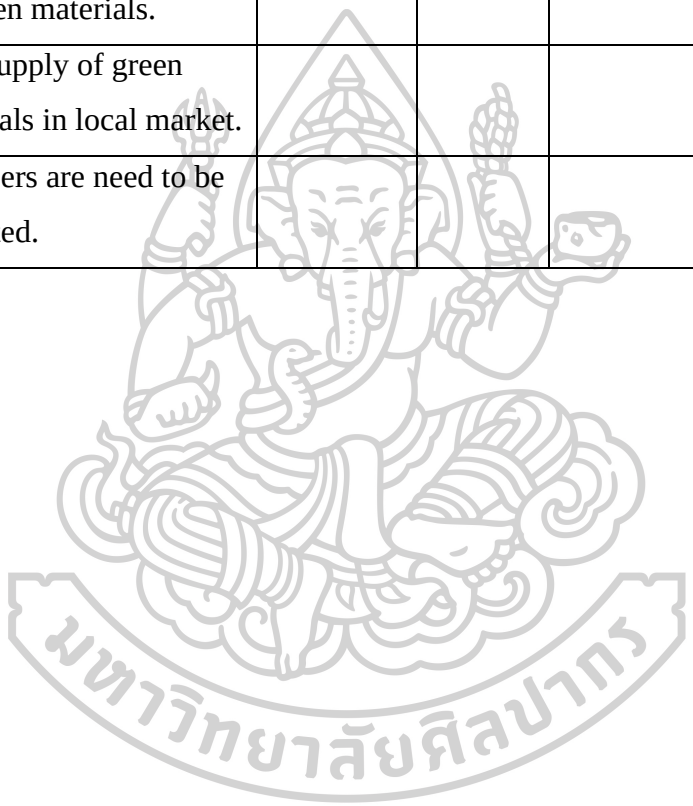
No.	Question	Answer
Q1.1	Do your construction project in Kunming?	□ Yes □ No
Q1.2	Is your construction project practicing sustainable construction?	□ Yes □ No
Q1.3	How big is your construction project?	……..RMB (estimate)
Q1.4	How many employees are in your construction site?	…….employees
Q1.5	Is your construction project state-owned?	□ Yes □ No
Q1.6	What is your position in the construction project?	□ Engineer □ Supervisor □ Asst. Manager □ Manager □ CEO □ Other……
Q1.7	How long have you been working in the construction industry?	□ 0-1 year □ 1-3 years □ 3-5 years □ 5-10 years □ More than 10 years
Q1.8	What is your education level?	□ High school □ Vocational □ Higher vocational □ Undergraduate □ Master degree □ Doctoral degree
Q1.9	What is your education major?	…….
Q1.10	How old are you?	…….years

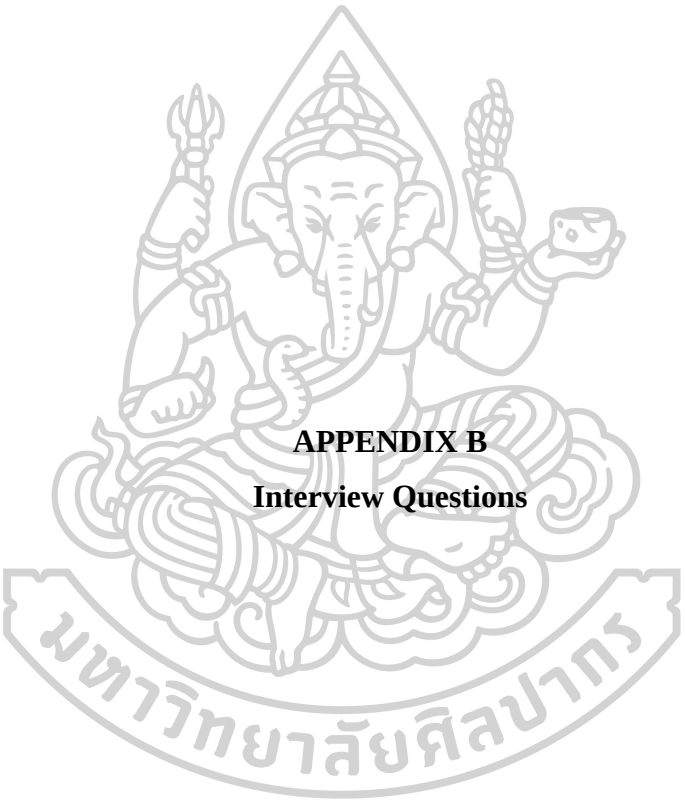
Part III: Based on your opinion, please select the important level of each factor that contributes to the success of green procurement stated in each item.

No.	Factors	Score				
		1: unimportant	2: slightly important	3: moderately important	4: important	5: most important
1	Incentive from government.					
2	Energy efficiency in construction site.					
3	Law enforcement to implement environmental protection.					
4	Top management enforcement to implement green construction.					
5	Save cost from waste management.					
6	Collaboration between designers, engineers, and other parties in construction site.					
7	Good design of construction products for reuse, recycling and recovery.					

No.	Factors	Score				
		1: unimportant	2: slightly important	3: moderately important	4: important	5: most important
8	Reduce the cost of the life cycle by using green procurement.					
9	The readiness of supplier for green procurement.					
10	Global trends, pressure from competitors, and customers.					
11	Company's image for environmental protection.					
12	Scarce of green procurement knowledge.					
13	Green procurement raises the construction cost.					
14	Lack of practical strategies in green procurement.					
15	Unclear of organization structure for green procurement.					
16	High accessibility for green materials.					

No.	Factors	Score				
		1: unimportant	2: slightly important	3: moderately important	4: important	5: most important
17	Low of customers' interest in green building.					
18	Risk raising due to using of green materials.					
19	Low supply of green materials in local market.					
20	Suppliers are need to be educated.					





APPENDIX B

Interview Questions

In your opinion,

1. What is the green procurement?

……
……
……

What are the aims of green procurement?

……
……
……

Can you explain the practices of green procurement in your construction project?

……
……
……

What do you receive from green procurement in your construction project?

……
……
……

2. What are the obstacles to implementing green procurement?

……
……
……
……

Please note that the order of question and answer is not necessary.

VITA

NAME Tan Xiu XIU