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FACTORS AFFECTING THE QUALITY OF CONSTRUCTION WORKS IN LAO PDR

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วัตถุประสงค์ของงานวิจัยนี้เพื่อระบุสาเหตุของปัจจัยที่ส่งผลต่อคุณภาพของงานก่อสร้างเชิงลบในสาธารณรัฐประชาธิปไตยประชาชนลาว เพื่อประเมินระดับความสำคัญของแต่ละสาเหตุและนำเสนอแนวทางการแก้ไขสาเหตุที่ส่งผลให้คุณภาพงานต่ำ วิธีการที่ใช้ในการวิจัยประกอบด้วยการศึกษาสาเหตุและระดับความสำคัญของสาเหตุของปัจจัยโดยการสัมภาษณ์และการทำแบบสอบถาม และใช้ดัชนีความสำคัญสัมพัทธ์ (Relative Importance Index, RII) ในการวิเคราะห์ระดับความสำคัญของสาเหตุ รวมถึงใช้การสัมภาษณ์เชิงลึกและการวิเคราะห์ค่าเฉลี่ยของความคิดเห็นจากผู้เชี่ยวชาญในการพัฒนาแนวทาง เพื่อป้องกันและแก้ไขสาเหตุที่ส่งผลต่อคุณภาพของงาน กลุ่มตัวอย่างที่ใช้ในการเก็บข้อมูลคือ ผู้เชี่ยวชาญที่ปฏิบัติงานในโครงการท้องถิ่นและโครงการจากต่างประเทศในเมืองเวียงจันทน์ ซึ่งเป็นเมืองหลวงของสาธารณรัฐประชาธิปไตยประชาชนลาว ผลการวิจัยพบว่า สาเหตุที่มีความสำคัญในอันดับสูงที่ส่งผลต่อคุณภาพของงานก่อสร้างในสาธารณรัฐประชาธิปไตยประชาชนลาว จากความคิดเห็นของผู้เชี่ยวชาญที่ปฏิบัติงานในโครงการท้องถิ่น เช่น การขาดแรงงานที่มีฝีมือ การใช้วัสดุก่อสร้างที่มีคุณภาพต่ำ สำหรับความคิดเห็นของผู้เชี่ยวชาญที่ปฏิบัติงานในโครงการจากต่างประเทศ เช่น การขาดแรงงานฝีมือ ความต้องการของเจ้าของโครงการไม่ชัดเจน เป็นต้น ในส่วนผลของการพัฒนาแนวทางที่ใช้ในการแก้ไขสาเหตุที่ส่งผลต่อคุณภาพของงานก่อสร้างผลลัพธ์ที่ได้คือ ควรมีการพัฒนาฝีมือแรงงานโดยภาครัฐและการประเมินฝีมือแรงงานก่อนเริ่มงานโดยผู้รับเหมา ซึ่งสามารถแก้ปัญหาคุณภาพของแรงงานได้ โดยเป็นแนวทางที่ได้รับการยอมรับในระดับสูงจากผู้เชี่ยวชาญที่ปฏิบัติงานในโครงการท้องถิ่นสำหรับการแก้ไขปัญหาโดยการประเมินฝีมือแรงงานก่อนเริ่มงาน โดยผู้รับเหมาเป็นแนวทางที่ได้รับการยอมรับในระดับสูงมากจากผู้เชี่ยวชาญที่ปฏิบัติงานในโครงการจากต่างประเทศ

ภาควิชา วิศวกรรมโยธา ลายมือชื่อนิสิต .....

สาขาวิชา วิศวกรรมโยธา ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

ปีการศึกษา 2557

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The objectives of this research are to identify causes of factors affecting quality of construction works in Lao PDR in negative aspects, to assess the relative important level of each cause of factor and to propose guidelines for solving such causes of factor leading to poor quality problems. The research methodologies consist of studying causes and important level of each cause of factor based on interviews and questionnaire surveys and was analysed by the relative importance index (RII) technique. In addition, the proposed guidelines for solving causes of factor are based on in-depth interview with individual informant and analyzed by the average weight technique. The data was collected from the perspectives of the respondents in local and in international projects located in Vientiane, the capital city of Lao PDR. The results of this research found that the important causes of factor affecting quality of construction works in Lao PDR in top ranking are such as lack of skilled labors, use of poor quality material and products which ranked by the respondents in local projects while lack of skilled labors, inadequate owner's need and project objective which ranked by the respondents in international projects. For the results of the proposed guidelines showed that creating and developing the skill of labors by government, and evaluating labor's qualification before working by the contractor to solve lack of skilled labors were agreed among respondents in local projects in the high level. On the other hand, respondents in international project were agreed with evaluating labor's qualification before working by the contractor in the very high level.

Department:	Civil Engineering	Student's Signature	.....
Field of Study:	Civil Engineering	Advisor's Signature	.....
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LISTS OF ABBREVIATIONS

LNCCI	Lao National Chamber of Commerce and Industry
MPWT	Ministry of public work and transport
RII	Relative importance index
RIP	Respondents in International Projects
RLP	Respondents in Local Projects

CHAPTER 1
INTRODUCTION

1.1 Introduction

Construction projects are highly increasing in developing countries such as majority of the ASEAN countries. Lao PDR is playing role in construction industry, especially with the increase in building construction such as hotels, supermarkets, office buildings, and etc. Similarly, with increasing owner's requirements and environment changes, the relative parties like designers, consultants, and contractors have to take into account and improve quality of final products. However, to achieve that goal, it is challenging because Lao PDR is less developed in terms of economy and technology.

However, the government has a policy to solve these problems by promoting Small-Medium Enterprises (SMEs). This policy aims to improve and expand SMEs (i.e., new business creation and survival and growth of existing enterprises) for competitive ability not only for local competitors, but also for foreign competitors in construction industry. As a result, there are many foreign direct investors attracted to invest in this country as a result of developing economy. Similarly, the employment rate and modern technology are improved. Some investors are the Chinese, Vietnamese, Thai, Singaporean and Japanese. Most of the investments are on electrical power, mining, agriculture, hotel and service, building, industrial and handicraft and so on (Newspaper, 2015). One of them, which is the building construction project is a significant contributor to construction sector due to a lot of constructed buildings in Lao PDR. It is implied that the building construction will continuously increase in the main city, especially in Vientiane Capital, which is significantly growing such as shopping mall, office building, hotel, apartments and so on. Most of those projects are carried out by both local and international companies.

In respect of local companies, most of them can be carried out for small to medium size of the projects, because they cannot execute for a large size of the projects. That results from several factors such as engineers and workers. For international companies are carried out only their own investment as the "full package"—that is, they implement in terms of budgets, design, supervisors and construction workers. Besides,

some of international investors hired local contractors to execute the construction projects. There are several things changed simultaneously. For instance, the size of project has been changed from small to large or low-rise to high-rise building. In addition, the construction company's size has been developed from small-enterprise to medium-enterprise. It reflects that the many local companies in the construction project are encountering with many issues not only for managing the project but also providing the training unskilled laborers and so on.

Construction project management is a key for project participants (e.g., the project owners, consultants, designers, prime contractors and subcontractors) involved which they have to take into consideration carefully in terms of cost, time, quality and safety managements. In particular, the quality management is very important part that the all parties have to organize it from feasibility stage until final stage of the project, in order to accomplish the goal of construction project within plan and specifications, and the owner's satisfaction. According to Naidu (2005) stated that quality is very important to increase the performance of organization by optimizing their operations, client's satisfaction and meeting the goals of business. Otherwise, if construction quality failure may results in aspect of the plan failure, poor workmanship, unsafe structures, time completion delays, cost overruns and lots of contract disputes (Rumane, 2011 quoted from FIDIC). However, lack of quality may occur among several reasons such as the complexity of construction, lots of parallel activities and dynamic nature of construction, and lots of project participants. In summary, the complexity of construction project results in the difficulty to manage the quality of construction.

The quality of construction is therefore dependent upon the control of construction, which is the primary responsibility of the contractor. It means that the contractors are the main party who will drive the project success in accordance with an intended purpose. In addition, the quality of construction work is dependent to a large extent on the attitudes of the contractors and consultants (Low and Peh, 1996). It is important to have good coordinating flow and improve teamwork to achieve the project quality objectives. A quality management system will not succeed unless the construction organizations improve their quality continuously in terms of products and services. On the other hand, the construction quality will be adversely affected if all parties in the contract do not carry out their duties properly. To achieve that, the quality

implementation must start at the beginning (input stage), during (in process) and at the end (finished goods) of the production process (Janipha and Ismail quoted from Wahid, 2006).

1.2 Problem Statement

Quality management in construction projects is a part of the construction management, in which all project participants have to emphasize on how to manage the project access the goals of plan and specifications in order to meet the need of the owner. As a result of the complexity of project and increasing of the competition for construction business in Lao PDR, there has become a main factor on quality management. For this reason, all parties in construction contract have to be aware significantly in their own responsibility. Unlike other developing countries, the construction project managers in Lao PDR is still low knowledge and competency in managing quality the work, nor do the project managers pay more attention the quality of the work, but care about the cost and profits of the project (Hang, 2010). Similarity, Lao contractors are not able to produce good quality construction. This is because the most of the laborers are unskilled (Group, 2013) , it means that the workmanship issue is a key factor affecting the quality of construction works in Lao PDR. This factor is also one important factors that reflect the construction business growth, which resulting from several hindrances such as poor background of Lao economic and technology, low knowledge and skills of personnel at all levels, and lack of opportunity to improve an organizational effectiveness and award of competitive business.

Quality is very important to increase the performance of organization by optimizing their operations, client's satisfaction and meeting the goals of business (Naidu 2005). The reason of lack of quality may however occur among several reasons such as the complexity of construction, lots of parallel activities and dynamic nature of construction, and lots of project participants. In summary, the complexity of construction project results in the difficulty to manage the quality of construction.

A number of previous studies have been conducted to examine and identify the factors affecting the quality of building construction projects in both developing and developed economic countries. For developed countries, most of studies examined and identified factors affecting the quality performance of construction projects and focused

on the construction companies that registered in quality management system, ISO 9001. As a part of developing countries, on the other hand, identified cause of quality failure in building construction project, quality issues, and examined the quality performance in construction projects (Amer 2002; Abdul-Rahmana et al., 2012; Iyer 2006; Janipha and Ismail, 2013; Callistus et al., 2014). However, these studies are not emphasized on factors affecting the quality of construction works in respect of negative effects. Therefore, this research focuses on factors affecting quality of construction works in Lao PDR. It means that the factors that affect the quality of the final products, namely, how well the final products conform to the specifications and the owner's requirements.

Therefore, this research persuades to come up on the causes of factors affecting the quality of construction works in Lao PDR and this is a first step of this country to improve quality of construction works. The main objective of this research is to identify the causes of factors that affect the quality of construction works, to determine the relative importance level of each cause leading to poor quality problems and to propose guidelines to solve the most important causes of factors affecting the quality of construction works. The process of conducting the research, it starts with literature review, pilot study, in-depth interview and generalization the findings, respectively. The sample size of this research involves both local construction projects and international construction projects. The data collection consists of two parts. The first part is to determine the important level of each cause of factor by using the Relative Importance Index (RII) technique and also its ranking by respondent's opinions in both local projects and international projects. Another part of data collection is to propose the guidelines for solving the causes of poor quality problems by using the average weight technique. The outcome of this research can be useful for all project participants in building construction projects understand and overcome with critical poor quality problems of construction works in Lao PDR. Moreover, the result of the finding would be compared the similarities and differences between both parties opinions for improving quality problems found in Lao building construction projects.

1.3 Research Objectives

The primary aims of this research are to:

1. Identify the causes of factor affecting quality of construction works in Lao PDR in negative aspects.
2. Determine the level of relative importance on causes of factor affecting quality of construction works and rank the most important causes of factor from the perception of both local and international project participants.
3. Propose the guidelines for solving causes of factor affecting quality of construction works

1.4 Scope of Research

This research studies the causes of factors affecting the quality of construction works in negative aspects as well as proposing the guidelines to solve such causes of factors in Lao PDR. To meet the objectives, this research focuses on the medium and high-rise building construction projects, which are located in Vientiane, the capital city of Lao PDR. These selected projects are based on the projects that being constructed in this city like office building, hotel, apartment, shopping mall projects and so on. In addition, these projects involve both local and international project investors. That means the sample size in this research focuses on who is the representative of the owner and contractor of these building construction projects.

1.5 Research Methodology

The results of this research are based on:

1. Literature Review: The main aim in carrying out the literature review is to collect the causes of factors that affect the quality of construction works and be more understanding on the topic of this study. There are various sources of gathering such causes of factors such as journals, paperwork, thesis, articles and book. The collected factors that related to the objective of this study has been analyzed by using the Cause and Effect Diagram (Fishbone Diagram) to identify and categorize into groups of causes of factors affecting the quality of construction works.

2. Preliminary study: The main aim of this preliminary study is to validate whether the questions are intelligible, easy to answer, unambiguous obtained from literature. There are six experts, who have more than five-teen years working experience in construction works, were interviewed to correct and to improve the questions in questionnaire corresponding to real situation of quality problems in Lao construction work.
3. Questionnaire development: the questionnaire develops into two sets, the first set is used to evaluate the level of important causes of factor affecting quality of construction works and rank such factors, while another one is used to assess the agreement level among respondents towards the proposed guidelines. The details of questionnaire development has presented in Chapter 3.
4. Data collection: This research considers two methods for collecting data. The first method is the collecting of data by interviews with 27 RLPs and 5 RIPs. Another method is the collecting of data by in-depth interviews with respondents, as identified in section 7.
5. Data analysis: the selection of a suitable tool for analyzing data collected is the most crucial to fulfill the research objectives. This research adopts the relative importance index (RII) for analyzing data, which obtained from opinions of RLP and RIP, in order to determine the important level of causes of factors affecting the quality of construction works and rank the relative importance from the most important causes of factors to least important ones, respectively. Another data analysis is done by the average weight technique, as presented in Chapter 3.
6. Result discussion and validity: This research will be done through its results with making up more reliability and discussion of the result correctly. To achieve that, the discussion will be compared together both the local and international stakeholder's perception on how to solve of such quality problems for construction works in Lao PDR. Another validity of information acquired will compare with previous studies in case of the present results are relatively similar with previous one.

7. Recommendations: The recommendation for solving the problems is according to the in-depth interview with the company directors, project managers, project engineers, project supervisors, and site manager. There are 7 experts in local projects and 3 experts in international projects were participated to propose guidelines for reducing and improving the quality problems.
8. Conclusion and recommendations: the conclusion of this research will provide a brief overall research results, identify limitation of research, and provide recommendations to project participants on how to use guidelines in construction works and propose for next research.

1.6 Expected Benefits

After this research finish, it can be useful to the project participants in building construction projects as follows:

1. The finding of this research can be determined problems and causes of quality in construction works in Lao PDR.
2. The finding of this research will be also used to guide for project participants (owner, consultant, contractor, designer and government) to improve quality problems that most affected towards the construction works and to prevent them in advance before its damages may be occurred in their construction projects.

CHAPTER 2
LITERATURE REVIEW

2.1 General

This chapter reviews the relevant information that deal with causes of factors affecting the quality of construction works. First, this chapter describes the definition of quality in general terms. Next, it provides definition of quality in construction industry, followed by the quality management in construction project. Finally, it describes the factors affecting quality of constriction works.

2.2 Quality Definitions

There is no one can be defined regarding quality correctly due to depending on the owner satisfaction. Kerzner (2009) and Chung (1999) stated that "Quality may mean different things to different people". Some take it to represent customer satisfaction, others interpret it as compliance with contractual requirements, yet others equate it to attainment of prescribed standards. The international Organization for Standardization (ISO) formally defines quality as the 'totality of features and characteristics of a product or service that bear on its ability to satisfy stated and applied needs' (ISO, 1994a). This definition implies that there is a need to identify the features and characteristics of products and services that relate to quality and form the basis for measurement and control. The "ability to satisfy applied needs" reflects the value of the product or service to customer, including the economic value as well as safety, reliability and maintainability.

According to Kerzner (2009), Kodak definition of quality is those products and services that are perceived to meet the needs and expectations of the customer at a cost that represents outstanding value. Another perspective, ISO 9000 implied in terms such as fitness for use, customer satisfaction, and zero defects are goals rather than definitions. According to Juran and Godfrey (1999) gives the meaning of "fitness for use" the quality means those features of the product which respond to customer needs and meaning of quality as conformance to specification at the time of final product test. The latter definition fails to consider numerous factors which influence quality as defined by customers: package, storage, transport, installation, reliability, maintain-

ability, customer service, and so on. The definition is based on the assumption that quality is determined by what a customer requires and up to his willing.

The diversity of these definitions may be explained by examining into eight principal quality dimensions (Amer, 2002 quoted from Evans and Lindsay, 1992).

1. Performance: a product's primary operating characteristics.
2. Features: the properties of a product.
3. Reliability: the probability of a product's surviving over a specified period of time under stated conditions of use.
4. Conformance: the degree to which physical and performance characteristics of a product match pre-established standards.
5. Durability: the amount of use one gets from a product before it physically deteriorates or until replacement is preferable.
6. Serviceability: the speed, courtesy, and competence or repair.
7. Aesthetics: how a product looks. Feeds, sounds, tastes or smells.
8. Perceived quality: subjective assessment resulting from image, advertising or brand names.

Definitions above can further be summarized under the name of those contributors to the quality movement whose philosophies, methods, and tools have been proved useful in quality practices. They are called the "quality gurus." Their definitions are of quality are:

1. Crosby (1979): Conformance to requirements not as "goodness" nor "elegance."
2. Deming (2000): Quality should be designed into both product and the process.
3. Feigenbaum (1991): Best for customer use and selling price.
4. Ishikawa (1985): Quality of the product as well as after-sales services, quality of management, the company itself, and the human being.
5. Juran (1999): Quality is fitness for use.
6. Oakland (2003): Quality is meeting customer's requirements.

2.3 Quality in Construction project

Many previous researchers provided a different definition of the construction project quality. According to Chung (1999) stated that quality of construction is even more difficult to define. First of all, the product is usually not a repetitive unit but a unique piece of work with specific characteristics. Secondly, the needs to be satisfied include not only those of the client but also the expectations of the community into which the completed building will integrate. The construction cost and time of delivery are also important characteristics of quality". Similarly, Rumane (2011) quoted from CII Source Document 79 (1992) describes quality in construction project that quality has many meanings; nevertheless, for projects, conformance to established requirements has relevance and clarity. Another term is needed for the term requirements. Requirements are contractually established characteristics of a product, process, or service. A characteristic is a physical or chemical property, a dimension, a temperature, a pressure, or any other specification used to define the nature of product, process or service. The requirements are initially set by client and are then translated during the preplanning phase into a conceptual design and estimate developed into a project scope and more fully defined. During the Design phase, the requirements are translated into specific design documents (drawings, plans, specification, purchase orders, and the like). Procurement of fabricated items often proceeds concurrently with design. The products of design and procurement reach the construction site for erection and installation during the construction phase.

According to Jha and Iyer (2006) quoted from Collins (1996) describes quality professionals use a number of definitions to define project quality. Quality in its simplest form can be defined as: 'meeting the customer's expectations,' or 'compliance with customer's specification.' No matter what definition we follow for quality, it becomes very complex when everyone try to put it into actual practice. For a user, quality is nothing but satisfaction with the appearance, performances, and reliability of the project for a given price range. Another definition of quality in construction is known as getting the job done on time; getting the job done within budget given; and achieving the specification requirements (Alotaibi (2014) quoted from Hart (1994); (Chung, 1999). Based on the foregoing, Rumane (2011) summarized that the quality of construction projects can be defined as follows: Construction project quality is the

fulfilment of the owner's needs per defined scope of works within a budget and specified schedule to satisfy the owner's or user's requirements. The phenomenon of these three components can be called the "construction project trilogy" and is illustrated in Figure 2.1.

The quality in construction that it is also achieved by the people who take pride in their work and have the necessary skills and experience to do the work (Oberlender, 2000). The actual quality of construction depends largely upon the control of construction itself, which is the principle responsibility of the contractor. What is referred to today as "quality control," which is a part of a quality assurance program, is a function that has for years been recognized as the inspection and testing of materials and workmanship to see that the work meets the requirements of the drawings and specifications.

Based on the philosophies of quality gurus, quality of construction projects can be evolved as follows:

1. Properly defined scope of work.
2. Owner, project manager, design team leader, consultant, and constructor's manager are responsible to implement quality.
3. Continuous improvement can be achieved at different levels as follows:
    a. Owner: Specify the latest needs.
    b. Designer: Specification should include the latest quality materials, products, and equipment.
    c. Constructor: Use the latest construction equipment to build the facility.
4. Establishment of performance measures.
    a. Owner
        - To review and ensure that designer has prepared the contract documents that satisfy his needs.
        - To check the progress of work to ensure compliance with the contract documents.
    b. Consultant
        - As a consultant designer, to include the owner's requirements explicitly and clearly define them in the contract documents.

- As a supervision consultant, supervise contractor's work per contract documents and the specified standards.

c. Contractor

- To construct the facility as specified and use the materials, products, and equipment that satisfy the specified requirements

5. Team approach: Every member of the project team should know that TQM is a collaborative effort, and everybody should participate in all the functional areas to improve the quality of the project work. They should know that it is a collective effort by all the participants.
6. Training and education: Both consultant and contractor should have customized training plans for their management, engineers, supervisors, office staff, technicians, and laborers.
7. Establish leadership: Organizational leadership should be established to achieve the specified quality. Encourage and help the staff and laborers to understand the quality to be achieved for the project.

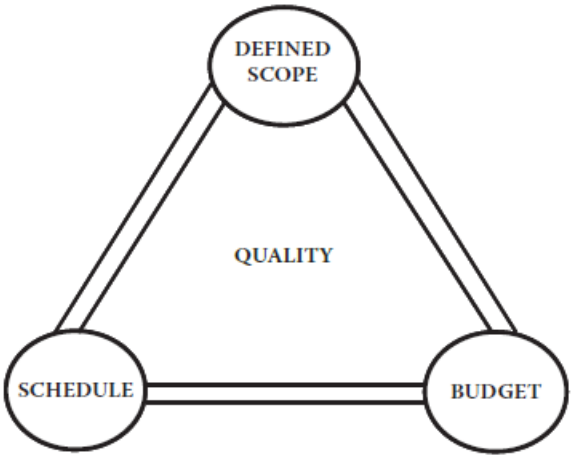


Figure 2.1 Construction project trilogy (Rumane, 2011)

2.4 Quality Management in Construction

Rumane (2011) stated that quality management in construction projects is different from manufacturing. Quality in construction projects encompasses not only the quality of products and equipment used in the construction, but the total management approach to completing the facility per the scope of works to

customer/owner satisfaction within the budget and in accordance with the specified schedule to meet the owner's defined purpose.

Chung (1999) has described the quality of construction, the quality of building work is difficult, and often impossible, to quantify since a lot of construction practices cannot be assessed in numerical terms. The framework of reference is commonly the appearance of final product. It is often a matter of personal judgment and consequently a subject of contention. In fact, a building is of good quality if it will function as intended for its design life. As the true quality of the building will not be revealed until many years after completion, the notion of quality can only be interpreted in terms of the design attributes. So far as the builder is concerned, it is fair to judge the quality of his work by the degree of compliance with the stipulations in the contract, not only the technical specifications but also the contract sum and the contract period. His client cannot but be satisfied if the contract is executed as specified, within budget and on time. Therefore, quality management in construction projects a quality product of building construction is one that meets all contractual requirements (including statutory regulations) at optimum cost and time.

The project manager is the ultimate responsibility for quality management on the construction projects. Quality management has equal priority with cost and schedule management. However, the direct management of quality may be the responsibility of the quality assurance department. For a labor intensive project, management support (i.e., the project office) is typically 12 to 15 percent of the total labor dollars of the project. Approximately 3 to 5 percent can be attributed to quality management. Therefore, as much as 20 to 30 percent of all the labor in the project office could easily be attributed to quality management (Kerzner, 2009, p. 887).

From the project manager's perspective, there are six quality management concepts that should exist to support each and every project (Kerzner, 2009) quoted the (PMBOK Guide, 4th Edition Book). They include: quality policy, quality objectives, quality assurance, quality control, quality audit, and quality program plan
Ideally, these six concepts should be embedded within the corporation culture.

2.4.1 Quality policy

The quality policy is a document that is typically created by quality experts and fully supported by top management. The policy should state the quality objectives, the level of quality acceptable to the organization, and the responsibility of the organization's members for executing the policy and ensuring quality. A quality policy would also include statements by top management pledging its support to the quality. The quality policy is instrumental in creating the organization's reputation and quality image.

A good quality policy will:

- Be a statement of principles stating what, not how
- Promote consistency throughout the organization and across projects
- Provide an explanation to outsiders of how the organization views quality
- Provide specific guidelines for important quality matters
- Provide provisions for changing/updating the policy

2.4.2 Quality objectives

Quality objectives are a part of an organization's quality policy and consist of specific objectives and the time frame for completing them. The quality objectives must be selected carefully. Selecting objectives that are not naturally possible can cause dissatisfaction and disillusionment. Examples of acceptable quality objectives might be: to train all members of the organization on the quality policy and objectives before the end of the current fiscal year, to set up baseline measurements of specific processes by the end of the current quarter, to define the responsibility and authority for meeting the organization's quality objectives down to each member of the organization by the end of the current fiscal year, etc.

Good quality objectives should:

- Be obtainable
- Define specific goals
- Be understandable
- State specific deadlines

2.4.3 Quality assurance

Quality assurance is the collective term for the formal activities and managerial processes that are planned and undertaken in an attempt to ensure that products and services are delivered at the required quality level. It is the quality assurance function that tries to ensure that the project scope, cost and time function are fully integrated. According to ISO 9000 quoted that the quality assurance is "those planned and systematic actions necessary to provide adequate confidence that product or service will satisfy given requirements for quality." Nevertheless, quality assurance in construction projects covers all activities performed by the design team, contractor and quality supervisor staff to meet owner's objectives as specified and to ensure that the project is fully functional to the satisfaction of the owners.

A good quality assurance system will:

- Identify objectives and standards
- Be multifunctional and prevention oriented
- Plan for collection and use of data in a cycle of continuous improvement
- Plan for the establishment and maintenance of performance measures
- Include quality audits

2.4.4 Quality control

Quality control is a collective term for activities and techniques, within the process, that are intended to create specify quality characteristics. Such activities include continually monitoring processes, identifying and eliminating problem causes, use of statistical process control to reduce the variability and to increase the efficiency of processes. Quality control certifies that the organization's quality objectives are being met (Kerzner, 2009).

Moreover, quality control refers to the technical aspect of quality management. Project team members who have specific technical expertise on the various aspects of the project play an active role in quality control. In addition, they set up the technical processes and procedures that ensure that each step of the project provides a quality output from design and development through implementation and maintenance. Each step's output must conform to the overall quality standards and quality plans, thus ensuring that quality is achieved.

A good quality control system will:

- Select what to control
- Set standards that provide the basis for decisions regarding possible corrective action
- Establish the measurement methods used
- Compare the actual results to the quality standards
- Act to bring nonconforming processes and material back to the standard based on the information collected
- Monitor and calibrate measuring devices
- Include detailed documentation for all processes

2.4.5 Quality audit

A quality audit is an independent evaluation performed by qualified personnel that ensures that the project is conforming to the project's quality requirements and is following the established quality procedures and policies.

A good quality audit will ensure that:

- The planned quality for the project will be met
- The products are safe and fit for use
- All pertinent laws and regulations are followed
- Data collection and distribution systems are accurate and adequate
- Proper corrective action is taken when required
- Improvement opportunities are identified

2.4.6 Quality plan

The quality plan is created by the project manager and project team members by breaking down the project objectives into a work breakdown structure (WBS). Using a treelike diagramming technique, the project activities are broken down into lower-level activities until specific quality actions can be identified. The project manager then ensure that these actions are documented and implemented in the sequence that will meet the customer's requirements and expectations. This enables the project manager to assure the customer that he has a road map to delivering a quality product or service and therefore will satisfy the customer's needs.

Quality plan can be considered as a work program organized by the constructor and the quality control staff. All the tests and inspections for any construction projects are expected to be explained in this plan. To prepare the plan, the constructor shall (Al-Ani and Al-Adhmawi, 2011 quoted from Simmons, 2001):

1) Plan the inspections and testing activities.

2) Identify in the quality plan that the inspections and testing to be performed on the items are listed in the contract in compliance with contractual and/or technical condition requirements.

3) Submit the plan for the client's concurrence following the award of the contract and before the work start.

4) Up-date the plan during the project life to reflect the current conditions of manufacturing, construction, inspecting and testing and resubmit the plan to the client.

The quality plan may be any format to suit the execution approach that has been followed by the constructor. The quality plan shall deal as appropriate with;

- Identification of the characteristics or items to be inspected and tested.
- Identification of required inspection, tests and special process operations and their relative locations in the construction cycle.
- Identification of hold points beyond which the activity shall not proceed until the required inspections or tests have shown satisfactory results and been documented.
- Provisions for the client to insert witness points at which activities are to be observed.

2.5 Total Quality Management in Construction

Total quality management (TQM) is an effort that involves every organization in the industry in the effort to improve performance. It permeates every aspect of a company and makes quality a strategic objective. TQM is achieved through an integrated effort among personnel at all levels to increase customer satisfaction by continuously improving performance. TQM focuses on process improvement, customer and supplier involvement, teamwork, and training and education in an effort to achieve customer satisfaction, cost effectiveness, and defect-free work. Today TQM is considered a fundamental requirement for any organization to compete, let alone lead,

in its market. It is a way of planning, organizing, and understanding each activity of the process and removing all the unnecessary steps routinely followed in the organization.

In other word, TQM is a philosophy that makes quality values the driving force behind leadership, design, planning, and improvement in activities. The culture of good teamwork and cooperation at all levels in an organization is essential to the success of TQM. In construction process, there are several elements that affect the total quality management as shown in Figure 2.2.

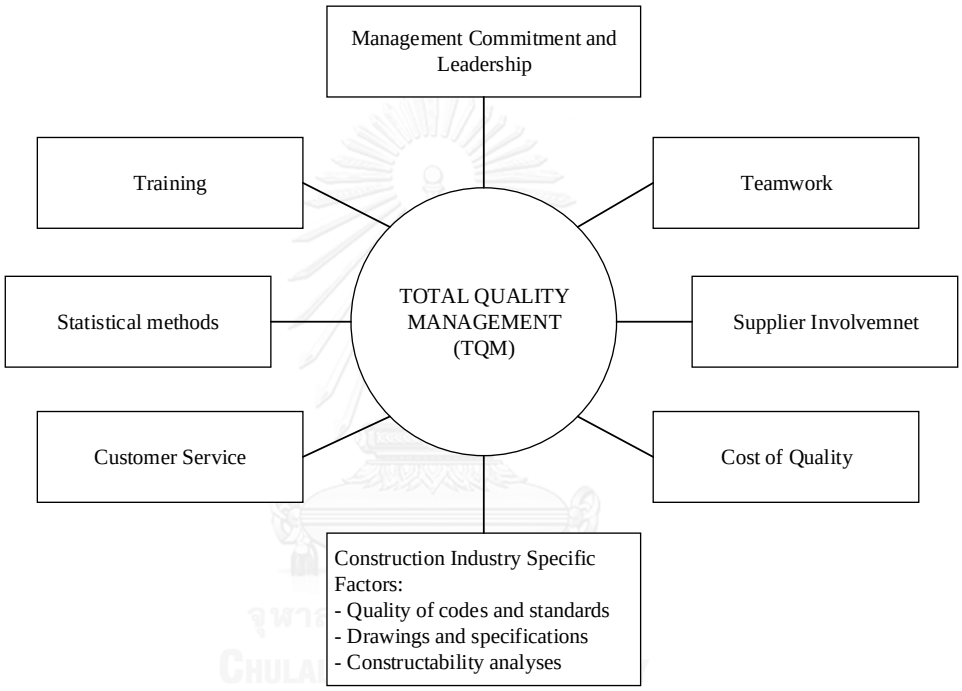


Figure 2.2 Elements of total quality management in the construction process (Arditi and Gunaydin, 1997)

2.6 Factors affecting the quality of construction projects

The construction quality is based on the organization's characteristics, procedure of working, and contractor follows the drawings and specifications under defined budgets, skill of labor, quality of materials and applied equipment. The management issues were the most important factors that affected construction quality for developed economic of countries. According to Kandeil et al., (2010), the main factors involve with quality issues are the application of quality standard, management commitment, communication, activities during design and planning and relationship

between construction players. While another research stated that the factors that most important affecting the construction quality like attitudes or commitments of management, the cooperation of parties, and abilities and experience levels of project managers.

Amer (2002) identified factors affecting quality of building construction projects during the construction phase in Gaza Strip. It found that the most important factors affecting quality of building construction project was the characteristics of site layout, skill and experience of site staff, characteristics of design documents and using equipment, materials, quality and labor management systems and the owner quick response in making decisions. Another Jha and Iyer (2006) studied the critical factors affecting quality performance in construction projects. Authors focused on two sets of success and failure attributes. The result found that the factors having positive (success attributes) contributions to achieving the desired quality level are project manager's competence, top management support and their competence, interaction between project participants, owner's competence, and monitoring and feedback. While factors that adversely affected (failure attributes) the quality performance of projects are: conflict among project participants; hostile socio-economic environment; harsh climatic condition; project manager's ignorance and lack of knowledge; faulty project conceptualization; and aggressive competition during tendering, and availability of resources, including machinery and labor, was particularly important because it affects construction quality in underdeveloped countries (Ying and Yip, 2010). The main players in construction process, the contractor is involved in construction quality such as optimize resources to materialize the final constriction products, meeting the specification requirement and implementation of formal quality system (Che Ali et al., 2010). Heravitorbati et al., (2011) extracted and identified current quality defects, problems and issues which commonly arise during a typical in construction projects. Also, this research still had obtained factors from previous research had been done. The collected factors classified in to four main headings, namely, stakeholder managerial, technical, cultural and political, and environmental, material and equipment. As a result, it highlighted that a poor stakeholder management appears to be one the most fundamental causes of quality failure. Another researcher of Adenuga (2013) found five most important factors affecting quality of public housing projects comprising of poor

communication of design requirements by owners, poor labor skills and supervision, lack of clarity in project design and buildability problems, availability of skilled labor and availability of materials.

Ali and Wen (2011) tried to find out the factors that contribute to poor workmanship and possible measures to minimize the problem. The factors contribute to poor workmanship in construction through literatures, they are: poor project management; complicated role of subcontractor; lack of experience and competency of labors; language barrier to communication and lack of communication; unsuitable construction equipment; poor weather condition; limited time and limited cost. Nevertheless, they suggested with sixth possible ways to minimize the workmanship quality problem; strict supervision, training and education, proper communication among parties involved, proper construction management, proper manpower management, and proper design.

Janipha and Ismail (2013) developed the conceptualization of quality issues in Malaysian construction environment. The research emphasized to investigate the quality issues in current situation. The list of quality issues were obtained from literature review and preliminary interviews. The result arranged from the most affect to the lowest one in the construction environment, it shows that the material supply by supplier, supplier relationship and communication, and project supervision, project information and documentation, quality culture and attitude, competitive bidding, nature of construction environment and management commitment, respectively. According to Cao (2010) mentioned that causing of quality problems consists of problems concerning the construction procedures and regulations; problems of design and calculation; substandard materials and products; out of control of construction and management; the influence of natural conditions; improper use of facilities. Abdul-Rahman et al., (2012) investigated the causes of quality failures in the building construction projects. The results showed top five causes of quality failure that insufficient skill levels among workers, inadequate reviews of the design and engineering drawings, lack of site layout studies, poor quality improvement programs, and lack of training personnel.

However, the causes of factors affecting quality of construction works were collected from literature and were analyzed by using Cause and Effect Diagram tool, in

order to understand in-depth the causes of quality problems and how such factors affecting the quality of building construction projects. The details of causes of factors gathered from literature will be presented in Chapter 4.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 General

The study of theory and review of the previous research relating to the topic are crucial steps to find out the research topic and to use as a guideline to conduct this research. This chapter describes about the research methodology, which consists of determining which research approach is appropriate for this study. Then, the research design is discussed which provides how to conduct this research achieved by using some techniques. In addition, data collection conducts to determine how to gather data comfortably (e.g. low cost and short-time). Finally, selecting appropriate techniques to analyze data that obtains from questionnaire survey, in order to determine level of importance causes of factors that affect the quality of construction works.

3.2 Research Approach

This research is defined as a descriptive research approach because this research focuses on the explanation in fact on quality problems in current construction situations. This approach also made questions on how to indicate those events correctly. Sometimes, this research approach may be an explorative research or determining a correlation between the relative variances. The results of research are mostly like a finding answers of the question that related to the situation in fact. In addition, this approach has always met in general which relate to the exploration or attitude research or personal's opinion through organization or things that happened. In this research will explore and identify the factors affecting the quality of construction works in Lao PDR.

As for this research, the descriptive research approach contains sub-two research approaches. The first step is a qualitative approach which is necessary the first step to have preliminary survey, according to research aims to make the question prepared clearly and to find out additional problems in real event (current construction work in Lao PDR). Additionally, this step will conduct the in-depth interview process in the last step of this research in order to provide a guideline to elaborate and improve quality problems in Lao building construction works. The guidelines of this approach depend on the respondent's perception or opinion. Quantitative approach will be

suitable for a large number of respondent targets by using the questionnaire method. This approach carries out to evaluate level of importance of each factor by using formula defined and using statistics analysis to test a significant difference about the perception of respondents between local and international projects.

3.3 Research Design

The research design is useful in planning how to do research well in order to correspond with the research objective. Kothari (2004) indicated that the important features of a research design as follows:

- It is a plan that specifies the sources and types of information relevant to the research problem.
- It is a strategy specifying which approach will be used for collecting and analyzing the data.
- It also includes the time and cost budgets since most study are done under these two constrains.

However, a good research design is often characterized by adjectives like flexible, appropriate, efficient, economics and so on. In general, the design which minimizes bias and maximizes the reliability of the collected and analyzed data is considered a good design. For the procedure of this research will be demonstrated in Figure 3.1. The figure describes the step arranged from literature review stage to conclusion of the research. Next section explains the details each step of the research design.

3.3.1 Literature Review

The main aim in carrying out the literature review is to collect the causes of factors affecting quality of construction works and be more understanding on the topic of this study. There are various sources of gathering such factors such as journals, paperwork, thesis, articles and books. The collected factors were divided into ten main factors such as design, owner, contractor, execution, quality system, supervision, labor, material, equipment and machine, and external factor. Additionally, each factor was contained cause of factor (see details in Chapter 4).

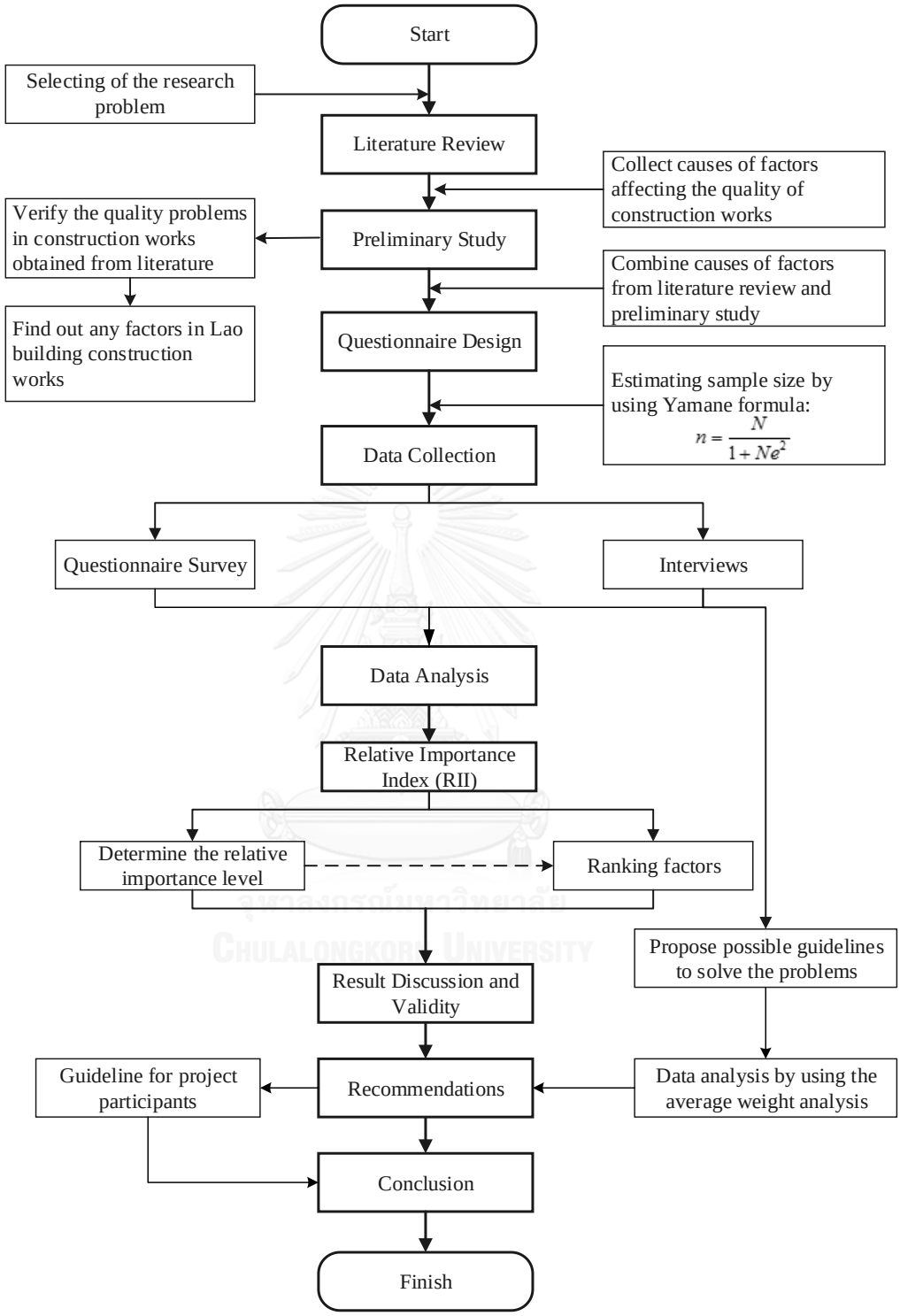


Figure 3.1 Procedures and framework of research methodology

3.3.2 Preliminary study

After gathering the causes of factors affecting the quality of construction works, the pilot study was conducted for testing the wording of the questions, establishing the length of the questionnaire, avoiding ambiguous questions, suggestions for analyzing the data, as well as testing the technique selected for collecting the data. The main aim of this preliminary study is to validate whether the questions are intelligible, easy to answer, unambiguous obtained from literature. To do that, the appropriate numbers of respondents for pilot study to enhance the questionnaire was conducted by Darwish (2005) with six experts. Therefore, the pilot study of this research was done with 6 construction experts in order to explore the quality of construction works in Lao PDR as well as exploring on factors affecting the quality of construction works. These experts, who has more than 10 years working experience in construction works, were interviewed. The details of experts were highlighted in Appendix D. In addition, they were requested to identify the internal validity and to what extent it was suitable to be used as an instrument to realize the goals and aims of this research. The group of experts has agreed that the questionnaire is suitable to achieve the studying goals with some amendments. After that, author has made these amendments in the structure and language of the questionnaire to be consistent with the local problems on quality of construction work context.

3.3.3 Questionnaire development

There are two sets of questionnaire developed. First, after verifying initial questionnaire was improved and then the second questionnaire has been developed in order that use to data collection. Questionnaire was used to evaluate the level of important causes of factor that affect the quality of construction works and rank order of such causes of factor. In addition, the questionnaire form separates into two parts. The first part is the respondent's demographics characteristics (e.g., educational level, age, experience, and occupation). The second part contains the causes of factor lists that affect the quality of construction works. The respondents were asked to assess the importance level of causes of factors affecting the quality of construction works by using five-point Likert scales from 1 to 5 (1-very low important; 2-low important; 3-medium important; 4 important and 5-very important) and they were asked to provide

the reasons of each factor as well. The questionnaire form will be illustrated in Appendix B.

The second questionnaire was conducted for studying guidelines to solve causes of factor affecting the quality of construction works. For details of questionnaire contents were shown in Appendix C.

3.3.4 Data collection

To achieve information that corresponds with the research objectives, this research considers two methods for collecting of data.

3.3.4.1 Data collection by interviews with questionnaire

The results of second objective in this research are conducted by the interviews with questionnaire method because the response is depended on the willingness of informants. The questions asked informants by using the close-ended and open-ended questions. The close-ended questions were conducted at the beginning; for example, does the labor's wages affect the quality of construction works? The respondents were evaluated by using five-point Likert scale. It was following by open-ended questions, which conducted to ask the respondent's opinion on the reasons towards each factor that affects the quality of construction works. A completed questionnaire form was used to interview with 32 respondents (27 RLPs and 5 RIPs). The details of sample size in this research will be indicated in the sample selection section 3.3.5.

3.3.4.2 Data collection by in-depth interview

Collecting of data by in-depth interview will be carried out in order to obtain a utilized information to be used as a guideline precisely ways not only for improving the quality of construction works in Lao PDR, but also reduce the probability of the events in the future. The questions often asked not only for information and opinions, but also allows the interviewer to probe the richness of emotions and motivations related to the quality solving. This method is simultaneously implemented with the questionnaire survey owing to limited time and budget for gathering data. Respondents should be the project director and project manager and project supervisors who are experts to provide a good recommendation for reducing and improving quality of building construction works in Lao PDR.

3.3.5 Sample Selection

The appropriate sample selection is the most important technique to acquire an accurate information from sample size as the representatives of others people in some area or some country. A large number of sample size is suitable for quantitative research by using statistical testing data, while a small number of sample is used for qualitative research with small group of sample size. This research conducted the quantitative and qualitative research, as mentioned in section 3.2. According to (Fellows and Liu, 2008) stated that the boundary between 'large number' and 'small number' statistics is at n = 32, although the size adopted in practice often is n = 30 (see Levin & Rubin 1998), where n is the sample size. To obtain more details and to pursue new and interesting aspects, the current projects were selected between medium and large projects where located in Vientiane. In addition, to ensure that the finding of this research reflect to the real situations in Lao construction works. The sample selection of this research is conclusively building construction projects located in Vientiane, the capital city of Laos. During period 2014 to 2015, there are 51 projects for local investors while 10 projects for international investors (theses number of projects collected from MPWT). The selected project size (both project area and height) as the sample of this research was illustrated in Table 3.1.

The sample of this research presents according to objective of this research, which consists of two objectives. The first objective is to determine the level of importance towards factors affecting the quality of construction works (corresponding to second objective of this research). This research was calculated the sample size using Yamane (1973) formula, as indicated in equation (1).

$$n = \frac{N}{1 + Ne^2} \quad \text{.....(1)}$$

Where, n : Sample size (Expected construction company)

N : Population size (Overall construction companies)

e : An error of sampling was approximately taken 20% or (allowed error = 0.20)

Due to the response rate basing on their volunteer feeling, this research was added for sampling error 20% of overall population targets, only 80% of confidence number. The result of expected sample size is highlighted in Table 3.2.

Another sample size determination for studying guidelines how to solve causes of factor affecting quality of construction works was selected sample subjecting to the respondent's working experience, who has experienced more than 15 years in the construction works. There are ten experts (7 experts in local projects and 3 experts in international projects) target were selected from respondents, who evaluated level of cause of important causes of factors, were used as sample size of this objective, as indicated in Appendix D.

Table 3.1 Level and size of the project in Lao PDR

Level 1	Level 2	
Large Project	Medium Project	Small Project
• Building area more than 10,000 m^2 • Building height more than 26 m	• Building area between 2,000 m^2 to 10,000 m^2 • Building height between 12 m to 26 m	• Building area less than 2,000 m^2 • Building height less than 12 m

(Source: Rules on governing construction, MPWT, 2013)

Table 3.2 Sample size collecting from MPWT (2014-2015)

Type of project	Population size (N)	Estimated sample size (n)
Local project investors	51	16
International project investors	10	7
Total	61	23

3.3.6 Data Analysis

The selection of a good technique for processing collected data is a crucial method to correspond to objectives. There are many previous studies that were successfully used in the previous researches to assess the relative importance (Darwish, 2005; Andi and Minato, 2003; Enshassi et al., 2009; Al-Tmeemy et al., 2012) for analyzing data. This research use therefore the Relative Importance Index (RII) to

assess the relative importance of each cause of factor affecting the quality of building construction works. The important level is based on the numerical scores on the questionnaire responses. The next section will describe in detail of how the relative importance index is done.

3.3.6.1 Relative Importance Index (RII)

This tool is conducted to determine the importance of the various factors identified contributing to poor quality of construction works. The five-point scale ranged from 1 (very low important) to 5 (very important) were used. This tool is an ordinal scale value assigned for each response appearing in Table 3.3. Ordinal scale contains the numbers that indicate the relative position of the objects but not the magnitude of difference between them. For example, ranking the causes of factors affecting the quality of construction works by the respondents.

Table 3.3 Measurement scale of relative importance level

Ordinal scale	Criteria	Description
1	Very low important	Very low affects the quality of construction works
2	Low important	Low affects the quality of construction works
3	Medium important	Medium affects the quality of construction works
4	High important	High important affects the quality of construction works
5	Very high important	Very high important affects the quality of construction works

The score for each factor is calculated by summing up the scores given to it by the respondents. The relative importance index (RII) was calculated by using the following formula (Fagbenle et al., 2004):

$$RII = \frac{\Sigma P_i U_i}{N(n)} \text{.....(2)}$$

Where,

RII = relative importance index

P_i = respondent's rating the causes of factor affecting quality of construction works

U_i = number of respondents placing identical rating on causes of factors affecting quality of construction works

N = total sample size

n = the highest attainable score (i.e. 5 in this case)

The relative importance index for all the low quality factors and groups is calculated by using the equation (1) above. The indices are ranked by owners, consultants, contractors. The group index is the average of relative importance index of low quality factors in each group.

Example:

There are five respondent's responses the important level of unskilled labors (F1) as in Table 3.4.

Table 3.4 Using RII formula for determining important level of causes of factor affecting quality of construction works

Respondents	Likert scale					N	$\sum P_i U_i$	RII
	1	2	3	4	5			
Local projects		1	6	12	8	27	108	0.80
International projects				3	2	5	22	0.88

- $RII = \frac{(1x0 + 2x1 + 3x6 + 4x12 + 5x8)}{27x5} = 0.80$ (For RLP)
- $RII = \frac{(1x0 + 2x0 + 3x0 + 4x3 + 5x2)}{5x5} = 0.88$ (For RIP)

3.3.6.2 The average weight technique

This technique is used to calculate the average weighted value to assess the agreement level of experts towards each guideline proposed. This research used rating scales to response to each questions. When designing a rating scale, a researcher must specify the number of points on the scale. A common using for responding number was a five (or seven) point scale which is used to allow the individual to express how much

they agree or disagree with a particular statement (Likert, 1932). In this research, the respondents evaluated the proposed guidelines by using five-point rating scale questions, as illustrated in Table 3.5 and the weighted average based on the weight assigned to each answer guideline. The rating average is calculated as follows:

$$The\ average\ weight = \frac{X_1W_1 + X_2W_2 + ...+ XnWn}{Total} .....(3)$$

Where:

W= weight of answer guideline

X= response count for answer guideline

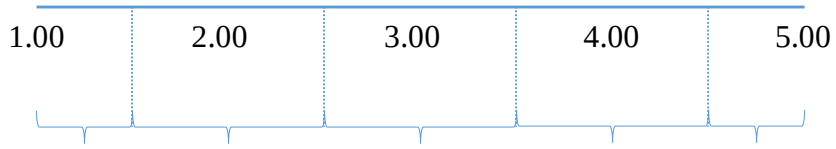
Table 3.5 Description the meaning of rating scale

Rating Scale	Measurement	Description
1	Very low agree	The proposed guideline is very low agree
2	Low agree	The proposed guideline is low agree
3	Medium agree	The proposed guideline is medium agree
4	High agree	The proposed guideline is high agree
5	Very high agree	The proposed guideline is very high agree

The principle of inference in order to rank order the average weight of agreement level among respondents can define the range of score, as shown in Table 3.6.

Table 3.6 Determine the interval score and interpret the average value (Srisatidnarakul, 2012)

The average Weight	Interpretation
1.00-149	Very low agree
1.50-2.49	Low agree
2.50-3.49	Medium agree
3.50-4.49	High agree
4.50-5.00	Very high agree



Interpretation:

Very low agree Low agree Medium agree High agree Very high agree

- Average score = 1.49 is not middle score between 1.00-2.00 (very low agree to low agree)
- Average score = 2.49 is not middle score between 2.00-3.00 (low agree to medium agree)
- Average score = 3.49 is not middle score between 3.00-4.00 (medium agree to high agree)
- Average score = 4.49 is not middle score between 4.00-5.00 (high agree to very high agree)
- Average score = 1.50 can interpret the meaning to be very low agree rather than to be low agree
- Average score = 2.50 can interpret the meaning to be low agree rather than to be medium agree
- Average score = 3.50 can interpret the meaning to be medium agree rather than to be high agree
- Average score = 4.50 can interpret the meaning to be high agree rather than to be very high agree

Based on the result of data analysis, the average weight of each guideline was calculated by using equation (3).

Example:

The weighted average of G1 = $\frac{(0*1)+(0*1)+(2*3)+(3*4)+(2*5)}{(0+0+2+3+2)} = 4.00$

Interpretation:

The average weight of G1 (Create and develop labor skills) equal to 4.00 indicates that the average sentiment among respondents to create and develop labor skills (G1) found in the level of agree among their responses.

3.3.7 Inferential Statistics

Essential statistical testing is used to verify some basic elements in the structure of the questionnaire. Summary of these testing are shown below.

3.3.7.1 Independent sample t-test

T-test was conducted to find if there is a significant difference between the ranking of the representative of the contractors and the consultants through the causes of factor affecting quality of construction works. T-test was carried out on the average weighted causes of factor resulted from ranking of each cause of poor quality problem in section 3.3.3 of the questionnaire development.

The research question:

"Do owner's representatives and contractor's representatives perceive causes of poor quality problems differently?"

The research hypothesis:

There is a significant difference in perception of owner representatives and contractor representative in local projects regarding to causes of poor quality problems. This difference is related to management techniques, resource management, motivation, and experience.

The null hypothesis:

There is no difference in perception of causes of poor quality problems between the owner's representatives and the contractor's representatives.

3.3.7.2 One-Way ANOVA test

One-Way ANOVA test was done to find if there is a significant difference due to the position of the respondent who filled the questionnaire. One-Way ANOVA test is used when there is more than one group belonging to one variable, as in our case the groups of director, project manager, project engineer, project supervisor, and site engineer are related to one variable which is position. The average weighted causes of poor quality problems were resulted from score of the respondents (section 3.3.4.1 of the questionnaire) are used in this test.

The research question:

"Do the position of the respondents affect the ranking of the causes of poor quality problems?"

The research hypothesis:

There is a significant difference in perception between the director, project manager, project engineer, project supervisor, site manager and site engineer towards ranking causes of poor quality problems.

The null hypothesis:

There is no difference between the director, project manager, project engineer, project supervisor, site manager and site engineer towards ranking causes of poor quality problems.

3.3.7.3 The spearman correlation coefficient test

The purpose of validating the statistical approach is in line with recommendation of Statisics.com (2004-2009). Therefore, the Spearman correlation coefficient will be used to find if there is a significant difference between the ranking of RLP and RIP. The Spearman test was made on the ranking of factors affecting the quality of construction works, as shown in Chapter V.

The research question:

"Do ranking of RLP differ from ranking of RIP through causes of factor affecting quality of construction works?"

The research hypothesis:

There is a significant difference in perception of respondents between local projects and international projects.

The null hypothesis:

There is no difference in the ranking of causes of factors affecting quality of construction works between RLP and RIP.

To test hypothesis of research, the Spearman rank correlation coefficient (rho) was conducted by using SPSS.

3.3.7.4 Cronbach's alpha test

There are three common ways to estimate the reliability of the measures: test–re-test reliability, inter-item reliability and inter-rater reliability. If two measurements of something yield very different scores, the measures must contain a high degree of measurement error. This research used Inter-item reliability to assess the reliability of the measurement as it is relevant for measures which consist of more than one item and assesses the degree of consistency among the items on a scale (internal consistency reliability). The test of Cronbach alpha was performed to measure the internal reliability of the items on a test or questionnaire and ranges from 0 to 1.0 and a Cronbach alpha coefficient over 0.70 was acceptable (Sekaran, 2000). In other words, the recommended acceptable cut-off level of 0.70 was employed in the present study. Additionally, the corrected item-total correlating all items has to be over 0.30, as suggested by Henryson (1971), Hair et al. (1998), and Palant, (2007). Their recommendations were applied in the research for the assessment of scale reliability and internal consistency.

However, Srisatidnarakul (2012) argued that before cutting-off in which value of corrected item-total correlation less than 0.30, the researcher should consider carefully whether cutting it out or should be improved further its values. Here are some principles to conduct as follows. In case of question in questionnaire is unclear, difficult to make understanding, or inconsistency of scale measurement should be cut-off. In case of the question is on the other hand consistent with attitude of measurement but it is unclear, it would not be cut-off but should be improved. The former reason is that if researcher cuts it out, sometimes it may be influenced the occupancy of contents that needs to measure.

CHAPTER 4
QUALITY OF CONSTRUCTION WORKS IN LAO PDR

4.1 General

This chapter explains the quality of construction works in Lao PDR. The data collection conducts by pilot survey with 27 RLPs and 5 RIPs who are the company's directors, project managers, project supervisors, project engineers, and site engineers in building construction projects located in Vientiane, the capital city of Lao PDR and then all of the collected data analyzes by using the relative importance index (RII) to assess the relative important level of each cause of factor affecting quality of construction works as well as ranking order of most important causes of factors. Additionally, the most significant factors discuss the ranking between RLP and RIP. This chapter describes consisting of construction sector in Lao PDR following by description of survey data in Vientiane, and determining the importance level the causes of factors affecting quality of construction works. Finally, the findings discuss from the perspective of the respondents.

4.2 Construction sectors in Lao PDR

Currently, the construction sector in Lao PDR is increasing around the country, especially in Vientiane, which is the capital city of country. Increasing of such projects reflect from there are many local and foreign investors being invested on construction sector such as office building, commercial building, shopping mall, hospital, etc. These projects can be separated by fund sources which includes both local investment projects and international investment projects. Most of local projects built as small project size such as office building, residential building, hospital, hotel and apartment. Conversely, as a part of international projects, most of projects built as big projects such as commercial building, shopping mall and 5 stars hotel. Future growth in the Laotian construction sector is likely to be fueled by high FDI in natural resources, high public investment including Official Development Assistance in infrastructure, and a current real estate boom in major urban center in the country. The trend is expected to continue at least in the medium term due to uncertainty in the long term. It is estimated that there are currently about 300 registered construction companies in the country and about

1,000 small contractors involved in construction works. They collectively employed more than one hundred thousand workers (the largest sector in terms of employment as estimated by the Lao Construction Association) (Group, 2013).

According to Vientiane Planning and Investment Department reported that there are between 700 to 800 investment projects in Vientiane, which were mainly funded by private investment in Specific and Special Economic Zones, general businesses and government land concessions (Newspaper, 2015). However, Lao construction sector relies heavily on imported skilled labor from China and Vietnam as well as a large number of skilled Thai workers due to lack of skilled labors in this country. According to the Lao Construction Association reported that the average proportion of foreign workers in the construction sector ranges from 30 percent to 80 percent depending on the size and sophistication of construction projects. The construction sector contains an infrastructure development project (e.g. electricity, water supply, health, education, transport and so on) and commercial construction projects have still in progress increasingly (Group, 2013).

4.3 Description of survey data in Vientiane

With increasing of such building projects, this research studies merely in Vientiane, the capital city of Laos as a case study because this area deems to be the most quickly development on economic and varies the construction projects. As mentioned in Section 4.2, the construction projects being implemented by both local and international investors. In this study, the local investment projects mean the project that funded by the local private, government whereas for international investment projects mean the projects that invested by foreign investor and joint venture with Lao government. The main investor is China, Vietnam, and Thailand in building construction projects, so that this study involves all of them.

Based on the information of the building construction projects were collected from department of urban planning and construction, MPWT of Lao PDR and obtained from site survey, there are totally 61 building construction projects (there are 51 projects for local investment and 10 projects for international investment) that being constructed in four main districts in Vientiane such as Sisattanak, Chanthabouly, Xaysettha, and Sikhottabong as population size of study. The surveyed projects during

data collection was shown in Figure 4.1 and Figure 4.3 for projects that invested by local investors and in Figure 4.2 and Figure 4.4 for projects that invested by international investors

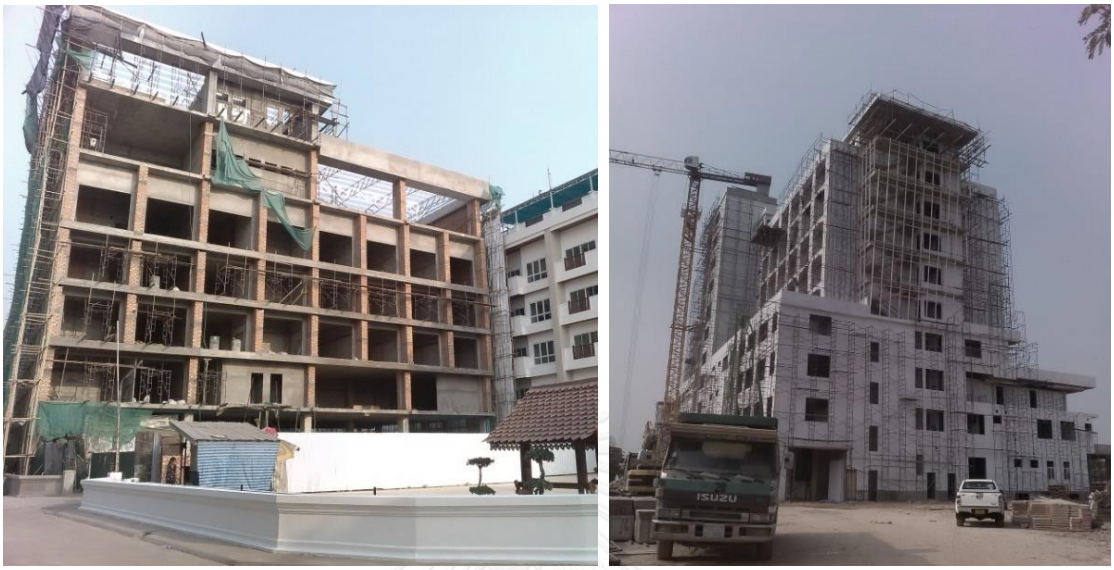


Figure 4.1 Local project investors in Vientiane

Figure 4.2 International project investors in Vientiane

Figure 4.3 Interview with a project manager of local consulting companies

Figure 4.4 Interview with project manager (left side) and site manager (right side) of international construction companies (Thai companies)

Selecting of such projects was based on the size and sophistication of the construction projects. Only a medium and a large project size were selected as the sample size (see in Chapter 3). The reason is that why this research focuses on a medium and a large current project. This is because the research studies about causes of factors affecting the quality of construction works, which is not only described the affecting factors towards quality of work, but it is also finding out an evidence of each factor by the site survey with taking photos. In addition, to ensure that the finding of this research reflect to the actual situations in Lao construction works. In terms of projects adopted for survey and respondents asked to answer the questions of this study can be separated to describe as follow: for local investment projects, researcher was surveyed both public projects and private projects. For public projects, most of surveys were the office building and hospital as a medium project size and these project employed local construction companies and consultant companies.

As a part of private projects were mostly constructed hotel, apartment, and office building. In some project however was not employed consulting company or personal consultant as the owner's representative but the owner leaves the contractors manage all of activities in construction project. However, for international investment project, they manage all process of projects, namely, financial, design, construction, material, equipment, and personnel. There are some projects were almost managed by their team, but all process were implemented under the rules of Lao government and law on construction of Lao PDR. For example, Latsavong Plaza project is the largest project in Vientiane, this project operation consists of 5 stars hotel, commercial building, shopping mall and variety facilities usage. The project invested by Chinese investor and the project inspected and monitored by the civil engineer of MPWT as representative of Lao government.

As a result, there are 16 largest building construction projects (5 international investment projects and 11 local investment projects) located in Vientiane, see more details in section 4.3.1, were surveyed and interviewed with the person who willing to cooperate answer questionnaire; however, they are the directors, project managers, project supervisors and project engineers. This study can be interviewed with questionnaire the owners, consultants, and contractor's representatives of totally 32 respondents (27 RLPs and 5 RIPs). For RIP, there are 3 respondents from Thai company

and 2 respondents from Chinese company. It took time around 2 hours to 2.30 hours per each interviewee as well.

4.3.1 Type of project

This research focuses on a medium and a large project scale. This research conducts with 61 construction projects in Vientiane Capital as the population. There are 51 local investment projects and 10 international investment projects. The expected sample size was calculated by using equation 1, which indicated in chapter 3 methodology of the research can be obtained 16 projects for local investment and 7 projects for international investment. In practice, there are only 11 local projects were surveyed and interviewed, which equal to 69% of expected sample size. On the other hand, there are only 5 international projects of 7 projects, which equal to 71% of expected sample size. However, the sample size was not as the expected number, this is because time contains in data collection as well as using individual interview technique. For detail of information was shown in Table 4.1 below.

Table 4.1 Number of surveyed projects in Vientiane, Lao PDR

Type of project	Population size (N)	Estimated sample size (n)	Actual sample size	Percentage (%)
Local investment	51	16	11	69
International investment	10	7	5	71
Total	61	23	15	-

4.3.2 Organization of the respondents

The data collection were done by the representative of the project owner, consulting or design companies, and construction companies in both local and international project investors. Table 4.2 and Figure 4.5 show the type of respondent organization; as a result, there are 2 project owner's representative (9% of overall local organization), 11 design and consulting companies (48% of overall local organization) and 10 construction companies (43% of overall local organization). However, there are only 5 respondents for overall international projects involving in this research.

Table 4.2 Respondent's organization

Type of organization	RLP		RIP	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Consulting Company	13	57	2*	40
Construction Company	10	43	3**	60
Total	23	100	5	100

Note: (*) means that there are two projects (ITECC and Thongkhunkham Market). These projects have a concession by Thai investor and each project has one representative of the owner, consulting and construction companies can participate to answer the questionnaire.

On the other hand, (**) means that there are three projects, as explained more in details as follows:

- Project A (Latsavong Plaza) has a concession by Chinese investor and constructed the project by Chinese contractor as well as consulting company. This research can interview only one person who is the representative of the contractor due to not availability of one who is the representative of the consulting company.
- Project B (Vientiane Center), this project has a concession by Chinese investor and constructed by Chinese contractor as well as consulting company like the same with Project A. only one person who is the representative of the contractor can be available time to answer the questionnaire.
- Project C (Asian Trade Center), this project has a concession by Taiwan investor, consulting of the project by the owner, and constructing by Thai company. Only one person who is the representative of the contractor was interviewed for data collecting in this research.

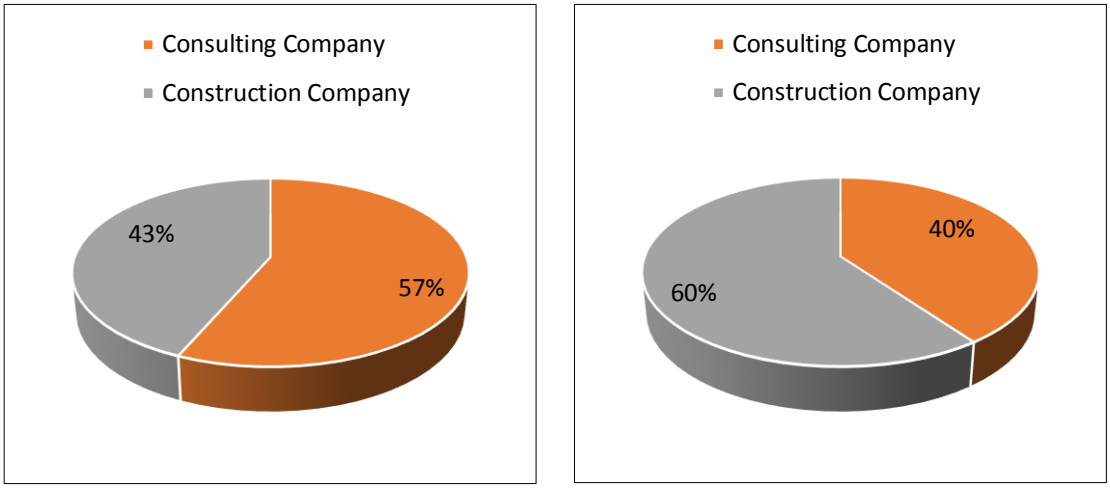


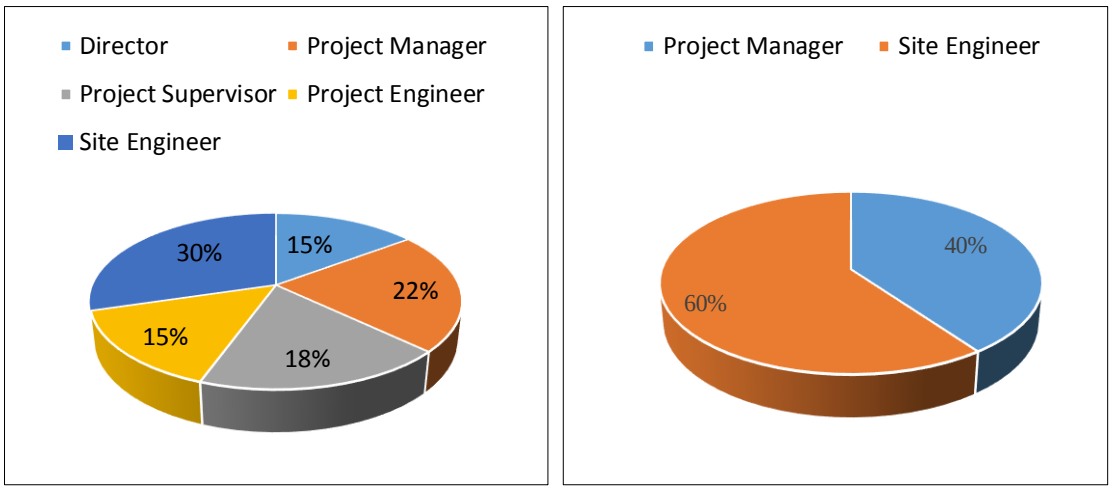
Figure 4.5 Organization of RLP (left hand side) and RIP (right hand side)

4.3.3 Position and number of the respondents

The respondent's position of this research was interviews with the project directors, project managers, project engineers, project supervisors, site engineers, and site engineers. There are 27 RLP (4 directors, 6 project managers, 5 project supervisors, 4 project engineers, and 8 site engineers) were interviewed. On the other hand, there are 5 RIPs (2 project managers, and 3 site engineers) were interviewed. The details were shown in Table 4.3 and Figure 4.6.

Table 4.3 Position and number of RLP and RIP

Position	RLP		RIP	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Director	4	15	-	-
Project Manager	6	22	2	40
Project Supervisor	5	18	-	-
Project Engineer	4	15	-	-
Site Engineer	8	30	3	60
Total	27	100	5	100



(a) RLP (n_1=27) (b) RIP (n_2=5)

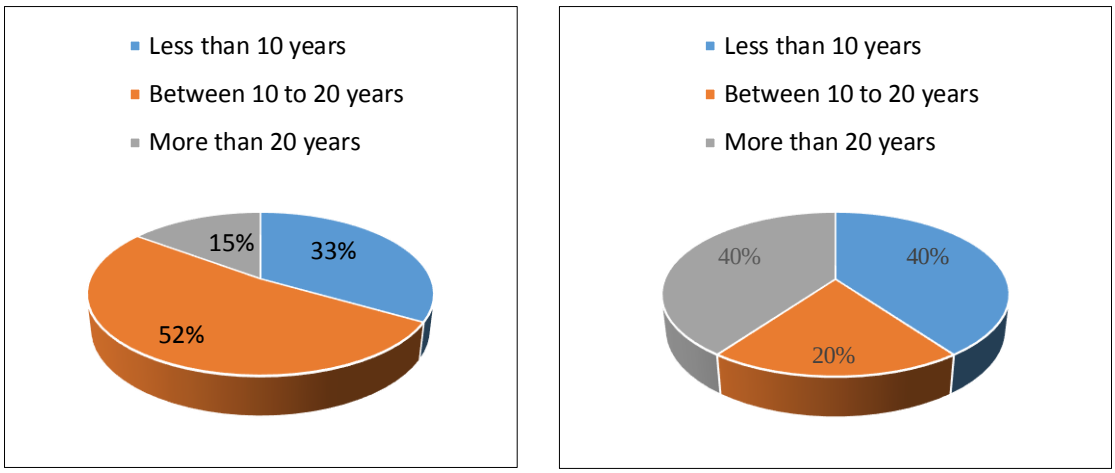
Figure 4.6 Number of the total respondents both RLP and RIP (n=32)

4.3.4 Working experience of respondents

The method of the respondents is important factor affecting the output of the study. So that this research has varies working experience of the respondents, which arrange from 5 to 31 years working experience and categorized them into three groups. The first group was determined the experience less than 10 years; secondly, it determined between 10 and 20 years working experience. Last group was organized with respondent who has experience more than 20 years. If it evaluated as a percentage of each category, it can be described as follows: for experience less than 10 years, it equals to 33% for RLP; 40% for RIP. Another group of experience between 10 and 20 years working equals to 52% for local projects; 20% for RIP. The last group of experience more than 20 years equals to 15% for RLP; 40% for RIP, as shown in Table 4.4 and Figure 4.7.

Table 4.4 Working experience of the respondents

Working Experience (year)	RLP		RIP	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Less than 10	9	33	2	40
Between 10 to 20	14	52	1	20
More than 20	4	15	2	40
Total	27	100	5	100



(a) RLP (b) RIP

Figure 4.7 Working experience of the respondents involving the construction field

4.4 Explanation the reasons for causes of factors affecting the quality of construction works

Before this research explains the reasons of each factor affecting the quality of construction works, researcher would present on factors affecting the quality of construction, which obtained from literature and interviews with experts in construction work in Lao PDR. There are 35 factors were evaluated the relative importance index and divided into 4 groups, as shown in Appendix A for overall causes of factor that affecting quality of construction works in Lao PDR with sources of each cause factor, as shown in Table 4.5.

The following explanation will be provided the reasons of each factor affecting the quality of construction works, which discusses and show evidences according to site survey and the perspective of the respondents.

4.4.1 Project definition process

F1: Unclear owner's requirements for design (dimension, function or layout): actually, the requirements of the owner must be clearly defined at the beginning of the project and be agreed to by both the owner and design firm. The more time and effort are spent at the beginning in defining requirements, the more smoothly the project will progress. Objective setting is important because it provides a focus for scope definition, guides the design process, controls the construction process, and influences the motivation of the project team. According to the perspective of RIP stated that for international

project, the owner set specification of project out clearly in term of reference (TOR) to inform bidders preparing their documents , that means the owner is clearly specified level of quality. On the other hand, many local project owners need the lowest construction cost, so the quality of works is depended on the consultant defines as the owner budget. In this case, some owners was not hired neither individual consultant nor consultant company, meaning that, the owner selects or defines specification of material and quality of project by own self. From interviews, most of respondents state that the budget of local project owner is a main problems that affects the quality of work as the owner needs with low cost construction. This is clearly implied that its specification of material or products may not be as quality needs. As a result, it will result in the stability of structure and age of material or products operation shorter. As a result, the changed works may affect the cost overrun, increasing schedule, including the quality of other works. For example, once of housing construction project has been delivered to the project owner and the owner operates the building, at that time, the owner needs to change function of operation space to working room or changing for working room to be spaced area.

- *Evidence:* the reason of unclear owner's requirements, the budget of the owner is a major problem that affects the quality of works as the owner's budget has a little bit in which cannot complete the project. Upon time running, the owner's requirement would change mind and offer to change some works, even though that works nearly finished or already finished.

Table 4.5 Causes of factor affecting the quality of construction works in Lao PDR

Code	Causes of factor affecting the quality of construction works in negative aspects	Sources
F1	Inadequate owner's need and project objective	[19]
F2	Low experience and knowledge of designers	[10]
F3	Lack of local regulation on design level of designers	[*]
F4	Effect of design code and standard on quality	[1]
F5	Low quality drawing and specification	[2-6]
F6	Lack of coordination and communication among design parties	[1] [10]
F7	Improper conditions of the owner for employing contractor	[*]
F8	A written contract conditions with unclear specifications	[19]

Table 4.5 Causes of factor affecting the quality of construction works in Lao PDR (Continued)

Code	Causes of factor affecting the quality of construction works in negative aspects	Sources
F9	Limited construction duration	[15]
F10	Low experience and competency project manager	[13]
F11	Disorder construction management and erroneous construction sequence	[7]
F12	Lack of technical and professional expertise and resources to perform task	[13]
F13	Unfollowing the norms of construction quality acceptance and operating procedures	[7]
F14	Lack of training course on quality for staff	[8] [13]
F15	Improper personnel allocation to their tasks	[*]
F16	Undocumented construction	[6-7]
F17	Unclear or incompleteness shop drawing and specifications	[8]
F18	Improper construction method or technique	[10]
F19	Change order during construction by the owner	[*]
F20	Communication issue between Laotian and foreigner on construction site	[9-10]
F21	Lack of coordination between design and contractor parties	[*]
F22	Lack of establishment of local quality system	[3-4]
F23	Lack of local quality inspection system	[*]
F24	Lack of local quality control and assurance system	[*]
F25	Low experience and competency of supervisor	[4] [20]
F26	Lack of full-time supervision and inspection	[6] [12-14] [18]
F27	Lack of coordination between the contractor and the supervisor	[*]
F28	Lack of skilled labor	[7-8][11-12][14-15]
F29	Low labor's wages/ Worker’s ignorance or negligence	[*]
F30	Use of poor quality material and products/Improper material usage as the specifications in contract	[7][18]
F31	Poor management of storage and usage	[7]
F32	Poor document control (poor report of material checking and testing)	[8]
F33	Use of improper equipment or a machine for construction	[12]
F34	Poor equipment or a machine-operator’s skill	[*]
F35	Poor climate condition during construction	[7] [15-17]

Note: [1] Lukumo (2012), [2] Rateb (2014), [3] Amirhossein et al. (2011), [4] Amer (2002), [5] Arditi et al. (1999), [6] Building Research Establishment (1987), [7] Cao (2010), [8] Abdul-Rahman (2012), [9] Janipha and Ismail (2013), [10] Andi and Minato (2003), [11] Hang (2010), [12] Hoonakker et al. (2010), [13] Callistus et al. (2014), [14] Adenuga (2013), [15] Ali and Wen (2011), [16] Jha and Iyer (2006), [17] Ahzahar et al. (2011), [18] Tenzin (2005), [19] Oberlender (2000), [20] Alwi, et al. (2001) and [*] new factors gathering from pilot study in Lao construction sites.

4.4.2 Design process

Design phase is a one factor that affects the quality of work in construction phase because if the design process conducts with good quality, it means that the construction quality meet the requirements of the project. The following explanation will discuss the design factors affecting the quality of construction works as follows:

F2: Low experience and knowledge of designers: according to the interviewee's perspective stated that most of designers are still low experience and knowledge for design and construction techniques. This is because most of them have experienced from previous projects for designers, who passed work before. In terms of knowledge of designers are mostly learned from university and training course from senior designers. However, most of designers just design merely a small to medium projects, but no experience for high-rise building due to up to now there is no high-rise building project in Lao PDR, which designed by Lao designers. This problems still have many limitations such as limitation on height of the building, economic of the country, trust of the owner to competency of designers and so on. Additionally, Lao designers have a good design, but less knowledge on construction techniques. Hence, as a result, this factor may affect the constructability of the constructor to follow as the design guides and it may result in poor quality of construction works in case of revising some items. Moreover, it may result in the design duration and construction for adjusting design and rework in the construction site. For instance, the designer designed the stair's direction of four residential buildings; as a result, after the construction of building completed, the owner can be detected its stairs were wrong direction with Feng Shui).

- *Evidence:* in practice, the owner needs to hire designers who just graduate the bachelor's degree to design the building, even though the owner has known they just graduate and have a young experience in design. However, this is hard to avoid due to the design fee lower than professional designers.

F3: Lack of local regulation on design level of designer: in Laos, there is no standard or law stating on the responsibilities of the designers. So, this factor may result in conflict between designer and the owner or community if the building failure, which occurred by design. In addition, it may affect the quality of construction work in case of the owner hires who offers lower cost of design, as mentioned in *F3*.

- *Evidence:* In Laos, there is no rule or law on building control, which still under consideration of the government and relevant parties.

F4: Effect of design code and standard on quality: in Laos, so far, there is a construction law, but there is no unified national codes for design of buildings. Therefore, architects and engineers just followed on some foreign country codes like American, French and Russian. Only urban law is now expected to be approved by the National Assembly in this session. However, each standard there is a little bit difference like safety factor of building, etc. So that it is based on the designer to choose in which one is appropriate or nearly with situation of each region. If designers missing to do that, this will be affected quality of construction works in terms of beauty of final products and appropriate operations of the owner. For instance, the designer follows the American or French design standard. The building code which mostly used for Local designers are the international building code (IBC), as shown in Figure 4.8 and the ACI code, as shown in Figure 4.9 and. However, the design code of each country has a little bit owing to differencing on environment and geography. If they lack of taking into account on local condition, as a result the dimension and size of structural members may be bigger than real one.

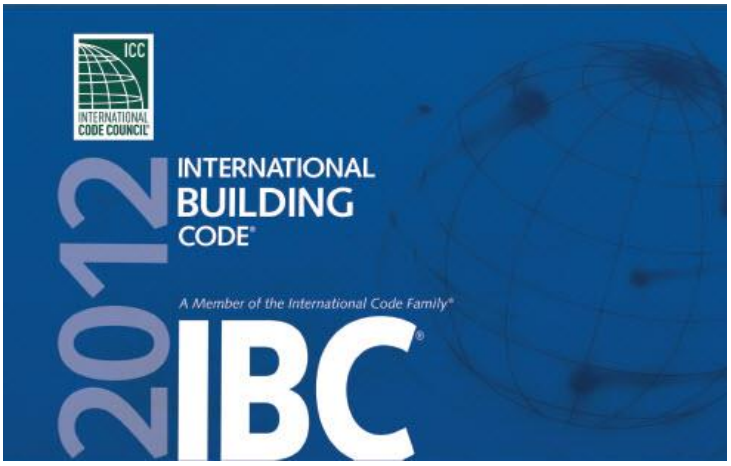


Figure 4.8 International building code (2012)

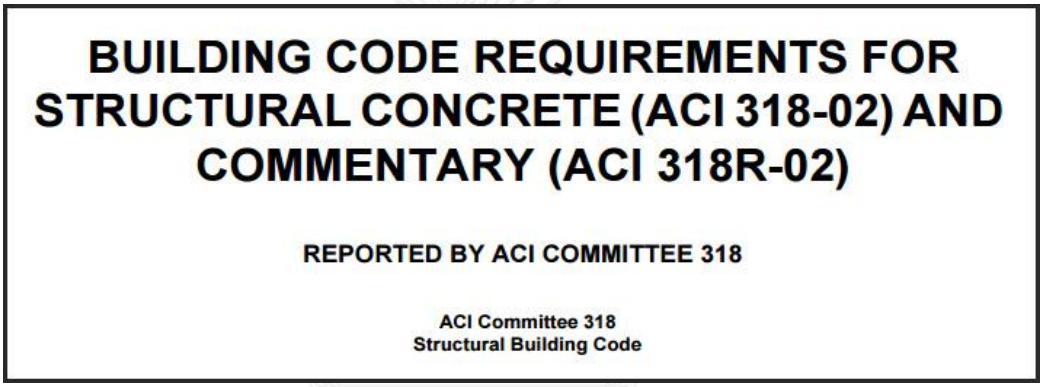


Figure 4.9 Building code requirements for structural concrete (ACI 318R-02)

F5: Low quality drawing and specification: preparing the design and documents is vital task for designers to service as the owner's requirements. A good quality of drawing and specification is one that most important thing that all designers should produce performance and service on time and good quality. Some respondent stated that initially in design documents include drawing, bill of quantities (BOQ), and construction technology manual, but in fact, the latter is rarely used in local projects, as shown in Figure 4.10 highlighted the construction specification and technique manual created by designer for international projects to guide regarding the specification, scope of work, and construction technique. However, the service of the designer in terms of low quality of drawing and specification is still issued, which may cause by many reasons. The first reason is resulted from defection between the designer and the owner's agreement on its specifications such as misunderstanding of either designer or owner explains

regarding agreement the use of each material. Another reason is from design fee is quite low. The most important thing is that insufficiency of designer or designer team for reviewing the drawing and specification. According to respondents stated that these cases are often occurred in measuring of dimension and specifying the specification of each material unclearly, as shown in Figure 4.11 the dimension specified with small scale, it indicates to low quality of drawing. Hence, these reasons may affect the quality of work in terms of material wastage and taking more time on account of reworks. For instance, a part of unclear drawing is mostly affected the operation during construction phase such as marking of dimension and setting point to install electrical and piping works, as shown in Figure 4.12.

❖ *Evidence:*

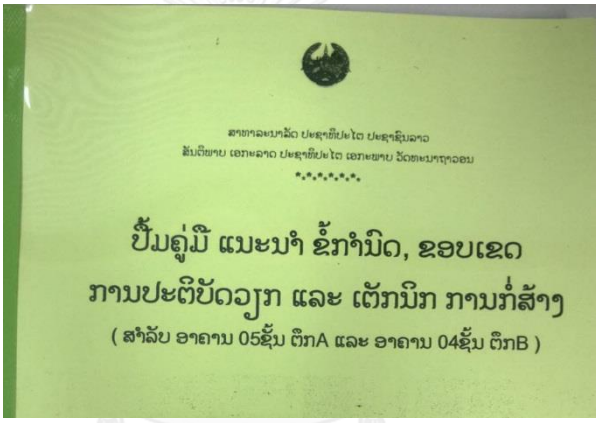


Figure 4.10 Construction specification, scope and techniques manual for international projects

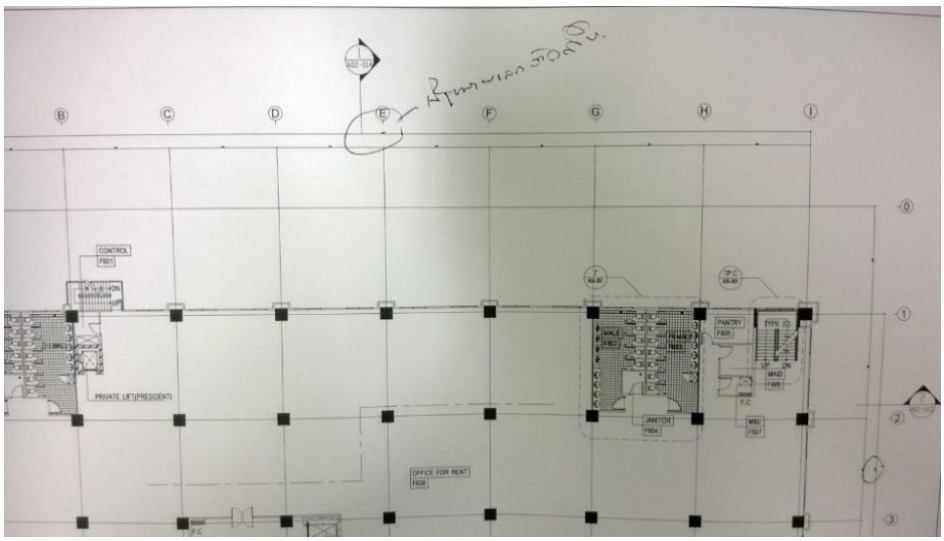


Figure 4.11 Unclear dimension of plan drawing

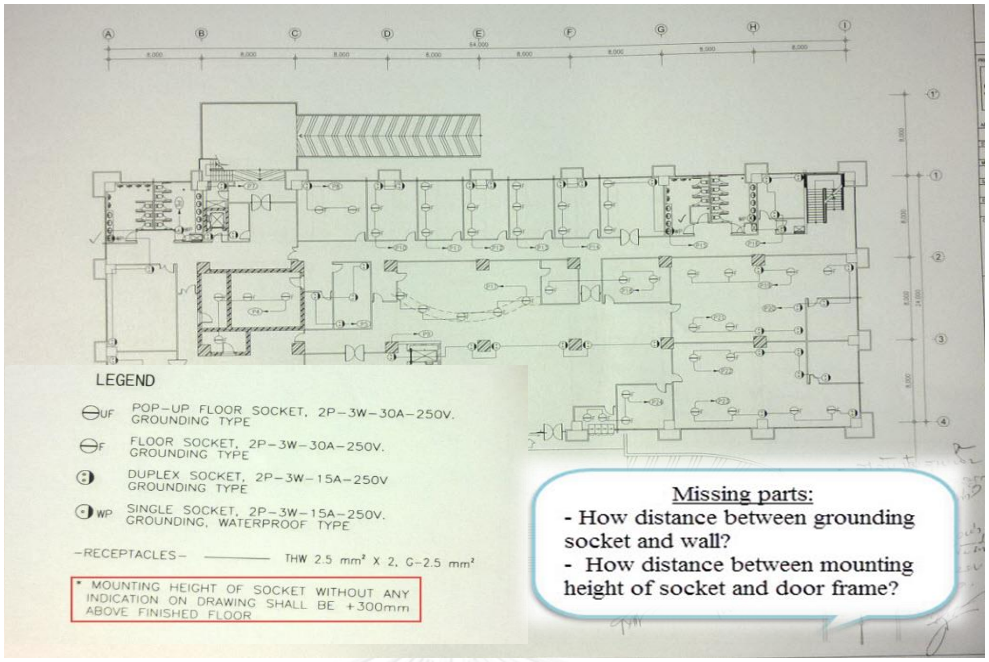


Figure 4.12 Unclear drawing of electrical work

F6: Lack of coordination and communication among design parties: a good coordination and communication among design parties is to produce an effective design, without that it may result in changing some items during the construction and its effects the quality of works around due to destroying.

- *Evidence:* From interview, most of respondents stated that the designer in Lao PDR is independent company or freelance, which is unskillful in design. Some of designers have been working with big design companies, but their coordination with each other are still ineffective, especially between the architects and engineers.

4.4.3 Employment process

F7: Improper conditions of the owner for employing contractor: selecting the appropriate personnel with their ability is necessary thing to product a good quality of works. A common method in selecting contractor by the owner can be divided according to the size and sophistication of the projects. In other words, each project has a difference of methods (e.g. public project and private project is quite difference in terms of contract). Owner is usually selected the construction company by the negotiation type of contract in which considers a company offering the lowest bidder and image of company for private project; on the other hand, a common method of

public project owner is conducting by the means of bidding. However, according to respondent's opinion state that there is still have a gap of this method as bidder, who has experienced and big enough to operate the project, buys instruction to bidders document by own money and offer other bidder's name as instruction to bidders after that the one who awards the contract paid to them as amount that agreed to each other. Another international project owners are mostly employed the companies from own country to construct the project or can say they have "full-package" namely, they support financial resource, personnel all levels such as project manager, constructor, labors, and materials. Nevertheless, the method and condition of selecting contractor by the owner may be affected the quality of construction works in case of employing who offers the very low project cost as awarding contract. This will affect the completion of project as schedule as insufficient financial allocation as well as resulting in quality of works, if the contractor tries to reduce specification of material, including quantity of works to save the project cost.

In terms of selecting the consultant, some private project at the level of medium size to small one do not employ consultants in case of the owner can inspect work by own self, while a large project size is necessary to employ consultants as representative. A common method for selecting consultant is mostly based on the employment fee, plus image of company, but there are some project, the owner employs an individual consultant due to the lower cost of employment. As a result, it may affect the quality of construction work in case of employing the consultant, who is low experience and competency on inspection and control quality of works.

- *Evidence:* There are common method of employing the construction and consulting companies. For government projects, the owner advertises via newspapers or television, while local private project investors are conducting two types of contract such as bidding and negotiation contract. For international project investors, if a big project, they have companies from their country such as Latsavong Plaza invested by the Chinese investor, ITECC market invested by Thai investor and Crown Vientiane Plaza invested by the Vietnamese investor.

F8: A written contract conditions with unclear specifications: actually, the project owner must have a contract with the contactor, who awarded the construction contract. The terms should have payment statement, schedule, quality of material, construction technical specification, etc. in general, the owner has been followed the contract form as international standard such as FIDIC. For construction contract in Laos is subjected to the size and complexity of the project and agreement of parties. One of them should be clear in terms of the specification of material and construction techniques in construction contract. If not doing so, the problem may happen, which be chanced for contractor to change specification of materials and using low specification instead of material specified in drawing if lack of supervisor, who representative of the owner monitors regularly. As a result, it may affect the quality of material and stability of structure as well.

F9: Limited construction duration: normally, the construction duration was agreed between the owner and contractor in contract. In case of this factor is mostly occurred by the contractor hurries construction to reduce time, and saving cost of construction without approved by the supervisors or engineers. Consequently, inspectors or site engineers are insufficient inspection and testing of the work such as inadequate concrete vibration.

4.4.4 Construction and Supervision process

Contractor is a main role in construction phase as their responsibilities several things such as:

- performing construction work defined by the contract drawing and specifications using means and methods that are the contract's responsibility
- obtaining the permits related to the works for which the contractor is responsible
- developing and implementing a quality control (QC) plan for inspection and testing of the work
- developing and implementing a safety plan to ensure a safe work site
- delivering submittals defined by the contract drawing and specifications, such as:

- Shop drawings, manufacturer's drawings, calculations and data, and product information.
- Contract schedule updated monthly noting progress and looking ahead to upcoming work.
- Requests for payment supported by reports as called for in the contract.
- Record drawings of the as-built work.
- Operation and maintenance (O&M) manuals and training of agency staff called for in the contract specifications.

▪ Submit requests for information (RFI) to the CM to obtain clarification of the design intent.

▪ Submit requests for change (RFC).

F10: Poor experience and knowledge project manager of contractor on quality planning: in order to produce a good quality of works, the experience and competency of contractor is a major factor in quality control (QC) plan for inspection and testing of the work. If project manager is low knowledge and ignore the appropriate planning tools and established quality norms, it results in poor quality of construction works.

❖ *Evidence:* according to respondents stated that most of the construction project managers say on quality of the work, but they provide less importance problem than cost of the construction and profits.

F11: Disorder construction management and erroneous construction sequence: the project planning of each planner has a different process and technique depending on the working experience of them (i.e. project manager or construction manager), who organized the project planning and scheduling. If the planner conducts poor planning, it will lead to increase construction duration; as a result, it is necessary to make a new plan. However, it may be affected the quality of construction works in terms of planning of some works during a rainy season. For instance, if the construction planner plans the foundation work during a rainy season, it will lead to the strength of concrete ineffectively.

F12: Lack of technical expertise and resources to perform task: site engineer or quantity surveyor is a key person to control and monitor all activities of construction; therefore, the selecting of them to perform work is a crucial step to produce a good quality of works. From interviews stated that most of the contractors employ engineers, who just graduated from university as a site engineer. Even though they are less experienced on construction site such as construction technique of temporary steel frame installation, the contractors are still selected them to operate the works. If do so, it may be affected the quality of construction works.

F13: Unfollowing the norms of construction quality acceptance and operating procedures: according to the interview, there are several reasons for modifying the specification of materials or products without following as specification agreed in contract conducted by the contractor. The first reason was caused by the owner selected the bidder, who offers with lowest construction cost, as awarding construction contract. Another reason is that the conniving of contractor and supervisor to reduce quantity and specification of materials. This action will be directly affected the quality of final products.

F14: Lack of training course on quality for construction staff: the objective of training personnel is to upgrade their knowledge and learn new construction technologies. In addition, the contractors are often training the personnel on responsibilities to perform the work done as the goals of the project. But in practice, a small construction company paid time for training personnel owing to saving payment for course. For this reason, it may lead to poor quality of workmanship and construction works.

- *Evidence:* the training course for personnel is mostly conducted by meeting at every week before executing next works. The meeting discusses merely about construction techniques and reporting the progress of works while the discussion on quality of work is overlooked.

F15: Improper personnel allocation to their skills (subcontractors and construction labors): allocation the subcontractor and construction team as their competencies is a main factor to achieve the project's requirements and specifications. In real situation, it is difficult for contractor to hire the appropriate persons due to lack of skilled labors.

Consequently, the use of the inappropriate labors to their skills may result in poor quality of construction works.

- *Evidence:* due to lack of skilled labors in specific works and shortage of labors in construction sector of Lao PDR, the contractor employed raw labors, who have never worked in construction before.

F16: Undocumented construction when changing order (Not building to drawings or specifications): before the project commenced the construction, the drawing and other documents are required as the drawing is indicated the quality of work such as the specifications of material used and scope of requirements. So that if lack of construction drawing may result in poor quality of work completed. In this case occurs when the owner changed or modified some works during construction.

- *Evidence:* when changing order occurred during construction by the owner, actually, there is no official documents for that change. The owner and contract just express by oral contract to each other.

F17: Unclear or incompleteness shop drawing and specifications: with interviews and site survey, a small number of the respondents stated that some construction companies were not re-checked and created shop drawing for construction, just only follows the contract drawing received from designer. Others argued that all construction projects should be shopped drawing for construction in details in order to construct easier for constructor. Besides, there are two reasons of unclear or incompleteness of shop drawing. For one thing is caused by the contractor reviews drawing with incompletion. Yet another thing is the ability of draft man to shop of such drawings. therefore, unclear or incompleteness shop drawing and specifications, it may be resulted in the use of material with unsuitable specification as the specification needed as well as resulting in wrong dimension measurement. It is also affected the quality of final products.

F18: Improper construction method or technique: based on information from respondents stated that each constructor may have different methods or techniques of the construction. If constructors executed with inappropriate methods, it may lead to lose materials and time overrun because of spending time for corrective action of defective works. Moreover, it may result in poor quality of construction work. For

instance, based on site visit of one office building project, the work on site is pouring concrete for column. Similarly, during the operations, there is one constructor catch the column rebar and shaking it after pouring concrete finished a minute. This action is wrong way as the construction technique, as shown in Figure 4.13.

Figure 4.13 A wrong technique of column concrete pouring

F19: Changing order during construction by the owner: according to the interviewee's perspective stated that most of the owners changed order during construction because the demand of owner is inconstant about specifications of the project in design phase. These changes are mostly occurred in the change of operation function (e.g. moving walls or adding). This action may directly affect the quality of works.

- *Evidence:* naturally, if the owner's requirements is unclear at the beginning, design phase because of unfixing of the owner, the following problem is that changes the material or function of building operations.

F20: Communication issue between Laotian and foreigner on construction site: this factor involves affecting quality of works, if communication issue is ineffective between construction staff on site. Currently, the construction projects in Laos, there are a lot of foreign labors such as Vietnamese, Chinese, Korean, and Thailand. The

problem is happened with Vietnamese labors, most of them cannot understand Lao language while a little bit ones have listening and speaking skills. This issue may result in the operation of the works that cannot along as planned and technicality required.

- *Evidence:* there are a lot of foreign workers in Lao construction project such as Vietnamese, Thai and Chinese.

F21: Lack of coordination between the design and the contractor parties: a good communication both two parties is to control the construction items as design required. If do not so, it may bring about the structure failure. As interviewed in construction fields, some interviewees said that amount of not a lot of designers give all design documents (design calculation file, drawings) to contractor managed by own self owing to low design fee. Others expressed the reasons that both the contractor and designer attempted to connive with each other to reduce quantity of work by changing material specification. These actions may directly result in poor quality of construction works for a long time.

F22: Lack of establishment of local quality system: many researchers were defined the quality system of construction as the need of the owner to ensure that all construction processed conform to quality norms. Unlike developing countries standardization of quality system, ISO 9001 or others, Lao PDR has not established the quality system of construction work yet. However, this system is under consideration by the Association of Lao Architects and Civil Engineers (ALACE) to set up this system. To do that, "it is a talent task to achieve that because of not more competitors of the construction business in Laos and the owner's satisfaction to pay more for this system. In addition, lack of personnel who can establish this standard." One of ALACE member, said'. Others stated that the construction projects in Laos is a small to medium project, so that it is difficult to create a standard, while another interviewee argues that this is true at present but in the future is essential needed. Nevertheless, if there is not quality system, the supervisor may be paid on attention to inspect and supervise the construction activities onsite effectively. For this reason, it may result in poor quality of construction works.

F23: Lack of local quality inspection and control system: quality inspection is defined as a specific examination, testing, and formal evaluation exercise and overall appraisal of a process, product, or service to ascertain if it conforms to established requirements. The results are usually compared to specific requirements and standards for determining whether the item or activity is in line with the target. Therefore, if lack of inspection system for quality in construction, it is difficult to compare the results of completed works to inspection system due to lack of this system in Laos. It means that a common conducts as the requirements of quality inspection is based on the contract requirements, namely, the results are compared to the requirement specified in contract. According to site survey, most construction projects specified that all the contracted works are subject to inspection by the owner/consultant/owner's representative. A common quality inspection in construction project also conducted by checking of materials or products, including equipment received from suppliers. In addition, testing of raw materials and concrete must be finished before usage and re-test items or activities completed. However, through methods above there are several construction projects concerning with poor quality of construction, which caused by existing system is ineffective. The issue regarding experiences of the interviewees is a main factor in construction project because the employment of inspector or site engineer having a novice experience graduated from university.

- *Evidence:* for common quality inspection practices conducted by the means of checklist of items before starting the work, and inspecting after work done; on the other hand, the quality control is mostly conducted by collecting the sampling from factory or construction site and testing in laboratory or on construction site such as testing concrete compressive strength, or testing fresh concrete on site by the means of slump test (see in Figure 4.14 and 4.15).

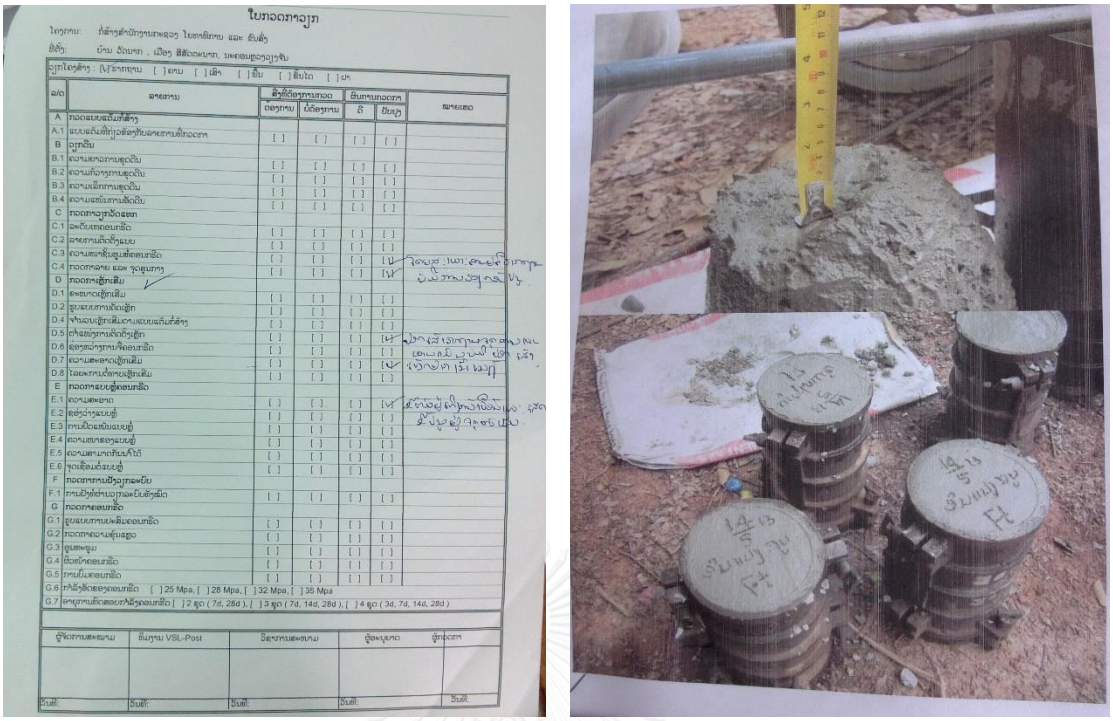


Figure 4.14 Sample of foundation work checklist (at the left side) and concrete test of slump and compressive strength (at the right side)

Figure 4.15 Compressive concrete test in Laboratory

F24: Lack of local quality assurance system: quality assurance is a program covering activities necessary to provide quality in the work to meet the project requirements. Quality assurance involves establishing program related policies, procedures,

standards, training, guidelines and system necessary to produce quality. The quality assurance program in Laos has not been established yet, but it is considering as step by step for establishing this program. A common carrying out of quality assurance in Lao construction is that the assurance of products supplied by the suppliers, concrete testing assured by the testing institute, and assured by the contractor about the construction that defects, which was resulted from the construction techniques. According to the perspective of respondents stated that if lack of this program, it may result in the owner's confidence and safety of community around. In other words, it may be affected the quality of construction works owning to neglecting of the project supervisors. On the other hand, quality control is the specific implementation of the quality assurance program and related activities. Effective quality control reduces the possibility of changes, mistakes and omissions, which in turn result in fewer conflicts and disputes. The procedure of quality control consists of planning, coordinating, developing, checking, reviewing, and scheduling the work. Based on site survey, most of construction projects employed site engineer as the contractor's representative while the project supervisor was employed by the owner to control quality of works. Moreover, they said that site staff is more affected the quality of construction works than existed quality assurance and control.

- *Evidence:* Figure 4.16 shows the certificate of concrete quality from concrete factory in Vientiane.

ສາທາລະນະລັດ ປະຊາທິປະໄຕ ປະຊາຊົນລາວ
ສັນຕິພາບ ເອກະລາດ ປະຊາທິປະໄຕ ເອກະພາບ ວັດທະນະຖາວອນ

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ວັນທີ 03 OCT 2014

ໃບຢັ້ງຢືນຄຸນນະພາບ

COMPRESSIVE STRENGTH TEST RESULTS

Project: ກໍ່ສ້າງສຳນັກງານກະຊວງໄຍທາທິການ ແລະ ຂົນສົ່ງ

Submit by : Phetlaiphone Concrete Factory

Item No.	Description	Sampling Date	Testing Date	Age Days	Slump Cm	Size Cm	Weight Gr	No Vehicle Time	Load Kn	Comp Strength Mpa	Average Mpa	Strength Requirement
1		19/09/14	26/09/14	7	8.0	15x30	12,580		450	25.48		
2	ຄົນເຮົາ	19/09/14	26/09/14	7	8.0	15x30	12,570		400	22.65	23.78	25Mpa
3		19/09/14	26/09/14	7	8.0	15x30	12,590		410	23.21		

Remark: CONCRETE STRENGTH..... 25 Mpa VOLUME ... .M^3

Place of testing . Lab of PLP. . . . . .

Tested by

Checked by

Manager of PLP

ບ.ຈາຍ ສຸລະເສີນ

ຖະໜົນກຳແພງ ເມືອງ,ບ້ານດອນກອຍ,ເມືອງຊີສັດຕະນາກ, ນະຄອນຫລວງວຽງຈັນ, ລຸ້ມ.ນ 4160
ໂທລະສັບ :021 350980.351246,330075 ແຟັກ: 021 351245, 330075
ເວັບໄຊ: www.phetlaiphone.com

Figure 4.16 Certificate of concrete quality from concrete factory in Vientiane

F25: Low experience and competency of project supervisor: supervisor's jobs are to use available resources effectively and efficiently. In other words, a good supervisor would be able to comprehend in-depth about the construction, including drawing and planning. Based on the perspective of respondents said that Lao supervisors are still low experience and knowledge because it was highlighted in terms of making decision of supervisor some works in construction site not being decisive. A wrong decision was directly resulted in modifying or removing some items or activities of construction work; as a result, it may be led to poor quality of construction works.

F26: Lack of full-time supervision and inspection: to meet the value at the end of the products or services, the supervisor should be executed all items or procedures regularly and continuously. From site surveyed and interviews indicated that all of projects surveyed have supervisor or site engineer to ensure that all activities on site job followed as the specification of the project required. Nevertheless, there are some respondents argued that even if each project has a supervisor, they are still worked overload due to some person was responsible more than one construction site. This is a reason of lack of timely inspection. Therefore, it may result in the defection of construction and lead to poor quality of the final products. Besides, some respondents also argued that lack of timely supervision and inspection may affect the time increases owing to waiting the supervisor's checking before the construction beginning.

F27: Lack of coordination between the contractor and the supervisor: a good communication and coordination between the contractor and supervisor was a reason of producing good quality of construction works in accordance with specific requirements. From interviews, researcher can be concluded it into two aspects concerned with coordination of site staff in construction field. To begin with the communication between the contractor and supervisor has been good relationship in some projects. This is revealed by the respondents that some projects the contractor and supervisor, who was represented the owner, was trying to connive for reducing quantity, quality, including specifications. Other respondents provided a different perspective of this factor affecting the quality of construction works that ineffective coordination or misunderstanding communication between both parties may be resulted in changing or modifying some items and affected the quality of construction works.

F28: Lack of skilled labors: according to the interviews with respondents reported that experience and skill of labor is unsatisfied and unskilled because most of Lao laborers came from rural areas, which has not passed a technical school before entering to work in construction site. They enter to working in construction industry is only as part-time of them, after they harvest rice season. Moreover, the limited job opportunities in rural areas, it is resulted in unskilled laborers. Through this problem, almost construction projects are difficult to produce a good quality as the owner's satisfaction.

- *Evidence:* Figure 4.17 indicates the wall cracking that resulting from low labor skills.

Figure 4.17 Cracks in wall resulting from lack of skilled labors

F29: Low labor's wages: the wage of labor in Lao PDR is lower than other developing countries, especially ASEAN countries. According to the National Assembly convention holed on December, 2014 reported about the rising of labor wage from 626000 LAK (78 USD) to 900,000 LAK (112 USD) per month, H.E. Ms. Onechanh Thammavong, Minister of Labor and Social Welfare said. This value is very low if comparing with others countries, especially ASEAN countries. With low wage of workers, many construction projects is concerning with insufficiency of workers and this issue resulted in poor workmanship and poor quality of construction works.

- *Evidence:* the wage of labor in construction collected from the respondents

Table 4.6 Labor's wage in construction project of Lao PDR

Type of labor.	Local labor salary per month (USD)	Vietnamese labor salary per month (USD)
Foreman	12.5-18.75	18.75-25
Draft man	10.5-12.5	12.5-15
Men workers	9.5-10	11.25-18.75
Women workers	8.75-9.5	-

(Note: 1USD = 8,000 LAK)

F30: Use of poor quality material and products (Improper material usage as the specifications in contract): with the construction projects surveyed, selection of material was followed as specifications in contract. Due to lack of availability a good quality of locally materials, the contractor would be promptly informed the owner to consider other material that equivalent to specification instead of the specification, which was specified in contract. However, the reasons for influencing quality of construction works as mentioned in *factor 6*, it brought about selecting of materials is not along the requirements of the project.

F31: Poor management of storage and usage: in Laos, site layout management is quite ineffective in a large project where placed material storage and tools. To be clear this factor, from site survey indicated that most of projects they kept merely cement and tools indoor construction building and stored in a hut while steel or rebar just leaves outdoor because of limited construction site, as demonstrated in Figure 4.18 about the placing of steel bars in construction site. This action may lead to poor material efficiency, especially in rain season.

Figure 4.18 Placing of steel rebar in local office building construction project

F32: Poor document control (poor report of material checking and testing): inspector or engineer is responsible for checking of the materials or products since it was arrived and tested it before usage and installation. In practice, inspector just reviews the certificate of received materials from factory whereas inspector does not confidence that such materials corresponding with the certificate of material quality or not and then brings it to re-test to ensure that these materials conforming to specifications required. If not, it may lead to structure failure either during construction or operation phase.

F33: Use of improper equipment or a machine for construction: based on interviews and site survey with several local construction projects can be summarized that the use of some equipment was inappropriate to work because of inadequate equipment. The reason of this insufficiency is because the some contractors do not need to rent or purchase such equipment for saving of direct costs.

F34: Poor equipment or a machine-operator's skill: due to increasing of new modern technologies, which is paying important role in construction industry, the high experience and skill of operator was required. For instance, a high-rise building project is necessary skilful operator to control the piling machine; however, if applied the operator who was unskilled, it may affect the deviation of pile direction and result in pile failure during execution.

F35: Poor climate condition during construction: Construction between May to October is the project manager or site manager should be considered carefully in monitoring and predicting weather every day before work days. According to the interviewee stated that the climate condition during construction is based on planning in advance by the site manager deals with the weather in advance. If not, a bad climate during construction affects the quality of workmanship, including quality of construction works such as the concrete pouring work.

- *Evidence:* the annual monsoon cycle was gives Laos two distinct seasons: May to October is wet and November to April is dry. Temperatures vary according to attitude of each region in the country.

CHAPTER 5
IMPORTANT LEVEL FOR CAUSES OF FACTOR AND DISCUSSION

5.1 General

This chapter explains the results of data analysis and discusses the finding of the research, which explains in the following steps. To begin with the result of data analysis, determining the importance level of causes of factors affecting the quality of construction works and interpreting the results of each group was presented. These causes of factors are then tested the consistency among respondents by using Spearman's rank order coefficient correlation, and Cronbach's alpha is also conducted to validate the relative important level among respondent's perspective. The results can explain the ranking of both RLP and RIP related to project definition, design, employment, and construction and supervision process. In addition, top ten most important causes of factor discuss in each group of the respondents. The result of validating the ranking of two parties found that the most important causes of factors affecting the quality of construction works are considered very important to RLP are less important to RIP. For the result of the reliability test indicated that it indicates that internal consistency reliability value of both respondent exceed 0.7, it means that responses among RIP are very high reliability.

5.2 Determining the important level of causes of factors affecting the quality of construction works

This research aims to identify causes of factors affecting the quality of construction works and to assess the relative important level, and find out the guidelines to reduce the most important causes of factors affecting quality of construction work in Lao PDR. Therefore, in order to fulfil the second objective, this research applied the relative importance index (RII) technique to analyze data were collected from 27 RLPs and 5 RIPs by individual interview with company's directors, project managers, project supervisors and project engineers, and site managers of the building construction projects in Vientiane. Raw data obtaining from interviewing with respondents that mentioned above was shown in Appendix E.

The process of determination an important level of each factor and ranked by opinions of RLP and RIP conducts as follows.

1) RLP and RIP rate the important level to each factor evaluated by using five-point Likert scale of 1 to 5 (1-very low important to 5-very important).
2) Researcher calculates the collected data with RII, as indicated in equation 2, to determine important level and to prioritize such factors by averaging value of each group.
3) Each factor was ranked order and separated between ranking of RLP and RIP and the priority was ranked from the most important factors to least important ones, as illustrated in Table 5.1.

The results of data analysis from 27 RLPs and 5 RIPs for causing of factors affecting the quality of construction works was present in overall factor (see in Table 5.1 shows the relative important index of causes of factor affecting quality of construction works from RLP) and top ten significant factors (see in Table 5.2 for RIP). Furthermore, the relationship between overall factors and the relative importance index of each factor was demonstrated in Figure 5.1.

Table 5.1 Rank of causes of factors affecting quality of construction works by RII from RLP

Code	Causes of factor affecting quality of construction works	RLP	
		RII	Rank
F1	Inadequate owner's need and project objective	0.497	34
F2	Low experience and knowledge of designers	0.676	21
F3	Lack of local regulation on design level of designers	0.598	29
F4	Effect of design code and standard on quality	0.582	31
F5	Low quality drawing and specification	0.762	8
F6	Lack of coordination and communication among design parties	0.681	20
F7	Improper conditions of the owner for employing contractor	0.796	3
F8	A written contract conditions with unclear specifications	0.671	23
F9	Limited construction duration	0.632	27

Table 5.1 Rank of causes of factors affecting quality of construction works by RII from RLP (continued)

Code	Causes of factor affecting quality of construction works	RLP	
		RII	Rank
F10	Low experience and competency project manager	0.768	6
F11	Disorder construction management and erroneous construction sequence	0.754	10
F12	Lack of technical and professional expertise and resources to perform task	0.712	16
F13	Unfollowing the norms of construction quality acceptance and operating procedures	0.728	14
F14	Lack of training course on quality for staff	0.552	32
F15	Improper personnel allocation to their tasks	0.738	12
F16	Undocumented construction (Not building to drawings or specifications)	0.664	24
F17	Unclear or incompleteness shop drawing and specifications	0.706	17
F18	Improper construction method or technique	0.736	13
F19	Change order during construction by the owner	0.487	35
F20	Communication issue between Laotian and foreigner on construction site	0.599	28
F21	Lack of coordination between the design and the contractor parties	0.544	33
F22	Lack of establishment of local quality system	0.690	19
F23	Lack of local quality inspection and control system	0.768	7
F24	Lack of local quality assurance system	0.757	9
F25	Low experience and competency of supervisor	0.774	5
F26	Lack of full-time supervision and inspection	0.782	4
F27	Lack of coordination between the contractor and the supervisor	0.753	11
F28	Lack of skilled labor	0.830	1
F29	Low labor's wages/ Worker’s ignorance or negligence	0.582	30
F30	Use of poor quality material and products/Improper material usage as the specifications in contract	0.801	2
F31	Poor management of storage and usage	0.703	18
F32	Poor document control (poor report of material checking and testing)	0.727	15
F33	Use of improper equipment or a machine for construction	0.673	22
F34	Poor equipment or a machine-operator’s skill	0.653	25
F35	Poor climate condition during construction	0.633	26

Based on the result in Table 5.1 indicated that the most important factor that affects the quality of construction works were lack of skilled labors with RII score of 0.830, improper material usage as the specification in contract with score of 0.801, condition for selecting the contractor by the owner with score of 0.796, and the least important of poor planning of construction operating procedures and techniques with score of 0.754, respectively.

Table 5.2 Summary of top ten important causes of factor affecting quality of construction works from RLP

Code	Causes of factor affecting quality of construction works	RLP	
		RII	Rank
F28	Lack of skilled labor	0.830	1
F30	Use of poor quality material and products/Improper material usage as the specifications in contract	0.801	2
F7	Improper conditions of the owner for employing contractor	0.796	3
F26	Lack of full-time supervision and inspection	0.782	4
F25	Low experience and competency of supervisor	0.774	5
F10	Low experience and competency project manager	0.768	6
F23	Lack of local quality inspection and control system	0.768	7
F5	Low quality drawing and specification	0.762	8
F24	Lack of local quality assurance system	0.757	9
F11	Disorder construction management and erroneous construction sequence	0.754	10

Table 5.3 Rank of causes of factors affecting quality of construction works by RII from RIP

Code	Causes of factor affecting quality of construction works	RIP	
		RII	Rank
F1	Inadequate owner's need and project objective	0.840	2
F2	Low experience and knowledge of designers	0.760	9
F3	Lack of local regulation on design level of designers	0.560	33
F4	Effect of design code and standard on quality	0.600	31
F5	Low quality drawing and specification	0.640	26
F6	Lack of coordination and communication among design parties	0.720	16
F7	Improper conditions of the owner for employing contractor	0.680	23

Table 5.3 Rank of causes of factors affecting quality of construction works by RII from RIP (continued)

Code	Causes of factor affecting quality of construction works	RIP	
		RII	Rank
F8	A written contract conditions with unclear specifications	0.760	10
F9	Limited construction duration	0.760	11
F10	Low experience and competency project manager	0.840	3
F11	Disorder construction management and erroneous construction sequence	0.640	27
F12	Lack of technical and professional expertise and resources to perform task	0.840	4
F13	Unfollowing the norms of construction quality acceptance and operating procedures	0.720	17
F14	Lack of training course on quality for staff	0.560	34
F15	Improper personnel allocation to their tasks	0.760	12
F16	Undocumented construction	0.840	5
F17	Unclear or incompleteness shop drawing and specifications	0.760	13
F18	Improper construction method or technique	0.720	18
F19	Change order during construction by the owner	0.720	19
F20	Communication issue between Laotian and foreigner on construction site	0.560	35
F21	Lack of coordination between the design and the contractor parties	0.640	28
F22	Lack of establishment of local quality system	0.760	14
F23	Lack of local quality inspection and control system	0.800	8
F24	Lack of local quality assurance system	0.720	20
F25	Low experience and competency of supervisor	0.840	6
F26	Lack of full-time supervision and inspection	0.680	24
F27	Lack of coordination between the contractor and the supervisor	0.600	32
F28	Lack of skilled labor	0.880	1
F29	Low labor's wages/ Worker’s ignorance or negligence	0.640	29
F30	Use of poor quality material and products/Improper material usage as the specifications in contract	0.840	7
F31	Poor management of storage and usage	0.680	25
F32	Poor report of material checking and testing)	0.720	21
F33	Use of improper equipment or a machine for construction	0.760	15
F34	Poor equipment or a machine-operator’s skill	0.720	22
F35	Poor climate condition during construction	0.640	30

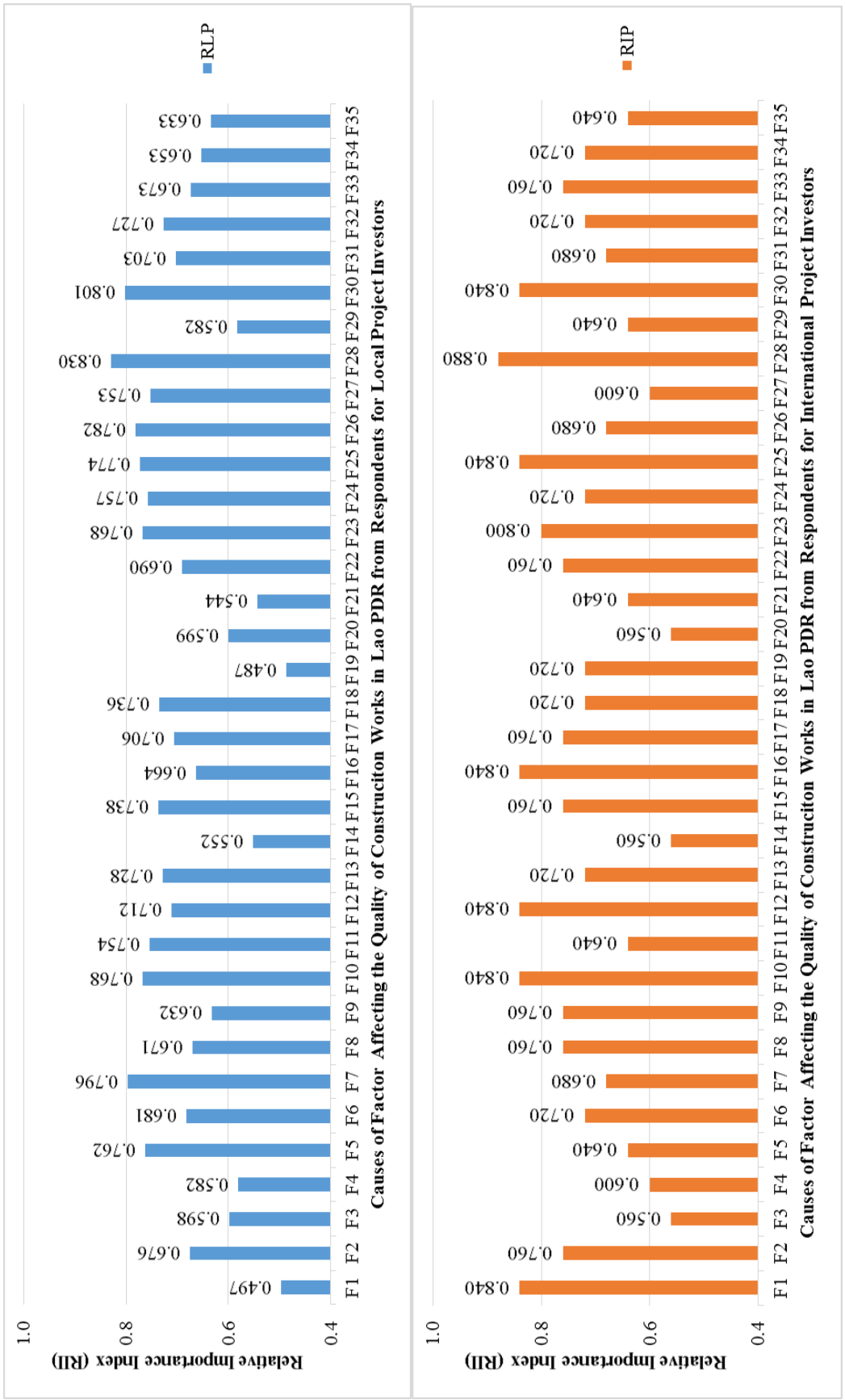

Figure 5.1 Overall causes of factor affecting quality of construction works in Lao PDR

Table 5.4 Summary of top ten important causes of factor affecting quality of construction works from RIP

Code	Causes of factor affecting quality of construction works	RIP	
		RII	Rank
F28	Lack of skilled labor	0.880	1
F1	Inadequate owner's need and project objective	0.840	2
F10	Low experience and competency project manager	0.840	3
F12	Lack of technical and professional expertise and resources to perform task	0.840	4
F16	Undocumented construction (Not building to drawings or specifications)	0.840	5
F25	Low experience and competency of supervisor	0.840	6
F30	Use of poor quality material and products/Improper material usage as the specifications in contract	0.840	7
F23	Lack of local quality inspection and control system	0.800	8
F2	Low experience and knowledge of designers	0.760	9
F8	A written contract conditions with unclear specifications	0.760	10

From the result in Table 5.4 indicated that the most important causes of factor affecting quality of construction works were lack of skilled labors with RII score of 0.880, unclear owner's requirements for design (dimension, function or layout of the project) with score of 0.840, poor experience and competency of project manager on quality planning with score of 0.840, and the least important of a written contract conditions with unclear specifications with score of 0.760, respectively.

If consideration about determining the relative important index as the project development, it can be summarized and discussed more in details as follows:

5.2.1 Project definition process

Based on the result from Table 5.1 summary of RII of RLP, it showed that inadequate owner's need and project objective (F1) has a RII score of 0.497 for RLP while RII score of 0.840 for RIP. This cause of factor was high important among RIP was less important among RLP. This is because RIP have been observed that unclear requirements of the owner for design is the most important factor that affects the quality of construction works because it may result in change of some works while construction

in case of unclear requirements of the owner. Consequently, it affects the quality of construction works.

5.2.2 Design process

Based on the result of RII in Table 5.5. It showed that low quality drawing and specification (F5) was ranked among RLP in the first position with RII score of 0.762. Following by lack of coordination and communication among design parties (F6) with RII score of 0.681, low experience and knowledge of designers (F2) with RII score of 0.676, Lack of local regulation on design level of designers (F3) with RII score of 0.598 and effect of design code and standard on quality (F4) with score of 0.582, respectively. It found that the problem of low quality drawing and specification by the designer was very affecting quality of construction works in Lao PDR. This is because there is no local standard on quality of drawing and specification, so most of designers set up by own pattern and commitment with cost of design from the owner. If low quality of drawing and specification, it may result in material usage may mismatch with the specification required.

On the other hand, the causes of factors related to design process in Table 5.6 were ranked among RIP. It found that the low experience and knowledge of designers was ranked in the first position with RII score of 0.760. Lack of coordination and communication among design parties (F6) was ranked in the second position with score of 0.720, following by low quality drawing and specification (F5) with score of 0.640 in the third rank, the effect of design code and standard on quality (F4) was in the fourth rank with score of 0.600, and lack of local regulation on design level of designers (F3) was ranked in the fifth rank with score of 0.560. The result found that low experience and knowledge of designers was very important affecting quality of construction among RIP. This is because if designer has a high experience in design with high knowledge, it may reduce design errors and poor quality of design document.

Table 5.5 Rank of causes of factor affecting quality of construction works related to the design process by RII from RLP

Code	Causes of factor related to design process	RLP	
		RII	Rank
F5	Low quality drawing and specification	0.762	1
F6	Lack of coordination and communication among design parties	0.681	2
F2	Low experience and knowledge of designers	0.676	3
F3	Lack of local regulation on design level of designers	0.598	4
F4	Effect of design code and standard on quality	0.582	5

Table 5.6 Rank of causes of factor affecting quality of construction works related to the design process by RII from RIP

Code	Causes of factor related to design process	RIP	
		RII	Rank
F2	Low experience and knowledge of designers	0.760	1
F6	Lack of coordination and communication among design parties	0.720	2
F5	Low quality drawing and specification	0.640	3
F4	Effect of design code and standard on quality	0.600	4
F3	Lack of local regulation on design level of designers	0.560	5

5.2.3 Employment process

The result of RII in Table 5.7 showed that the improper conditions of the owner for employing contractor was ranked among RLP in first position with RII score of 0.796, a written contract conditions with unclear specifications was in second rank with score of 0.671, and following by limited construction duration with score of 0.632. Based on the result of RLP in this process, it found that improper conditions of the owner for employing contractor was very important affect quality of construction work because according to the interview, the owner selects the contractor who is offered a lowest biding price awarding of contracts and selecting the consultant is based on with low cost in general.

However, in Table 5.8 showed the ranking among RIP towards important level regarding causes of factor affecting quality of construction works for employing process, it showed that a written contract conditions with unclear specifications was

ranked in the first position with score of 0.760, a limited construction duration was in the second rank with score of 0.760 and following by improper conditions of the owner for employing contractor was ranked in third position with score of 0.680. The reason for a written contract conditions with unclear specifications was ranked in first position. It is not surprising that unclear specifications in contract is more important for international perception than for local perception because all projects invested by foreigners are seriously followed in the international standard such as FIDIC, ADB, World bank standard, etc.

Table 5.7 Rank of causes of factor affecting quality of construction works related to employment process by RII from RLP

Code	Cause of factor related to employment process	RLP	
		RII	Rank
F7	Improper conditions of the owner for employing contractor	0.796	1
F8	A written contract conditions with unclear specifications	0.671	2
F9	Limited construction duration	0.632	3

Table 5.8 Rank of causes of factor affecting quality of construction works related to employment process by RII from RIP

Code	Cause of factor related to employment process	RIP	
		RII	Rank
F8	A written contract conditions with unclear specifications	0.760	1
F9	Limited construction duration	0.760	2
F7	Improper conditions of the owner for employing contractor	0.680	3

5.2.4 Construction and Supervision process

Based on the results of RII in Table 5.9 showed that lack of skilled labor was ranked among RLP in the first position with RII score of 0.830 because most of labor in Laos still low experience and skills to perform the complexity and works that needs high quality. Following by use of poor quality material and products or improper material usage as the specifications in contract was in the second rank with score of 0.801 because the contractors try to reduce quantity and specification of material or products to save cost of the project and profits. Lack of full-time supervision

Table 5.9 Rank of causes of factor related to construction and supervision process by RII from RLP

Code	Causes of factor related to construction and supervision process	RLP	
		RII	Rank
F28	Lack of skilled labor	0.830	1
F30	Use of poor quality material and products/Improper material usage as the specifications in contract	0.801	2
F26	Lack of full-time supervision and inspection	0.782	3
F25	Low experience and competency of supervisor	0.774	4
F10	Low experience and competency project manager	0.768	5
F23	Lack of local quality inspection and control system	0.768	6
F24	Lack of local quality assurance system	0.757	7
F11	Disorder construction management and erroneous construction sequence	0.754	8
F27	Lack of coordination between the contractor and the supervisor	0.753	9
F15	Improper personnel allocation to their tasks	0.738	10
F18	Improper construction method or technique	0.736	11
F13	Unfollowing the norms of construction quality acceptance and operating procedures	0.728	12
F32	Poor document control (poor report of material checking and testing)	0.727	13
F12	Lack of technical and professional expertise and resources to perform task	0.712	14
F17	Unclear or incompleteness shop drawing and specifications	0.706	15
F31	Poor management of storage and usage	0.703	16
F22	Lack of establishment of local quality system	0.690	17
F33	Use of improper equipment or a machine for construction	0.673	18
F16	Undocumented construction (Not building to drawings or specifications)	0.664	19
F34	Poor equipment or a machine-operator’s skill	0.653	20
F35	Poor climate condition during construction	0.633	21
F20	Communication issue between Laotian and foreigner on construction site	0.599	22
F29	Low labor's wages/ Worker’s ignorance or negligence	0.582	23
F14	Lack of training course on quality for staff	0.552	24
F21	Lack of coordination between the design and the contractor parties	0.544	25
F19	Change order during construction by the owner	0.487	26

Table 5.10 Rank of causes of factor related to construction and supervision process by RII from RIP

Code	Causes of factor related to construction and supervision process	RIP	
		RII	Rank
F28	Lack of skilled labor	0.880	1
F10	Low experience and competency project manager	0.840	2
F12	Lack of technical and professional expertise and resources to perform task	0.840	3
F16	Undocumented construction (Not building to drawings or specifications)	0.840	4
F25	Low experience and competency of supervisor	0.840	5
F30	Use of poor quality material and products/Improper material usage as the specifications in contract	0.840	6
F23	Lack of local quality inspection and control system	0.800	7
F15	Improper personnel allocation to their tasks	0.760	8
F17	Unclear or incompleteness shop drawing and specifications	0.760	9
F22	Lack of establishment of local quality system	0.760	10
F33	Use of improper equipment or a machine for construction	0.760	11
F13	Unfollowing the norms of construction quality acceptance and operating procedures	0.720	12
F18	Improper construction method or technique	0.720	13
F19	Change order during construction by the owner	0.720	14
F24	Lack of local quality assurance system	0.720	15
F32	Poor document control (poor report of material checking and testing)	0.720	16
F34	Poor equipment or a machine-operator's skill	0.720	17
F26	Lack of full-time supervision and inspection	0.680	18
F31	Poor management of storage and usage	0.680	19
F11	Disorder construction management and erroneous construction sequence	0.640	20
F21	Lack of coordination between the design and the contractor parties	0.640	21
F29	Low labor's wages/ Worker's ignorance or negligence	0.640	22
F35	Poor climate condition during construction	0.640	23
F27	Lack of coordination between the contractor and the supervisor	0.600	24
F14	Lack of training course on quality for staff	0.560	25
F20	Communication issue between Laotian and foreigner on construction site	0.560	26

and inspection was ranked in the third position with score of 0.782, and least cause of factors affecting quality of construction works in Lao PDR is that the change order during construction by the owner with score of 0.487 because the change terms was agreed by both owner and contractor. That means the contractor has to perform the works according to change conditions.

As part of ranking of RIP on causes of factors affecting quality of construction works in Table 5.10 found that the lack of skilled labor was arranged in the first position with RII score of 0.880. The reason is the same with RLP, following by low experience and competency project manager of contractor with score of 0.840. This factor was ranked in second position because the project manager is a key action in construction phase who performs all activities in the project such as establishing a quality planning, controlling all activities conforming to quality norms planed from the beginning until close out the project. Lack of technical and professional expertise and resources to perform task was ranked in the third position with score of 0.840 because in a large project is required the person who has high experience to manage the construction works as the project requirements and the least important factors affecting quality of construction works was the communication issue between Laotian and foreigner on construction site because labors work in team. For example, Chinese labors work together with their teams. Hence, this factor is less important affecting quality of construction works in Lao PDR.

5.3 Inferential statistics results

5.3.1 T-test result

According to Table 5.11 indicated that there is a high correlation in the ranking of the two samples. The null hypothesis can therefore be accepted concluding that the representative of the owners and contractors do not perceive causes of poor quality problems differently. There are an exception of this hypothesis in regard to the “low quality drawing and specification”, “lack of technical and professional expertise and resources to perform task”, “change order during construction by the owner”, “lack of establishment of local quality system”, “use of poor quality material and products”, and “poor document control (poor report of material checking and testing)” items. The

results showed that there is a significant difference in ranking this factor. (P-value less than 0.05).

Table 5.11 T-test results comparing the ranking of the owner's representative and the contractor's representatives in local projects

Causes of factor	LOR (N=16)		LCR (N=11)		t-value	P-value
	Mean	Std. Deviation	Mean	Std. Deviation		
F1	2.937	1.237	2.818	1.471	0.228	0.539
F2	3.437	1.153	3.636	1.120	-0.445	0.984
F3	2.875	0.957	3.545	0.687	-1.991	0.289
F4	2.625	1.500	2.727	1.555	-0.172	0.966
F5	3.500	1.211	4.000	.632	-1.252	0.010**
F6	3.375	1.025	3.364	1.120	0.027	0.996
F7	3.812	1.470	3.727	1.191	0.159	0.415
F8	3.312	1.352	3.273	1.348	.075	0.744
F9	2.937	1.526	3.545	1.128	-1.124	0.394
F10	3.687	1.138	3.454	1.439	0.469	0.350
F11	3.500	1.265	3.454	1.213	0.093	0.730
F12	3.375	1.408	3.818	0.982	-0.901	0.040**
F13	3.69	1.195	3.273	1.421	0.821	0.506
F14	2.875	0.885	3.273	0.904	-1.137	0.962
F15	3.875	1.088	3.636	1.120	0.553	0.901
F16	3.437	1.365	3.454	1.440	-0.031	0.933
F17	3.250	1.183	3.454	0.820	-0.496	0.293
F18	3.500	1.095	3.182	1.328	0.680	0.563
F19	2.625	1.408	3.454	0.687	-1.804	0.009**
F20	3.125	1.204	3.273	1.104	-0.324	0.654
F21	2.937	0.998	3.091	1.136	-0.371	0.630
F22	3.250	1.438	3.636	1.027	-0.765	0.048**
F23	4.063	1.063	3.455	1.293	1.338	0.360
F24	3.750	1.125	3.636	0.924	0.276	0.405
F25	3.813	0.981	3.818	0.874	-0.015	0.946
F26	3.625	0.885	3.727	0.905	-0.292	0.967
F27	3.563	1.153	3.364	1.362	0.409	0.633
F28	3.938	0.929	4.091	0.701	-0.464	0.311
F29	2.688	1.014	3.091	0.831	-1.089	0.318
F30	3.563	1.413	4.091	0.701	-1.143	0.012**
F31	3.125	1.088	3.545	1.036	-1.006	0.804
F32	3.625	1.088	2.909	1.578	1.399	0.045**
F33	3.125	1.088	3.091	1.300	0.074	0.426
F34	3.000	1.095	3.364	1.120	-0.840	0.481
F35	2.688	1.138	3.000	0.894	-0.762	0.338

*significant at 0.05 level

** P-value = less than 0.05

Additionally, according to Table 5.11 showed that the representatives of both owners and contractors have the same attitude through ranking the most of causes of poor quality problems. This can be reflected to the fact that they work under the same conditions and they are experiencing towards implementing the several stages of the construction projects.

5.3.2 One-Way ANOVA result

Table 5.12 One-Way ANOVA results

Item	Description	Sum of Squares	df	Mean Square	F	Sig.
F1	Between Groups	10.658	4	2.665	1.724	0.181
	Within Groups	34.008	22	1.546		
	Total	44.667	26			
F2	Between Groups	8.107	4	2.027	1.810	0.163
	Within Groups	24.633	22	1.120		
	Total	32.741	26			
F3	Between Groups	1.274	4	.319	0.348	0.843
	Within Groups	20.133	22	.915		
	Total	21.407	26			
F4	Between Groups	6.117	4	1.529	0.648	0.634
	Within Groups	51.883	22	2.358		
	Total	58.000	26			
F5	Between Groups	3.796	4	0.949	0.876	0.494
	Within Groups	23.833	22	1.083		
	Total	27.630	26			
F6	Between Groups	2.963	4	0.741	0.643	0.637
	Within Groups	25.333	22	1.152		
	Total	28.296	26			
F7	Between Groups	6.792	4	1.698	0.937	0.461
	Within Groups	39.875	22	1.813		
	Total	46.667	26			
F8	Between Groups	5.371	4	1.343	0.734	0.579
	Within Groups	40.258	22	1.830		
	Total	45.630	26			
F9	Between Groups	2.649	4	0.662	0.307	0.870
	Within Groups	47.425	22	2.156		
	Total	50.074	26			

Table 5.12 One-Way ANOVA results (continued)

Item	Description	Sum of Squares	df	Mean Square	F	Sig.
F10	Between Groups	2.485	4	0.621	0.359	0.835
	Within Groups	38.033	22	1.729		
	Total	40.519	26			
F11	Between Groups	0.457	4	0.114	0.066	0.991
	Within Groups	38.283	22	1.740		
	Total	38.741	26			
F12	Between Groups	4.117	4	1.029	0.619	0.653
	Within Groups	36.550	22	1.661		
	Total	40.667	26			
F13	Between Groups	1.732	4	0.433	0.232	0.917
	Within Groups	41.008	22	1.864		
	Total	42.741	26			
F14	Between Groups	2.330	4	0.582	0.688	0.608
	Within Groups	18.633	22	0.847		
	Total	20.963	26			
F15	Between Groups	1.592	4	0.398	0.301	0.874
	Within Groups	29.075	22	1.322		
	Total	30.667	26			
F16	Between Groups	6.492	4	1.623	0.847	0.511
	Within Groups	42.175	22	1.917		
	Total	48.667	26			
F17	Between Groups	0.800	4	0.200	0.162	0.955
	Within Groups	27.200	22	1.236		
	Total	28.000	26			
F18	Between Groups	3.221	4	0.805	0.536	0.711
	Within Groups	33.075	22	1.503		
	Total	36.296	26			
F19	Between Groups	10.038	4	2.509	1.909	0.145
	Within Groups	28.925	22	1.315		
	Total	38.963	26			
F20	Between Groups	2.066	4	0.516	0.355	0.838
	Within Groups	32.008	22	1.455		
	Total	34.074	26			
F21	Between Groups	5.467	4	1.367	1.334	0.289
	Within Groups	22.533	22	1.024		
	Total	28.000	26			
F22	Between Groups	2.519	4	0.630	0.346	0.844
	Within Groups	40.000	22	1.818		
	Total	42.519	26			

Table 5.12 One-Way ANOVA results (continued)

Item	Description	Sum of Squares	df	Mean Square	F	Sig.
F23	Between Groups	0.774	4	0.194	0.121	0.974
	Within Groups	35.300	22	1.605		
	Total	36.074	26			
F24	Between Groups	1.721	4	0.430	0.365	0.831
	Within Groups	25.908	22	1.178		
	Total	27.630	26			
F25	Between Groups	0.191	4	0.048	0.048	0.995
	Within Groups	21.883	22	0.995		
	Total	22.074	26			
F26	Between Groups	0.492	4	0.123	0.139	0.966
	Within Groups	19.508	22	0.887		
	Total	20.000	26			
F27	Between Groups	7.732	4	1.933	1.372	0.276
	Within Groups	31.008	22	1.409		
	Total	38.741	26			
F28	Between Groups	0.742	4	0.185	0.236	0.915
	Within Groups	17.258	22	0.784		
	Total	18.000	26			
F29	Between Groups	3.874	4	0.969	1.091	0.385
	Within Groups	19.533	22	0.888		
	Total	23.407	26			
F30	Between Groups	3.508	4	0.877	0.582	0.679
	Within Groups	33.158	22	1.507		
	Total	36.667	26			
F31	Between Groups	1.080	4	0.270	0.208	0.931
	Within Groups	28.550	22	1.298		
	Total	29.630	26			
F32	Between Groups	2.717	4	0.679	0.345	0.844
	Within Groups	43.283	22	1.967		
	Total	46.000	26			
F33	Between Groups	4.092	4	1.023	0.736	0.577
	Within Groups	30.575	22	1.390		
	Total	34.667	26			
F34	Between Groups	3.149	4	0.787	0.613	0.658
	Within Groups	28.258	22	1.284		
	Total	31.407	26			
F35	Between Groups	3.316	4	0.829	0.737	0.577
	Within Groups	24.758	22	1.125		
	Total	28.074	26			

The results are indicated in Table 5.12. P-value is greater than 0.05 in all causes of poor quality problems. This means that there is no significant difference between the means of five group's ranking (Director, Project manager, Project engineer, Project supervisor, and site engineer). The null hypothesis can be accepted. The results showed that there seems to be an overall agreement by all the groups regarding to causes of poor quality problems in Lao PDR.

It is clear that the position of the respondent who fills the questionnaire does not affect the viewpoint through ranking the causes of poor quality problems. This seems to be reflected to the fact that all of these groups are involved in the same experience in construction project.

5.3.3 The spearman correlation coefficient result

As indicated in Table 5.13 the results of validating the significant difference on causes of factor ranking between RLP and RIP. Correlation coefficient value equal to 0.358 at the significant level = 0.05 (2-tailed). Therefore it is concluded that there is no correlation between the ranking of both groups and the null hypothesis should be accepted. This means that most of the factors affected the quality of construction works that are considered very important to RLP are less important to RIP.

Table 5.13 Correlation coefficient testing of significant difference between RLP and RIP by using SPSS

			RLP	RIP
Spearman's rho	RLP	Correlation Coefficient	1.000	0.340*
		Sig. (2-tailed)	0.00	0.045
		N	35	35
	RIP	Correlation Coefficient	0.340*	1.000
		Sig. (2-tailed)	0.045	0.00
		N	35	35
*. Correlation is significant at the 0.05 level (2-tailed).				

5.3.4 Cronbach's alpha result

A reliability test was performed on factors affecting the quality of construction works variables. The variables consisted of 35 causes of factors (see in Table 5.1). Based on the result, all items of quality factors employed in this study were included, illustrating that, a Cronbach's alpha coefficient over 0.70 was acceptable. Additionally, the corrected item-total correlating all items has to be over 0.30.

The results of reliability test was shown in Table 5.14, it indicates that the result of the reliability test in terms of RLP, seeing that the value of Cronbach's alpha was equal to 0.957. This means that responses among RLP are very high reliability. On the other hand, the result of reliability analysis for responses of RIP, as indicated in Table 5.15 was equal to 0.900. This means that responses among RIP are very high reliability.

Table 5.14 Result of reliability testing for item-total statistics by using SPSS from RLP

Code	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
F1	0.429	0.957
F2	0.613	0.956
F3	0.472	0.957
F4	0.568	0.956
F5	0.659	0.955
F6	0.638	0.956
F7	0.461	0.957
F8	0.783	0.954
F9	0.564	0.956
F10	0.683	0.955
F11	0.791	0.954
F12	0.794	0.954
F13	0.705	0.955
F14	0.538	0.956
F15	0.678	0.955
F16	0.311	0.958
F17	0.620	0.956
F18	0.793	0.954
F19	0.390	0.957
F20	0.361	0.957
F21	0.678	0.955
F22	0.773	0.954
F23	0.700	0.955

Table 5.14 Result of reliability testing for item-total statistics by using SPSS from RLP (continued)

Code	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
F24	0.796	0.955
F25	0.733	0.955
F26	0.600	0.956
F27	0.708	0.955
F28	0.501	0.956
F29	0.506	0.956
F30	0.648	0.955
F31	0.601	0.956
F32	0.749	0.955
F33	0.620	0.956
F34	0.640	0.956
F35	0.431	0.957

Table 5.15 Result of reliability testing for item-total statistics by using SPSS from RIP

Code	Corrected item-total correlation	Cronbach's alpha if item deleted
F1	0.288	0.900
F2	0.479	0.897
F3	-0.110	0.909
F4	0.768	0.890
F5	0.976	0.886
F6	0.775	0.892
F7	0.059	0.902
F8	0.048	0.902
F9	0.830	0.895
F10	-0.174	0.910
F11	-0.735	0.908
F12	0.664	0.896
F13	0.310	0.900
F14	0.568	0.895
F15	0.069	0.903
F16	0.861	0.891
F17	0.664	0.896
F18	-0.643	0.909
F19	0.704	0.896
F20	0.568	0.895
F21	0.861	0.891

Table 5.15 Result of reliability testing for item-total statistics by using SPSS from RIP (continued)

Code	Corrected item-total correlation	Cronbach's alpha if item deleted
F22	0.422	0.898
F23	0.985	0.890
F24	0.753	0.892
F25	0.830	0.895
F26	0.595	0.896
F27	0.757	0.892
F28	0.561	0.897
F29	0.677	0.893
F30	0.069	0.903
F31	0.643	0.894
F32	0.125	0.901
F33	-0.414	0.911
F34	0.664	0.896
F35	0.805	0.889

CHAPTER 6
GUIDELINES FOR SOLVING CAUSES OF FACTOR AFFECTING QUALITY OF CONSTRUCTION WORKS

6.1 General

This chapter presents the guidelines to the project participants and other parties relating to the construction projects. Top ten factors of each group of respondent's ranking with the most important factors affecting the quality of construction works have been proposed the guidelines. The average weight conducts to assess the level of agreement among group of the respondents. Finally, the recommendation proposes as a guideline for the project owners, designers, consultants, contractors, and relevant parties in construction sector to evaluate their organization and use the proposed guidelines to reduce the occurred problems, or improve quality of construction works in Lao PDR.

6.2 Guideline for solving causes of factor affecting the quality of construction works

Top ten most important causes of factor that affect the quality of construction works, obtained from Chapter 5 were cut-off to find out the guidelines for reducing and solving these problems. These ten factors were shown in Figure 6.1 for ranking of RLP and in Figure 6.2 for ranking of RIP.

The designers and consultants, a key player at the design stage, shall be taken into consideration to reduce the problems (Andi and Minato, 2002) while the contractors, a key player at the construction process, shall be complained with the requirement of quality in construction in order to reduce these problems and produce a good quality of construction project as well as meeting the need of the project owner. The proposed guideline for improving quality problems were collected from literature of previous studies regarding to the quality problem's recommendation, plus the expert's opinion in Lao PDR. Doing that, relevant research on factors affecting the quality of construction projects were reviewed and gathered guidelines that corresponds to quality problems of this research. After that, questionnaire was developed to evaluate the level of agreement through such guidelines. The experts are evaluate by using 5-

point rating scale (1- very low agree; 2- low agree; 3- medium agree; 4- high agree and 5- very high agree). The questions were asked respondents; firstly, what is your opinion about the proposed guidelines to reduce and improve quality problems? Another question asked that do you have any guidelines towards each problem? If any, you can identify and evaluate the level of agreement as well.

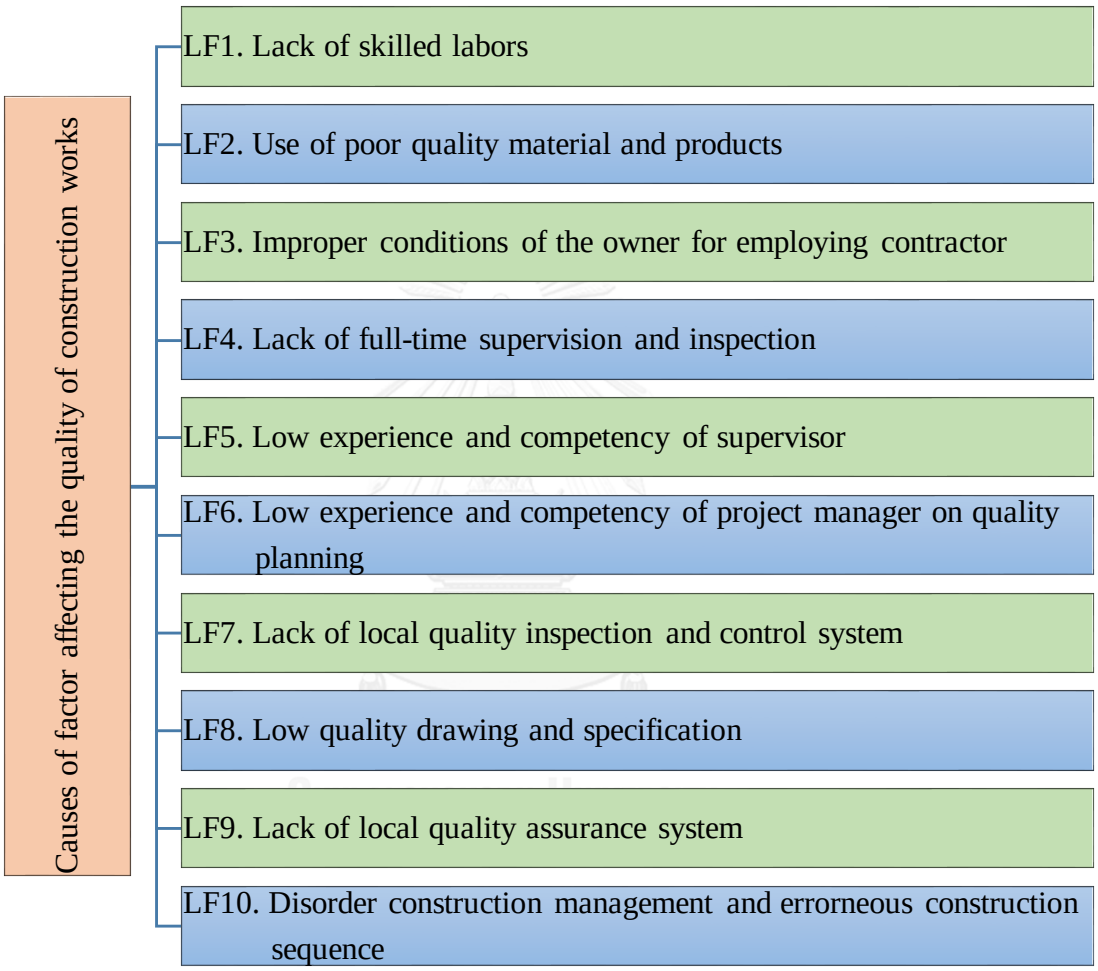

Figure 6.1 Top ten factors that most important affecting the quality of construction works in Lao PDR for ranking of RLP

Here are summarized the guidelines using to interview with both local and international exerts that selected as sample size in this research, as shown in Table 6.1 for experts in local projects and Table 6.2 for experts in international projects).

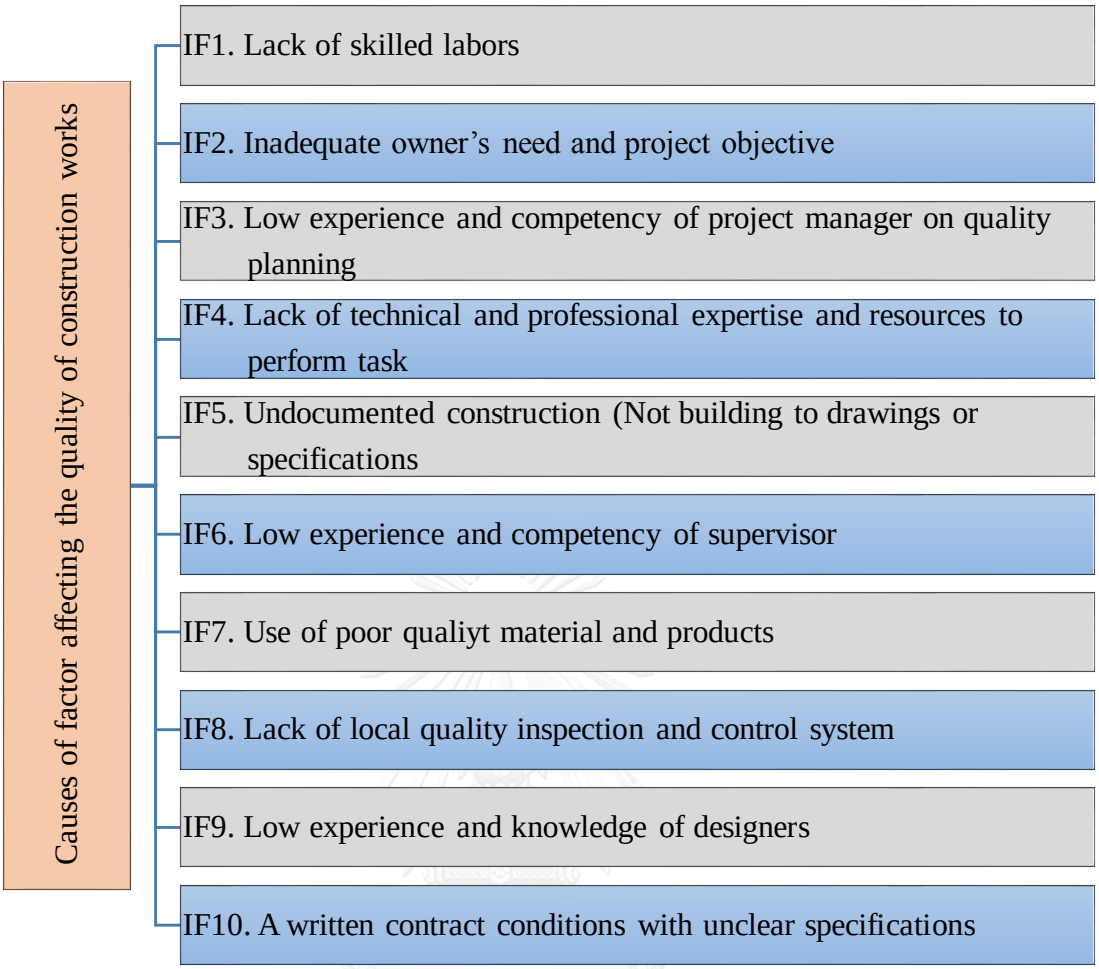

Figure 6.2 Top ten factors that most important affecting the quality of construction works in Lao PDR for ranking of RIP

Table 6.1 Guidelines for solving causes of factor affecting quality of construction works in Lao PDR for RLP

Code	Guidelines Proposed
LF1	G1. Create and develop labor skills by training either in school or construction site, which can be followed these guides: 1) Create unskilled labors (raw workers) by learning from training in school by government and construction site or learning by doing on construction site.

Table 6.1 Guidelines for solving causes of factor affecting quality of construction works in Lao PDR for RLP (Continued)

Code	Guidelines Proposed
LF1	2) Develop workers, who has skills to be foreman or craft man and inspector and higher such position, labor skills to become a specific professionals by conducting in technical or training course, doing that, the course should be followed as standard and upgrade, testing and issuing the certificate to learners as standard level of labor skills either in training center or institute of labor development. G2. Evaluate the labor's qualification before working, the contractor may evaluate sills of labor through craft certification
LF2	G3. Owner should define the specification of materials in contract in full details in order to protect contractor reducing specification of material while construction. G4. Owner should hire consultant to help in inspecting, controlling, and approving materials before use. G5. Contractor should offer equivalent material to the owner in case of lack of materials existing in market or insufficient production in factory.
LF3	G6. Owner should carry out as the local rule on employing contractor or can follow as these conditions: (i) image of company (ii) past performance experience (iii) personnel (iv) labor (v) equipment and machine (vi) financial resource (vii) certificate of company establishment. G7. Owner should avoid in employing who offers the construction cost with lowest price.

Table 6.1 Guidelines for solving causes of factor affecting quality of construction works in Lao PDR for RLP (Continued)

Code	Guidelines Proposed
` LF4	G8. Owner should remind supervisor or inspector in case of lack of responsibility to perform works. G9. Owner should employ person who expertise a specific field such as selecting an engineer to control and monitor structure work or selecting an architect to inspect the architecture work and other works can do like this.
LF5	G10. Owner should hire supervisor who has experience related to construction works, he may be employed either individual person or company as representative. If the owner hire an (a): (i) individual person: the owner should evaluate his past performance experience and expertise in controlling quality of construction works and (ii) consulting company: the owner should evaluate from company profile such as image of company, past project experience relating to the current project is constructing.
LF6	G11. Owner should select the project manager who has been passed work related construction as much as possible or evaluating the experience and competency of project manager from past performances both project management and quality planning.
LF7	G12. Government or relevant ministries should issue to having establishment on quality inspection and control system in construction work as the local standard to make the project owner's happiness with quality of the works. The process of doing that, it starts from individual person, company or association of Lao architects and civil engineers, or government division (Ministry of Public Work and Transport) are responsible to form system and submit to government or relevant agency consideration and issues to be decrees, regulations, or laws coverage around country.

Table 6.1 Guidelines for solving causes of factor affecting quality of construction works in Lao PDR for RLP (Continued)

Code	Guidelines Proposed
LF8	G13. Designer should be taken into account on quality of design service rather than speed of design to deliver design documents to the owner. For instance, designer has to think about how to create and draw a model for making constructor understanding how to build and installation in real construction. G14. Senior designer should re-check plans, drawings, specifications, including construction techniques in order to detect some defective points in drawing and making revise it immediately. G15. Contractor may review drawing plans and re-check constructability before commencement the construction operations to ensure that such drawing can install and build the project. If drawing is unclear in terms of dimension marking or text, the contractor has to inform to design or site engineer (if any) to check and revise such points.
LF9	G16. MPWT and LNCCI should have a policy on establishing system of quality assurance in construction works because if setting up this system, it would be helped in terms of safety of the owner and community as well.
LF10	G17. Contractor staff who manage and plan the project should take into account seriously to ensure that all activities of construction proceed in flow as schedule, plans and meeting the need of the owner's expectation.

Table 6.2 Guidelines for solving causes of factor affecting quality of construction works in Lao PDR for RIP

Code	Guidelines Proposed
IF1	G1. Create and develop labor skills by training either in school or construction site, which can be followed these guides: 1) Create unskilled labors (raw workers) by learning from training in school by government and construction site or learning by doing on construction site. 2) Develop workers, who has skills to be foreman or craft man and inspector and higher such position, labor skills to become a specific professionals by conducting in technical or training course, doing that, the course should be followed as standard and upgrade, testing and issuing the certificate to learners as standard level of labor skills either in training center or institute of labor development. G2. Evaluate the labor's qualification before working, the contractor may evaluate sills of labor through craft certification.
IF2	G3. The requirements of the owner must be clearly defined at the beginning of the project and be agreed with both the owner and design parties.
IF3	G4. Owner should select the project manager who has been passed work related construction as much as possible or evaluating the experience and competency of project manager from past performances both project management and quality planning.
IF4	G5. Owner should define the qualification of the contractor according to past performance of company and personnel, including architects, engineers and construction team.

Table 6.2 Guidelines for solving causes of factor affecting quality of construction works in Lao PDR for RIP (Continued)

Code	Guidelines Proposed
IF5	G6. Owner should enforce contractor for creating documents of construction while having change order the works. G7. Owner should hire supervisor or representative to form to form the changed works and to control quality of works in case of the owner cannot control the project by his self.
IF6	G8. Owner should hire supervisor who has experience related to construction works, he may be employed either individual person or company as representative. If the owner hire an (a): (i) individual person: the owner should evaluate his past performance experience and expertise in controlling quality of construction works and (ii) consulting company: the owner should evaluate from company profile such as image of company, past project experience relating to the current project is constructing.
IF7	G9. Owner should define the specification of materials in contract in full details in order to protect contractor reducing specification of material while construction. G10. Owner should hire consultant to help in inspecting, controlling, and approving materials before use. G11. Contractor should offer equivalent material to the owner in case of lack of materials existing in market or insufficient production in factory.
IF8	G12. Government or relevant ministries should issue to having establishment on quality inspection and control system in construction work as the local standard to make the project owner's happiness with quality of the works. The process of doing that, it starts from individual person, company or association of Lao architects and civil engineers, or government division (Ministry of Public Work and Transport) are responsible to form system and submit to government or relevant agency consideration and issues to be decrees, regulations, or laws coverage around country.

Table 6.2 Guidelines for solving causes of factor affecting quality of construction works in Lao PDR for RIP (Continued)

Code	Guidelines Proposed
IF9	G13. Director of design companies should set up a training course for designers in company both theoretical and practical parts. For theoretical course, designers are not only learned in school, but also learning from outside or seminar. As part of practical course is conducted by inspection in real construction to make comprehend in-depth on constructability between design process and construction. G14. Design companies should promote for designers exchanging their experiences in region and international level to gain more experience and new knowledge in design.
IF10	G15. Owner should define whether specification of material or products use in the project and quality of the works as well in contract clearly because the contract conditions is determined requirement of the owner.

6.3 Interpretation the results of the proposed guidelines

The completed questionnaire form was used to evaluate the level of agreement by experts in both local and international projects regarding the proposed guidelines in order to reduce quality problems in construction works in Lao PDR. There are 3 experts in international projects (from Thai companies) and 7 experts in local projects were interviewed to respond such guidelines. Then, the responses derived from experts were analyzed by using the average weight. The detail of responses and results were discussed in the following sections.

6.3.1 Background of information

An appropriate expert selection is a major factor to achieve the goal of the research, the respondent of this chapter was chosen depending on their experience plus position. Hence, this research is subjected to working experience of the experts who have more than 15 years of working experience in construction works, which selects from 27 respondents of studying the level of important causes of factor affecting quality

of construction works, for RLP; more than 8 years of working experience for RIP, as shown in Appendix D.

6.3.2 Result and interpreting of the proposed guidelines for experts in local projects

Based on the data collection by using questionnaire to evaluate the seven-teen proposed guidelines to solve the top ten most significant causes of factors affecting the quality of construction works. A group of RLP were asked to evaluate the proposed guidelines, the result of finding and interpretation will be discussed in the following sections.

6.3.2.1 Result of the proposed guidelines for experts in local projects

The result of data analysis for guideline solving the causes of quality problems for experts in local projects (see in Table 6.3) indicate that the average weight of agreement level among RLP for guideline (G1 and G2) to improve problem (LF1) found in the level of high agree with score of 4.00 and 3.57, respectively. The guideline (G3 and G4) to solve Problem (LF2) found in the level of very high agree with score of 4.86 and 4.86, respectively, while G5 found in the level of medium agree with score of 3.14. The guideline (G6 and G7) found in the level of high agree with score of 4.29 and 4.14, respectively to reduce problem (LF3) and guidelines (G8 and G9) found in the level of high agree with score of 4.29 and 4.29, respectively to improve problem (LF4). The guideline (G10) found in the level of high agree with score of 4.29 to improve problems (LF5). The guideline (G11) found in the level of medium agree with score of 3.43 to solve problem (LF6). The guideline (G12) found in the level of high agree with score of 3.86 to improve problem (LF7). The guidelines (G13, G14 and G15) found in the level of high agree with score of 4.14, 4.14 and 3.86, respectively to improve problem (LF8). The guideline (G16) found in the level of medium agree with score of 3.43 to reduce problem (LF9) and the G17 found in the level of high agree with score of 3.71 to improve problem (LF10).

6.3.2.2 Interpreting of the proposed guidelines for experts in local projects

All experts in local projects agreed with creating and developing of labor skills (G1) and evaluating the labor's qualification (G2) as the guidelines to improve unskilled labors, according to the respondent's opinions for creating and developing skills of labors are properly possible for long time due to lack of people interesting to work in this job, plus limited job opportunity in the country, especially in rural areas, even most of labors were from rural areas. The better possible way of training should provide them to practice on construction field with specific job and then issues them a certificate after finishing that job. Moreover, this method may attract labors interesting to work in construction more and more because they receive wages from doing works. As a part of labor qualification, it is quite difficult for local project suggested by the respondents that due to shortage of skilled labors in Lao PDR, depending on the owner and contractor's satisfaction to their craft certification before hiring them to work.

Table 6.3 The average weight of agreement level from expert's opinions in local projects

Code	Guideline Number	Average weight	Agreement Level
LF1	G1	4.00	High agree
	G2	3.57	High agree
LF2	G3	4.86	Very high agree
	G4	4.86	Very high agree
	G5	3.14	Medium agree
LF3	G6	4.29	High agree
	G7	4.14	High agree
LF4	G8	4.29	High agree
	G9	4.29	High agree
LF5	G10	4.29	High agree
LF6	G11	3.43	Medium agree
LF7	G12	3.86	High agree
LF8	G13	4.14	High agree
	G14	4.14	High agree
	G15	3.86	High agree
LF9	G16	3.43	Medium agree
LF10	G17	3.71	High agree

Specify in fully specification of material by the owner‘s requirements in contract (G3) and employing individual consultant or consultant company (G4) were agreed among experts in the very high level as the guidelines for improper material usage as the specification in contract. It means that such guidelines to be guided for the owner consideration regarding material specification should specified clearly in contract. The contractor should offer to have the equivalent specification of materials in contract to protect them self in case of lack of material in the market and so on (G5) was in the medium agreement to be guided for improper material usage by the contractor during construction.

Carrying out as the rules of employment the construction company by the owner (G6) and doing not employed only who offers the lowest price (G7) were high agreed among experts towards the guidelines for the owners in selecting the construction company with appropriate operators. It recommends that the owner should conducts in the following methods: (i) image of company: evaluating from performance experience in the past related to the present project (iii) competency of personnel and labor skills (iv) equipment: the company has own equipment to operate the project (v) financial resource, and (v) certificate of company establishment, at least. In addition, the government project invested by government or funder in which the project owned and constructed by the government, the project owner when choose the bidder, who awards the contract, should commit with rules of employment, which not only considers who offer the price underline of estimated construction price, but also considers the organization size of company and competency to do the work.

Reminding to all supervisors or employing of the new persons who represents to inspect the quality of construction works (G8) and sufficient number of supervisors or inspectors performing the work (G9) were arranged in high agreement to reduce the lack of timely supervision and inspection (LF4). This is because the project supervisor is a key person to control the project as the schedule, including quality of end products meet the specifications and satisfaction of the owner. Hence, the owner’s hiring the representative either individual consultant or consulting company to control the quality of works should be qualified the requirement of end products quality with adequate numbers of supervisor.

Instructing to the owner representative (if any) who qualified and experienced as the advisor of the project (G10) was positioned in high agreement as a guideline for improving problem of low experience and competency of supervisor (LF5).

Evaluating with adequate project manager experience with good quality planning and performance in employment stage by the contractor and the project owner (G11) was in medium agreement for reducing the poor experience and competency of project manager on quality planning (LF6) as a guideline for improving quality of works effectively. The reason of this guideline as a medium agree among respondents is that currently the quality planning is not the big problems because most of project manager has a plan that can control the quality of works as the project requirement. Another reason is that as result of there is just low-rise to medium-rise building being implemented in the present, so the quality management is not yet important to this country thanks to several factors.

Establishing the quality inspection and control system for construction works (G12) was in high agreement for improving the lack of quality inspection and control system (LF7). This is because basically the quality system every sectors, especially construction sector should have this system owing to having many benefits from this system. However, to establish this system is a nowadays challenging work to the relevant parties in organizing this system because of lack of policy, personnel. The possible way to set up this system, the first important thing is that all parties relating to construction industry, namely MPWT, ALACE, construction companies, or consulting companies should cooperate to building this system. Relevant parties like government should have policy for quality system.

Designers should prepare the design document such as drawing, specification and construction techniques (G13), head of designers should review to check defection points in documents (G14) and the contractor should review the design documents received from designer before operating works (G15) were agreed by experts in the same sound about low quality drawing and specification (LF8) in the high level. Concluding that, these three guidelines are crucial for the designers and contractors to produce a quality of drawing and specification, and reduce reworks during construction.

Establishing quality assurance system (G16) was agreed in the medium level to improve the lack of quality assurance system (LF9). The reason is that in Lao PDR do

not have any quality assurance system, but the government and relevant parties are considering this system. As we known, the quality assurance is used to make owner a confidence with production and service. Hence, this research have some way to organize system. For example, the most important thing to do that the government should set up the local standard regarding production control and assurance, and construction materials that exist in the country.

Defining the appropriate construction procedures and techniques (G17) was one of the guideline to reduce a poor quality issue in construction works of Lao PDR. It was evaluated among experts in the high agreement

6.3.2.3 Summary of the proposed guidelines for experts in local projects

The proposed guidelines were cut-off if the average weight value ranges between 3.50 and 5.00 (between high agree and very high agree). As a result, there are fourteen guidelines involve to solve ten most important causes of factors that affect quality of construction works in Lao PDR for experts in local projects. Figure 6.3 demonstrated the causes of quality problems and the proposed guidelines.

6.3.3 Result and interpreting of the propose guidelines for experts in international projects

The results of proposed guidelines were obtained from questionnaire by in-depth interview with individual expert and then data was analyzed by using the average weight technique to evaluate the level of agreement among experts in international projects. As a result, there are fifteen guidelines were proposed to solve top ten most important causes of factor affecting quality of construction works. The details of result were interpreted in the following sections.

6.3.3.1 Result of the proposed guidelines for experts in international projects

The result of data analysis for guideline to solve the quality problems from opinions of RIP (see in Table 6.4) indicates that the average weight of G1 found in the level of medium agreement with score of 3.33, while G2 found in very high agreement with score of 4.67 to improve problem (IF1). The guideline G3 found in high agreement with score of 4.33 to reduce quality problem (IF2) and G4 found in very high agreement with score of 5.00 to solve problem (IF3). The guideline (G5) found in very high agree-

ment with score of 5.00 to improve problem (IF4), and G6 found in the level of high agreement with score of 4.33 to improve problem (IF5), while G7 found in the level of very high agree with score of 4.67 as well. The guidelines (G8) found to be high agreement both two guidelines with score of 4.33 to improve problem (IF6), G9 found in high level of agreement with score of 4.33 to solve problem (IF7), and G10 and G11 found in very high level of agreement with score of 4.67 for all of them. The guideline (G12) found in the level of high agreement with score of 4.33 to reduce quality problem (IF8) as well as guidelines (G13 and G15) found in the level of very high agreement with score of 4.67 and 5.00, respectively. However, G14 and G16 found in the level of high agreement with score of 4.33 both guidelines to solve quality problem (IF9) and (IF10), respectively.

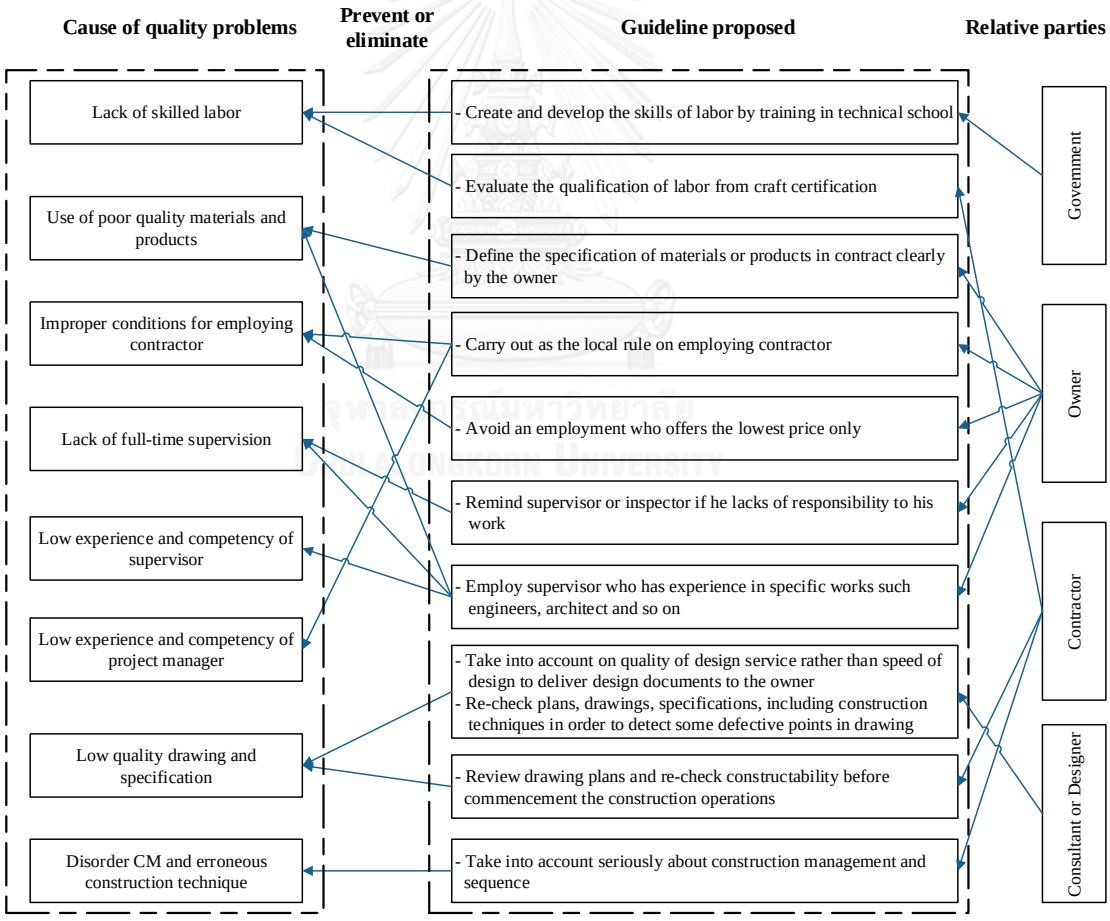

Figure 6.3 The causes of quality problems and the proposed guidelines for experts in local projects

6.3.3.2 Interpreting of the proposed guidelines for experts in international projects

Based on data analysis in Table 6.4, it indicates that creating and developing of labor skills (G1) was found in medium agreement among experts because this guideline can be divided into two levels of doing so. Training course by learning in school or training center, the objective is to upgrade their skills, while training by doing on construction site aims to be professional in specific work. For instance, once steel technician has trained in the foreign direct investor because he need to learn new technologies and techniques using installation of steel frame. On the other hand, evaluating the labor's qualification (G2) was found in high agreement to be the guidelines to improve unskilled labors in Lao PDR. According to the opinions of experts for creating and developing skills of labors by training course is a good way to improve skills of labors, but it is possible for long-term. The better way to increase their skills can be separated as follows: like experts in local projects, experts in international projects were agreed with course training on construction site. For labor qualification guideline, they recommended that main contractor must be reviewed seriously the certificate of subcontractor or constructor team.

Table 6.4 The average weight of agreement level for experts in international projects

Code	Guideline Number	Average Weight	Agreement Level
IF1	G1	3.33	Medium agree
	G2	4.67	Very high agree
IF2	G3	4.33	High agree
IF3	G4	5.00	Very high agree
IF4	G5	5.00	Very high agree
IF5	G6	4.33	High agree
	G7	4.67	Very high agree
IF6	G8	4.33	High agree
IF7	G9	4.33	High agree
	G10	4.67	Very high agree
	G11	4.67	Very high agree
IF8	G12	4.33	High agree
IF9	G13	4.67	Very high agree
	G14	4.33	High agree
IF10	G15	4.33	High agree

Adequate budget of the owner for design (G3) was found in high agreement level to guide the unclear owner's requirements for design (IF2). According to respondent's suggestion stated that most of local project owner need the lowest construction cost, but they want to get the end products with good quality. Therefore, adequate budget of the owner for design with selecting the appropriate designer is the important thing that the owner should be taken into account.

Evaluating with adequate project manager experience with good quality planning and performance in employment stage by the contractor and the project owner (G4) was found in the medium level to improve the poor experience and competency of project manager on quality planning (IF3) as a guideline for improving quality of works effectively. The reason of this guideline in the very agree level, this is because the quality planning is a major thing for a large project if the quality planning system is poor, the end products may be unsatisfied by the owner.

Defining the qualification of the construction companies, who join the bidding (if any) or other contract types (G5) was evaluated in the level of high very agreement for solving the lack of technical and professional expertise and resources to perform task (IF4). This guideline is common practiced by the owner for employment stage, conducting that, the owner should evaluate the experience of companies had done in the past, personnel, including architects, engineers, and construction team, at least.

Specifying the type of works with documents if the owner expects to be changed or modified during construction phase in advance and should have documents attached in contract (G6) was found in the high agreement for improving the change order during construction without construction documents (IF5) as if the owner predicts the change order in advance, it may reduce the conflict between parties. Employing an individual consultant or consulting company to draft and control quality of works required (G7) was a very high agreement because this guideline is more important for the owner taking into account to hire consultants or design company to draft document in design phase, employment, until construction documents.

Defining the qualification of individual consultant or company inspecting quality of works (G8) was found in the high agreement level for guiding regarding the low experience and competency of supervisor (IF6).

The owner should specify fully specification of materials in contract in order to reduce the conflict may be occurred in construction phase (G9) was a high agreement for solving (IF7). The project should have consultant inspecting, controlling, and approving materials before in use (G10), the contractor should offer to the owner about using equivalent materials or replacement in case of lack of materials existing in market or insufficient production in factory (G11) was found in the very high agreement to reduce an improper material usage as the specification in contract (IF7).

Establishing the quality inspection and control system in construction work (G12) was guided to improve lack of quality inspection and control system (IF8) in the level of high agreement. Training for designer both theoretical part and real practice, which authorized by the design company by the design company (G13) was guided in the very high agreement while promoting designers by exchanging their experiences in region and international level to add their competencies (G14) was a high agreement for improving the low experience and knowledge of designer (IF9). Employing consultant as a representative of the owner in defining the project requirements and quality of construction work (G15) was found in the level of high agreement for improving the owner's satisfaction regarding quality of construction works (IF10).

6.3.3.3 Summary of the proposed guidelines for experts in international projects

The proposed guidelines of top ten most important causes of factors affecting quality of construction works in Lao PDR for experts in international projects can summarize that there are fourteen guidelines to prevent or eliminate causes of quality problems, as shown in Figure 6.4. It demonstrated the causes of quality problems and guidelines proposed with relative parties involving each problem.

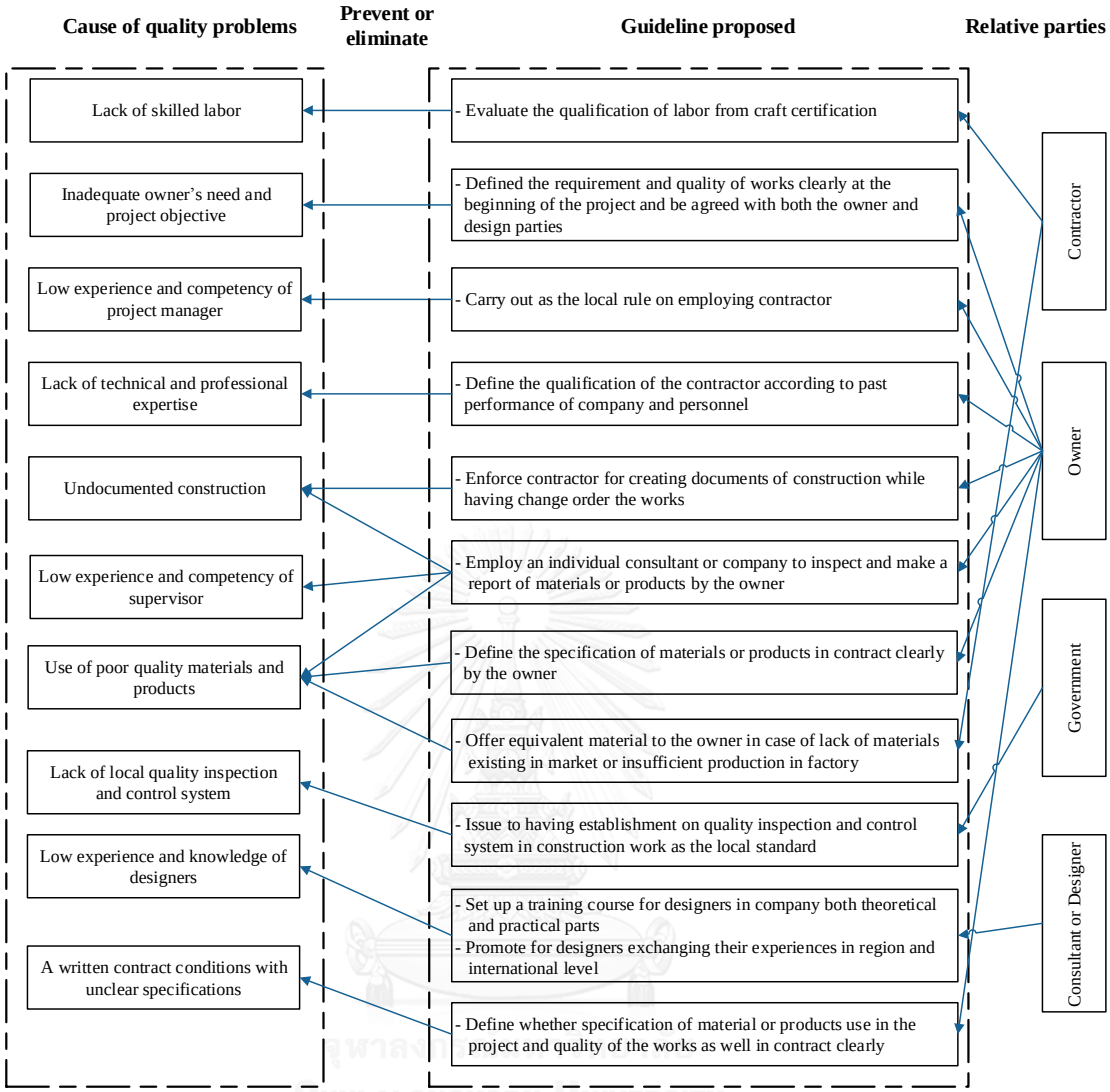

Figure 6.4 The causes of quality problems and the proposed guidelines for experts in international projects

CHAPTER 7
CONCLUSIONS

7.1 Conclusion

Quality of construction works in Lao PDR is still issued towards producing a good quality of the end products or construction. The problem is resulted from poor background of economic of the country, increasing modern construction technology, low skilled labors and lack of competency in project management. Through the problems foregoing, this research persuades to come up on causes of factors affecting the quality of construction works in Lao PDR and this is also a first step of this country to improve quality of construction works. The main objective of this research is to identify the causes of factors affecting quality of construction works, to determine the relative importance level of each factor and to propose guidelines for solving the most important causes of factors affecting the quality of construction works.

To complete the research goals, this research studies merely in Vientiane, the capital city of Lao PDR with local and international project investors. There are 6 respondents, who has experienced more than 10 years in construction works (only local project investors) were interviewed for pilot study to verify the question in questionnaire and to select the sample size. The second objective was completed with 32 respondents (27 RLPs and 5 RIPs) to determine the relative important level of each cause of factor by using the relative important index (RII), which measures by five-point Likert scale (1 means that cause of factor affects the quality of construction works in the very low important and 5 means that cause of factor affects the quality of construction works in the very important). Another objective was proposed the guidelines that completed by ten experts (7 experts for local projects and 3 experts for international projects) to evaluate the agreement level towards each guideline proposed for solving such causes of poor quality problems. The data was collected from experts with measuring the five-point scale (1 means that proposed guideline is very low agreement and 5 means that proposed guidelines is very high agreement). Also, the gathered data was analyzed by using the average weight technique.

As a result, from literature review and pilot study, can be collected with 35 causes of factors affecting the quality of construction works were collected and used in this study. Moreover, top ten most significant causes of factors from ranking of RLP are: lack of skilled labors, use of poor quality material and products, improper conditions of the owner for employing contractor, lack of full-time supervision and inspection, low experience and competency of supervisor, low experience and competency of project manager on quality planning, lack of local quality inspection and control system, low quality drawing and specification, lack of local quality assurance system, and disorder construction management and erroneous construction sequence, respectively. However, top ten significant factors from ranking of RIP are: lack of skilled labors, inadequate owner's need and project objective, low experience and competency of project manager on quality planning, lack of technical and professional expertise and resources to perform task, undocumented construction (Note building to drawings or specifications), low experience and competency of supervisor, use of poor quality material and products, lack of local quality inspection and control system, low experience and knowledge of designers, and a written contract conditions with unclear specifications, respectively. Furthermore, the results of the top ten causes of poor quality factor found that there are 5 causes of poor quality factor were agreed by both RLP and RIP are: lack of skilled labors, use of poor quality material and products, low experience and competency of supervisor, low experience and competency of project manager on quality planning, and lack of local quality inspection and control system.

As part of recommendations to each cause of top ten items was divided to discuss between top ten items of RLP and RIP. As a part of RLP, there are 17 guidelines proposed for solving top ten causes of poor quality factors for RLP; as a result there are 14 guidelines were found among experts to be able to guide for local project participants and relative parties. For instance, some guideline was proposed to reduce or prevent poor quality problem of construction works in Lao PDR, namely lack of skilled labors was in the first ranked among opinions of respondents both local and international projects as the most important causes of factor affecting quality of construction works.

The proposed guidelines through this cause of poor quality problems comprised of the creating and developing of labor skills by providing them a training course, which conducts by the government; and evaluating labor's qualification before working by the

contractor were guided to solve this problem. On the other hand, there are 15 guidelines were proposed to solve top ten causes of poor quality problems for RIP. The results found that there are only 14 guidelines used to be guided for solving causes of poor quality problems from the perspective among RIP.

7.2 Research contribution

The finding of this research can be fulfill the project participants (the project owners, consultants, contractors, designers, and other relevant parties in construction works) in the following significant steps. Firstly, the results of top ten that most important causes of factors affecting the quality of construction works can contribute to help all project participants taking into account carefully in terms of poor quality problems in construction works, which may result from the requirements on unclear quality of the work, consultants, or contractor practices and so on. Then, they should bring these problems for reducing and eliminating it at the pre-planning stage in once construction project, in order to produce a good quality of products and satisfaction of the owner, including safety of the neighboring communities as well.

Another contribution of the proposed guidelines to each of top ten causes of factors can help the owner in selecting whether consulting or construction company's competencies in order to perform and to deliver the works to the owner as specific schedule, within defined budget and quality of final construction works. In addition, as part of the consulting companies can be used these guidelines to pre-qualification their personnel in aspects of responsibilities in performing the work as the requirements while the contractors should be used these guidelines on quality planning and be organized a meeting or training courses to their personnel in organization. Besides, the design companies should be employed these guidelines in employing their personnel who has experienced in specific design. For instance, structure works should employed engineers who are able to design and graduate from civil engineering. Moreover, revenant parties such as government and other relevant Ministries can conduct and used these guidelines to establish quality system in construction sector, especially in building construction work, training course for labors, and material quality control in local factories.

7.3 Limitation and Future study

Although the results of this research were completed as the established objectives, it cannot avoid some limitations of the study. The first limitation was the timely constrains because this research is the descriptive research and the data was obtained from the perspectives and opinions of the respondents both in local and in international projects that being implemented in Vientiane. This constrain of time occurred with international project investors, especially the projects invested by the Chinese investors because of their unavailability time to response the questionnaire.

Another limitation is the scope of the study covers government and private projects. This has some differences in terms of combination among respondent's perspective between government projects and private projects towards ranking order on causes of factors affecting the quality of construction works.

Through the result of finding and some limitations of the study, it suggests that the next study should be separated between government projects and private projects to comprehend in-depth of quality problems. Another research title should be used these guidelines adopting in real construction projects in order to validate the proposed guidelines in this research.

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APPENDICES

Appendix A

Identify causes of factor affecting quality of construction works by using Cause-and-Effect Diagram

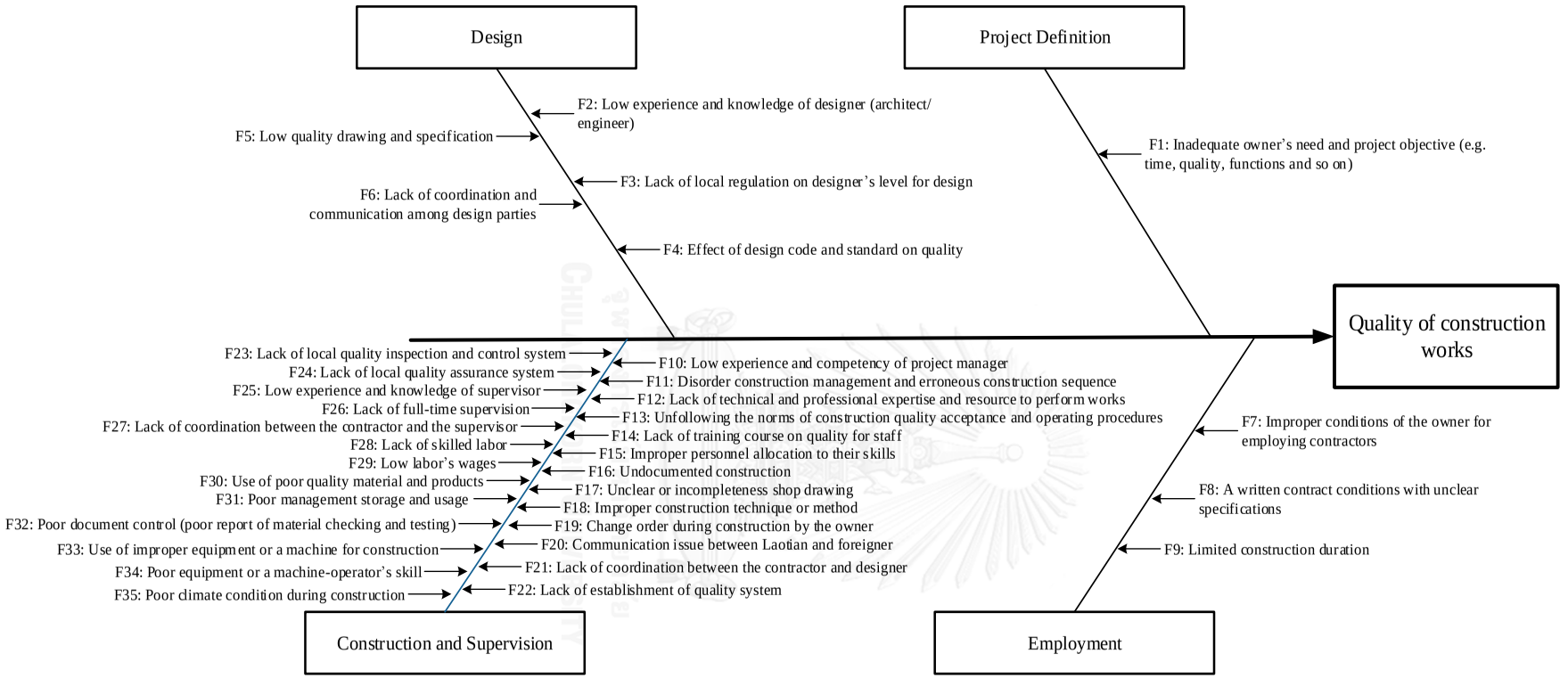
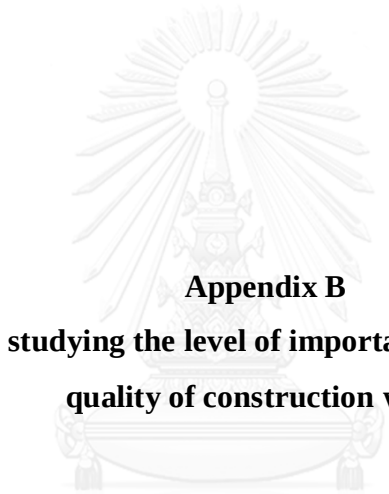


Figure A.1 Causes of factor affecting quality of construction works by using cause and effect diagram



Appendix B

Questionnaire for studying the level of important causes of factor affecting quality of construction works

QUESTIONNAIRE FOR STUDYING THE LEVEL OF IMPORTANT CAUSES OF FACTOR AFFECTING THE QUALITY OF CONSTRUCTION WORKS IN LAO PDR

This questionnaire is the collecting of data for Master's degree program. As part of the requirement for completing Master's degree in Civil Engineering and Management at Chulalongkorn University. It is a pilot study in a topic of "Factors Affecting the Quality of Construction Works in Lao PDR". As few years ago, there are several building construction project have been booming in Lao PDR, particularly in Vientiane such as residential, commercial buildings and so on. Through this change the project participants who provide a service (like designer, consultant and contractors) to the project owner has to improve and develop their organization to correspond with the fact issues. Quality of construction work is a crucial factor that will be helped them to overcome a business and having opportunity a awarding bidding as well as overcoming through satisfies of the owner.

The major objectives of this research consists of three parts.

- The first part is to identify factors affecting the quality of construction works in Lao PDR.
- The second part is to determine the relative importance level and rank the most important factors affecting the quality of construction works.
- The last part is to suggest possible ways to reduce and improve quality problems in Lao construction projects.

Nevertheless, this research cannot be completed if without the accurate information from the respondents. The information required are based on the experience and perspective of individual informants to answer each question identified. After data collection finished, all data will be analyzed in order to rank the relative importance from the most importance to the least importance factor. Finally, the factors that most important level will find possible ways as a guideline for reducing and improving quality of construction works in Lao PDR effectively.

All data included in this questionnaire form will be used for academic purpose only and will be severely confidential between the researcher and the respondents.

Regarding to this questionnaire form, it is divided into two parts as follows:

Part I: Respondent's information

Part II: Factors affecting the quality of construction works

Let me give an explanation briefly in terms of quality of construction works and factors affecting the quality of construction works of this research.

Quality of construction works: it can be defined as a strength of structure and beauty of the end construction activities.

Factors affecting the quality of construction works: it refers to the factors affecting quality of construction works. It is whether directly affects or indirectly affects. The directly affect, namely, low skilled labors may results in not produce a good quality of works, and poor supervision in construction site may cause poor workmanship and so on. On the other hand, in terms of indirectly affect, poor communication between the supervisors (Lao) and the labors (Vietnam) may lead to poor quality of works and so on. In addition, if these factors occur, it can be resulted in the construction quality failure, namely, unsafe structure, unstable workmanship, project delays, cost overrun, and dispute in construction contract.

Part I: Respondent's information

1. Please fill your current company information

   Company Name: _____

   Project Name: _____

   Respondent Name: _____

   Date of Response: _____

   Telephone Number: _____

   Email: _____

2. Please tick (√) in box types of project that your company dealing with

   ☐ Road-bridge projects

   ☐ Building projects (Housing, Hotel, Supermarket, Hospital, etc.)

   ☐ Dam or Canal project

3. Please tick (√) in box which of the following choice most accurately describes in your organization?

   ☐ Owner

   ☐ Consultant

   ☐ Contractor

4. Please tick (√) in box one job title of the respondent

   ☐ Director ☐ Project Manager ☐ Project Engineer

   ☐ Project Supervisor ☐ Site Manager ☐ Site Engineer

5. About previous experience of the respondent

   How many years have you worked in construction industry? _____

   How many projects have you done for last five years? _____

Part II: Factors affecting the quality of the construction works

There are three parts on how to answer the questions as follows:

1) Evaluating the relative important index of each factor that affects quality of construction works by rating number as identified below.

Ratting score	Criterion	Explanation
1	Very low important	This factor is very low influence the quality of construction works
2	Low important	This factor is low influence the quality of construction works
3	Medium important	This factor is medium influence the quality of construction works
4	Important	This factor is influence the quality of construction works
5	Very important	This factor is very influence the quality of construction works

2) Specifying more sub-factors relating to each major factor, if you think that it has more factors without the factors identified.

3) Explanation the reasons for influencing quality of construction works in each sub-factor.

Please rate the importance you attach to each of these factors affecting quality of construction works on a scale of 1 to 5 by circling an appropriate number.

2.2.1 Design related to factors	Very low important				Very important
1. Unclear owner's requirements for design (i.e. dimension, function or layout of building)	1	2	3	4	5
2. Limited design duration (Owner's demand to commence the construction quickly)	1	2	3	4	5
3. Experience and knowledge of designers	1	2	3	4	5
4. Lack of standard for determination the designer's responsible level	1	2	3	4	5
5. The effect of design code and standard on quality (Adopting an international standard for design such as American, French, etc.)	1	2	3	4	5
6. Low quality drawing and specification (A drawing with unclear and unspecified in details)	1	2	3	4	5
7. Coordination and communication among designer parties	1	2	3	4	5

If you have more factors, please write it down in the blank line below and rate the important level by ticking a box, at left-side of each appropriate number to the right of each factor.

8. _____	1	2	3	4	5
9. _____	1	2	3	4	5

Please explanation the reason of each factor above how it affects the quality of construction works.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

2.2.2 Owner's employment related to factors

1. Owner's satisfaction regarding quality of construction works 1 2 3 4 5

2. Condition for selecting the contractor and consultant by the owner 1 2 3 4 5

3. A written contract conditions with unclear specifications 1 2 3 4 5

If you have more factors, please write it down in the blank line below and rate the important level by ticking a box, at left-side of each appropriate number to the right of each factor.

4. _____ 1 2 3 4 5

5. _____ 1 2 3 4 5

Please explanation the reason of each factor above how it affects the quality of construction works.

1. _____

2. _____

3. _____

4. _____

5. _____

2.2.3 Contractor related to factors

1. Experience and competence of project manager on quality planning 1 2 3 4 5

2. Poor planning of construction operating procedures and techniques 1 2 3 4 5

3. Lack of technical and professional expertise and resources to perform tasks

1 2 3 4 5

4. Lack of complying with specification identified in contract conditions

1 2 3 4 5

5. Lack of training course for personnel 1 2 3 4 5

6. Improper personnel allocation to their tasks 1 2 3 4 5

If you have more factors, please write it down in the blank line below and rate the important level by ticking a box, at left-side of each appropriate number to the right of each factor.

7. _____ 1 2 3 4 5

8. _____ 1 2 3 4 5

Please explanation the reason of each factor above how it affects the quality of construction works.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

2.2.4 Execution related to factors

1. Undocumented construction while changing order 1 2 3 4 5

(Not building to drawings or specifications)

2. Unclear or incompleteness shop drawing and specifications 1 2 3 4 5

3. Improper construction method or technique 1 2 3 4 5

4. Changes order during construction by the owner 1 2 3 4 5

5. Limited construction duration 1 2 3 4 5

6. Communication issue between Laotian and foreigner on construction site

1 2 3 4 5

7. Lack of coordination between the design and the contractor parties 1 2 3 4 5

If you have more factors, please write it down in the blank line below and rate the important level by ticking a box, at left-side of each appropriate number to the right of each factor.

8. _____ 1 2 3 4 5

9. _____ 1 2 3 4 5

Please explanation the reason of each factor above how it affects the quality of construction works.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

2.2.5 Quality management system related to factors

1. Lack of establishment of quality system 1 2 3 4 5

2. Lack of quality inspection and control system 1 2 3 4 5

3. Lack of quality assurance system 1 2 3 4 5

If you have more factors, please write it down in the blank line below and rate the important level by ticking a box, at left-side of each appropriate number to the right of each factor.

4. _____ 1 2 3 4 5

5. _____ 1 2 3 4 5

Please explanation the reason of each factor above how it affects the quality of construction works.

1. _____

2. _____

3. _____

4. _____

5. _____

2.2.6 Supervision related to factors

1. Experience and competency of supervisor 1 2 3 4 5

2. Lack of timely supervision and inspection 1 2 3 4 5

3. Coordination between the contractor and supervisor 1 2 3 4 5

If you have more factors, please write it down in the blank line below and rate the important level by ticking a box, at left-side of each appropriate number to the right of each factor.

4. _____ 1 2 3 4 5

5. _____ 1 2 3 4 5

Please explanation the reason of each factor above how it affects the quality of construction works.

1. _____

2. _____

3. _____

4. _____

5. _____

2.2.7 Labor related to factors

1. Unskilled labor	1 2 3 4 5
2. Labor's wages	1 2 3 4 5

If you have more factors, please write it down in the blank line below and rate the important level by ticking a box, at left-side of each appropriate number to the right of each factor.

3. _____	1 2 3 4 5
4. _____	1 2 3 4 5

Please explanation the reason of each factor above how it affects the quality of construction works.

1. _____

2. _____

3. _____

4. _____

2.2.8 Material related to factors

1. Improper material usage as the specifications in contract	1 2 3 4 5
2. Poor management of storage and usage	1 2 3 4 5
3. Material checking and testing before usage	1 2 3 4 5

If you have more factors, please write it down in the blank line below and rate the important level by ticking a box, at left-side of each appropriate number to the right of each factor.

4. _____ 1 2 3 4 5

5. _____ 1 2 3 4 5

Please explanation the reason of each factor above how it affects the quality of construction works.

1. _____

2. _____

3. _____

4. _____

5. _____

2.2.9 Equipment and Machine related to factors

1. Use of improper equipment or a machine for construction 1 2 3 4 5

2. The equipment or a machine -operator's skill 1 2 3 4 5

If you have more factors, please write it down in the blank line below and rate the important level by ticking a box, at left-side of each appropriate number to the right of each factor.

3. _____ 1 2 3 4 5

4. _____ 1 2 3 4 5

Please explanation the reason of each factor above how it affects the quality of construction works.

1. _____

2. _____

3. _____

4. _____

2.2.10 Climate conditions related to factors

1. Poor climate condition during construction 1 2 3 4 5

If you have more factors, please write it down in the blank line below and rate the important level by ticking a box, at left-side of each appropriate number to the right of each factor.

2. _____ 1 2 3 4 5

3. _____ 1 2 3 4 5

Please explanation the reason of each factor above how it affects the quality of construction works.

1. _____

2. _____

3. _____

"Thank You Very Much for Your Time and Information Contribution"

Appendix C

Questionnaire for studying guidelines solving the causes of factor affecting quality of construction works

QUESTIONNAIRE OF STUDYING GUIDELINES FOR SOLVING CAUSES OF FACTOR AFFECTING QUALITY OF CONSTRUCTION WORKS IN LAO PDR FOR EXPERTS IN LOCAL PROJECTS

This questionnaire is the collecting of data for Master's degree program. As part of the requirement for completing Master's degree in Civil Engineering and Management at Chulalongkorn University. The objective of this questionnaire is to study guidelines solving the factors that most important affecting the quality of construction works in Lao PDR. In the questionnaire form was proposed guidelines towards each quality problems and the selected experts would be rated each guideline by using five-point rating scale as follows:

1= Very low agree, 2= Low agree, 3= Medium agree, 4= Agree, 5= Very agree

- Top ten most significant factors affecting the quality of construction works and the proposed guidelines for each factor

Quality factors	Quality Guidelines	Evaluation the level of agreement
Lack of skilled labors	G1. Create and develop labor skills by training either in school or construction site, which can be followed these guides: Create unskilled labors (raw workers) by learning from training in school by government and construction site or learning by doing on construction site.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree

Lack of skilled labors (continued)	2) Develop workers, who has skills to be foreman or craft man and inspector and higher such position, labor skills to become a specific professionals by conducting in technical or training course, doing that, the course should be followed as standard and upgrade, testing and issuing the certificate to learners as standard level of labor skills either in training center or institute of labor development. G2. Evaluate the labor's qualification before working, the contractor may evaluate sills of labor through craft certification	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree
Use of poor quality material and products	G3. Owner should define the specification of materials in contract in full details in order to protect contractor reducing specification of material while construction. G4. Owner should hire consultant to help in inspecting, controlling, and approving materials before use. G5. Contractor should offer equivalent material to the owner in case of lack of materials existing in market or insufficient production in factory.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree

Improper conditions of the owner for employing contractor	G6. Owner should carry out as the local rule on employing contractor or can follow as these conditions: (i) image of company (ii) past performance experience (iii) personnel (iv) labor (v) equipment and machine (vi) financial resource (vii) certificate of company establishment. G7. Owner should avoid in employing who offers the construction cost with lowest price.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree
Lack of full-time supervision and inspection	G8. Owner should remind supervisor or inspector in case of lack of responsibility to perform works. G9. Owner should employ person who expertise a specific field such as selecting an engineer to control and monitor structure work or selecting an architect to inspect the architecture work and other works can do like this.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree
Low experience and competency of supervisor	G10. Owner should hire supervisor who has experience related to construction works, he may be employed either individual person or company as representative. If the owner hire an (a): (i) individual person: the owner should evaluate his past performance experience and expertise in controlling quality of construction works and (ii) consulting company: the owner should evaluate from company profile such as image of company, past project experience relating to the current project is constructing.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree

Low experience and competency of project manager on quality planning	G11. Owner should select the project manager who has been passed work related construction as much as possible or evaluating the experience and competency of project manager from past performances both project management and quality planning.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree
Lack of local quality inspection and control system	G12. Government or relevant ministries should issue to having establishment on quality inspection and control system in construction work as the local standard to make the project owner's happiness with quality of the works. The process of doing that, it starts from individual person, company or association of Lao architects and civil engineers, or government division (Ministry of Public Work and Transport) are responsible to form system and submit to government or relevant agency consideration and issues to be decrees, regulations, or laws coverage around country.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree

Low quality drawing and specification	G13. Designer should be taken into account on quality of design service rather than speed of design to deliver design documents to the owner. For instance, designer has to think about how to create and draw a model for making constructor understanding how to build and installation in real construction. G14. Senior designer should re-check plans, drawings, specifications, including construction techniques in order to detect some defective points in drawing and making revise it immediately. G15. Contractor may review drawing plans and re-check constructability before commencement the construction operations to ensure that such drawing can install and build the project. If drawing is unclear in terms of dimension marking or text, the contractor has to inform to design or site engineer (if any) to check and revise such points.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree
Lack of local quality assurance system	G16. MPWT and LNCCI should have a policy on establishing system of quality assurance in construction works because if setting up this system, it would be helped in terms of safety of the owner and community as well.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree

Disorder construction management and errorneous construction sequence	G17. Contractor staff who manage and plan the project should take into account seriously to ensure that all activities of construction proceed in flow as schedule, plans and meeting the need of the owner's expectation.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree

"Thank you"

QUESTIONNAIRE OF STUDYING GUIDELINES FOR SOLVING CAUSES OF FACTOR AFFECTING QUALITY OF CONSTRUCTION WORKS IN LAO PDR FOR EXPERTS IN INTERNATIONAL PROJECTS

This questionnaire is the collecting of data for Master's degree program. As part of the requirement for completing Master's degree in Civil Engineering and Management at Chulalongkorn University. The objective of this questionnaire is to study guidelines solving the factors that most important affecting the quality of construction works in Lao PDR. In the questionnaire form was proposed guidelines towards each quality problems and the selected experts would be rated each guideline by using five-point rating scale as follows:

1= Very low agree, 2= Low agree, 3= Medium agree, 4= Agree, 5= Very agree

- Top ten most significant factors affecting the quality of construction works and the proposed guidelines for each factor

No.	Guidelines	Level of agreement
Lack of skilled labors	G1. Create and develop labor skills by training either in school or construction site, which can be followed these guides: 1) Create unskilled labors (raw workers) by learning from training in school by government and construction site or learning by doing on construction site.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree

	2) Develop workers, who has skills to be foreman or craft man and inspector and higher such position, labor skills to become a specific professionals by conducting in technical or training course, doing that, the course should be followed as standard and upgrade, testing and issuing the certificate to learners as standard level of labor skills either in training center or institute of labor development. G2. Evaluate the labor's qualification before working, the contractor may evaluate sills of labor through craft certification.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree
Inadequate owner's need and project objective	G3. The requirements of the owner must be clearly defined at the beginning of the project and be agreed with both the owner and design parties.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree
Low experience and competency of project manager on quality planning	G4. Owner should select the project manager who has been passed work related construction as much as possible or evaluating the experience and competency of project manager from past performances both project management and quality planning.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree

Lack of technical and professional expertise and resources to perform task	G5. Owner should define the qualification of the contractor according to past performance of company and personnel, including architects, engineers and construction team.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree
Undocumented construction (Not building to drawings or specifications	G6. Owner should enforce contractor for creating documents of construction while having change order the works. G7. Owner should hire supervisor or representative to form to form the changed works and to control quality of works in case of the owner cannot control the project by his self.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree

Low experience and competency of supervisor	G8. Owner should hire supervisor who has experience related to construction works, he may be employed either individual person or company as representative. If the owner hire an (a): (i) individual person: the owner should evaluate his past performance experience and expertise in controlling quality of construction works and (ii) consulting company: the owner should evaluate from company profile such as image of company, past project experience relating to the current project is constructing.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree
Use of poor quality material and products	G9. Owner should define the specification of materials in contract in full details in order to protect contractor reducing specification of material while construction. G10. Owner should hire consultant to help in inspecting, controlling, and approving materials before use. G11. Contractor should offer equivalent material to the owner in case of lack of materials existing in market or insufficient production in factory.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree
Lack of local quality inspection and control system	G12. Government or relevant ministries should issue to having establishment on quality inspection and control system in construction work as the local standard to make the project owner's happiness with quality of the works. The process of doing that, it starts from individual person, company or association of Lao architects and	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree

	civil engineers, or government division (Ministry of Public Work and Transport) are responsible to form system and submit to government or relevant agency consideration and issues to be decrees, regulations, or laws coverage around country.	
Low experience and knowledge of designers	G13. Director of design companies should set up a training course for designers in company both theoretical and practical parts. For theoretical course, designers are not only learned in school, but also learning from outside or seminar. As part of practical course is conducted by inspection in real construction to make comprehend in-depth on constructability between design process and construction. G14. Design companies should promote for designers exchanging their experiences in region and international level to gain more experience and new knowledge in design.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree
A written contract conditions with unclear specifications	G15. Owner should define whether specification of material or products use in the project and quality of the works as well in contract clearly because the contract conditions is determined requirement of the owner.	☐ Very high agree ☐ High agree ☐ Medium agree ☐ Low agree ☐ Very low agree

"Thank you"

Appendix D

Respondent's Information for studying the level of important causes of factor and for studying guidelines to solve causes of factor affecting quality of construction works

Table D.1 Respondent's information for pilot study

Code	Company Name	Position	Working Experience
LCR_4	Synesis group	Project Manager	16
LCR_5	PMC co., ltd.	Project Manager	31
LCR_{10}	Inpeng group	Director	12
LOR_3	Xanglao Engineering and Consultants co., ltd.	Director	15
LOR_4	Modern engineering cooperation co., ltd.	Project Manager	15
LOR_{14}	APA design co., ltd.	Project Supervisor	19

Table D.2 Respondent's information for studying the important level of causes of factors affecting quality of construction works

Code	Company Name	Position	Working Experience
Name of companies for local projects			
LOR_1	PT sole co., ltd.	Project Supervisor	9
LOR_2	MPWT	Project Supervisor	15
LOR_3	Xanglao Engineering and Consultants co., ltd.	Director	15
LOR_4	Modern engineering cooperation co., ltd.	Project Manager	15
LOR_5	SK consultants co., ltd.	Project Engineer	21
LOR_6	Archineer Associations co., ltd.	Site Engineer	7
LOR_7	Archineer Associations co., ltd.	Site Engineer	5
LOR_8	Archineer Associations co., ltd.	Project Manager	8
LOR_9	Bouakham design co., ltd.	Site Engineer	10
LOR_{10}	SK consultants co., ltd.	Site Engineer	11
LOR_{11}	Vienchan survey and design co., ltd.	Director	23
LOR_{12}	Souksavanh design and consulting co., ltd.	Project Engineer	27
LOR_{13}	EDC co., ltd.	Project Supervisor	10
LOR_{14}	APA design co., ltd.	Project Supervisor	19
LOR_{15}	AEC co., ltd.	Director	7
LOR_{16}	Chittakone design and consultants	Project Supervisor	11
LCR_1	Daoneua construction co., ltd.	Project Manager	20
LCR_2	ISC construction co., ltd.	Site Manager	16
LCR_3	Inpeng group	Project Manager	6
LCR_4	Synesis group	Project Manager	16

Table D.2 Respondent's information for studying the important level of causes of factors affecting quality of construction works (continued)

Code	Company Name	Position	Working Experience
LCR_5	PMC co., ltd.	Project Manager	31
LCR_6	04 construction co., ltd.	Site Manager	11
LCR_7	Huangsanaxay construction co., ltd.	Site Engineer	5
LCR_8	Khamphai sana group	Project Engineer	9
LCR_9	Chitchaleun construction co., ltd.	Project Engineer	13
LCR_{10}	Inpeng group	Director	12
LCR_{11}	Leuxay group	Site Manager	5
Name of companies for international projects			
IOR_1	Lao world public co.,ltd	Site Manager	8
IOR_2	Lao world public co.,ltd.	Project Manager	26
ICR_1	Ounxeun construction co., ltd.	Site Manager	21
ICR_2	Yunnan Jiangong No.5	Site Manager	5
ICR_3	Fangter group	Project Manager	16

Table D.3 Respondent's information of data collection for studying guidelines solving the causes of factors affecting quality of construction works

Code	Company Name	Position	Working Experience
Name of companies for international projects			
IOR_1	Lao world public co.,ltd	Site Manager	8
IOR_2	Lao world public co.,ltd	Project Manager	26
ICR_1	Ounxeun construction co., ltd.	Site Manager	21
Name of companies for local projects			
LCR_4	Synesis group	Project Manager	16
LCR_5	PMC co., ltd.	Project Manager	31
LOR_2	MPWT	Project Supervisor	15
LOR_4	Modern engineering cooperation co., ltd.	Project Manager	15
LOR_5	SK consultants co., ltd.	Project Engineer	21
LOR_{11}	Vienchan survey and design co., ltd.	Director	23
LOR_{12}	Souksavanh design and consulting co., ltd.	Project Engineer	27

Appendix E

Raw data for studying an important level of causes of factors and for studying guidelines solving causes of factors affecting quality of construction works from questionnaire

Table E.1 Raw data for studying an important level of causes of factors affecting quality of construction works

	Local Responses																										International responses				
	OR1	OR2	OR3	OR4	OR5	OR6	OR7	OR8	OR9	OR10	OR11	OR12	OR13	OR14	OR15	OR16	CR1	CR2	CR3	CR4	CR5	CR6	CR7	CR8	CR9	CR10	CR11	IOR1	IOR2	ICR1	ICR2	ICR3
F1	2	1	5	2	2	3	5	3	3	2	2	5	2	3	4	3	2	5	3	1	3	1	1	3	4	5	3	4	3	5	5	4
F2	3	3	5	4	3	2	5	4	4	4	2	3	1	4	5	3	5	2	5	4	3	2	3	3	4	5	4	4	4	5	4	2
F3	2	3	3	4	1	2	4	2	3	3	2	4	3	4	4	2	4	4	3	3	3	3	4	3	4	5	3	2	4	4	2	2
F4	2	5	1	2	4	1	1	1	4	2	2	4	1	5	4	3	5	2	2	2	1	1	4	1	4	5	3	4	3	3	4	1
F5	3	5	4	4	2	4	4	4	3	4	2	5	1	4	5	2	4	5	4	3	4	4	4	3	4	5	4	3	3	3	5	2
F6	4	3	4	4	2	2	4	4	3	4	2	5	2	3	5	3	4	4	3	3	2	4	4	1	4	5	3	4	3	3	5	3
F7	4	5	5	5	5	5	4	1	4	4	2	1	2	4	5	5	5	5	3	4	3	4	3	1	4	5	4	3	3	3	4	4
F8	2	5	5	4	4	3	5	2	4	2	2	3	1	4	5	2	4	4	3	4	2	1	4	1	4	5	4	3	4	4	4	4
F9	1	5	3	1	3	3	3	4	3	1	2	5	1	2	5	5	2	5	4	3	4	4	2	2	4	5	4	4	4	4	4	3
F10	4	5	4	4	3	5	5	3	3	4	2	4	1	4	5	3	4	4	4	5	2	4	1	1	4	5	4	4	4	4	5	4
F11	4	5	3	3	4	4	5	4	3	2	2	4	1	5	5	2	5	4	4	4	2	2	4	1	4	4	4	4	4	4	2	2
F12	2	5	4	2	3	5	5	4	2	3	2	5	1	4	5	2	5	4	4	4	2	3	3	3	4	5	5	4	4	4	4	5
F13	3	5	3	4	4	5	5	3	3	4	2	5	1	4	5	3	4	5	3	5	1	3	2	1	4	4	4	4	4	3	4	3
F14	1	3	3	2	2	4	4	3	2	2	3	3	3	3	4	4	4	4	3	3	1	3	3	3	4	4	4	2	3	4	3	2
F15	2	5	4	4	5	4	5	4	4	3	2	4	2	5	5	4	4	4	4	4	1	2	4	4	4	4	5	4	5	4	4	2
F16	3	3	5	3	4	4	5	1	4	4	2	5	1	2	4	5	2	1	4	4	4	1	5	4	4	4	5	4	4	3	5	5
F17	3	5	3	4	1	3	4	3	2	3	2	5	2	4	5	3	4	2	4	3	3	4	4	2	4	4	4	3	4	4	5	3
F18	4	5	4	3	5	4	4	3	2	2	2	4	2	4	5	3	4	4	3	3	2	1	4	1	4	5	4	4	4	3	4	3
F19	1	1	1	1	4	2	5	5	3	2	2	4	2	2	4	3	4	3	4	4	3	3	3	2	4	4	4	3	4	4	3	4
F20	4	1	4	1	4	4	5	3	3	2	2	4	4	2	4	3	5	2	4	3	3	2	4	2	3	5	3	3	4	3	3	1
F21	1	3	4	4	3	3	4	2	2	2	2	3	3	3	5	3	4	4	3	2	1	3	3	2	4	5	3	3	4	3	4	2
F22	2	5	4	2	4	4	4	3	3	1	2	5	1	2	5	5	4	4	4	4	4	3	3	1	4	5	4	4	3	3	5	4
F23	3	5	4	4	5	3	5	5	5	4	2	4	2	5	5	4	5	2	4	4	2	3	4	1	4	5	4	4	4	4	5	3
F24	3	5	4	4	4	4	4	5	3	2	2	5	2	5	5	3	5	3	4	3	2	3	4	3	4	5	4	3	3	4	5	3
F25	3	5	3	4	4	4	4	4	3	4	2	5	2	4	5	5	5	5	4	3	3	4	3	3	4	5	3	4	4	4	5	4
F26	4	5	4	4	4	4	4	5	3	3	2	3	2	4	3	4	5	4	4	3	2	4	4	3	4	5	3	4	3	3	4	3
F27	4	5	5	2	3	5	4	3	4	2	2	4	2	3	4	5	4	4	4	2	1	4	4	1	4	5	4	3	4	2	4	2
F28	4	5	4	3	4	5	4	5	3	4	2	3	3	4	5	5	4	5	4	5	4	3	4	4	4	5	3	4	4	5	5	4
F29	3	3	3	3	1	3	2	2	3	3	2	3	1	2	5	4	3	2	2	3	3	3	3	3	4	5	3	2	3	3	5	3
F30	4	5	4	4	1	4	3	5	4	2	2	5	1	3	5	5	5	5	4	4	4	3	4	3	4	5	4	4	4	3	5	5
F31	3	5	3	3	2	4	4	3	5	1	2	3	2	3	4	3	4	5	3	3	2	2	4	4	4	5	3	4	3	4	4	2
F32	4	5	4	4	4	4	4	4	4	2	2	4	1	3	5	4	5	1	4	2	1	2	4	1	4	5	3	3	4	3	4	4
F33	3	5	3	2	3	1	4	3	3	4	2	3	2	3	5	4	5	2	3	3	2	1	4	3	4	5	2	4	3	3	4	5
F34	4	3	3	1	3	2	4	3	2	2	2	5	3	3	5	3	5	4	3	2	3	2	4	2	4	5	3	4	4	3	4	3
F35	3	5	4	1	3	2	2	2	2	2	2	3	3	1	4	4	3	3	4	4	2	2	2	2	4	3	4	4	3	2	5	2

Table E.2 Raw data for studying the level of agreement of guidelines from expert's responses in local projects)

Code	Guideline Code	LCR_4	LCR_5	LOR_2	LOR_4	LOR_5	LOR_{11}	LOR_{12}
LF1	G1	3	3	4	5	4	5	4
	G2	4	3	3	4	4	4	3
LF2	G3	5	5	5	5	5	5	4
	G4	5	5	5	5	4	5	5
	G5	3	3	4	3	3	3	3
LF3	G6	5	3	5	5	3	5	4
	G7	4	3	4	4	5	5	4
LF4	G8	5	4	4	5	4	4	4
	G9	5	4	4	5	4	4	4
LF5	G10	4	4	4	4	5	5	4
LF6	G11	3	4	3	4	3	3	4
LF7	G12	4	3	3	4	4	5	4
LF8	G13	4	3	5	5	3	5	4
	G14	5	3	4	4	4	4	5
	G15	4	3	4	4	3	4	5
LF9	G16	3	3	3	4	4	3	4
LF10	G17	4	3	4	4	3	5	3

Table E.3 Raw data for studying the level of agreement of guidelines from expert's responses in international projects)

Code	Guideline Code	IOR1	IOR2	ICR1
IF1	G1	4	3	3
	G2	5	5	4
IF2	G3	5	5	3
IF3	G4	5	5	5
IF4	G5	5	5	5
IF5	G6	5	4	4
	G7	4	5	5
IF6	G8	5	4	4
IF7	G9	4	5	4
	G10	5	5	4
	G11	5	5	4
IF8	G12	4	5	4
IF9	G13	5	5	4
	G14	4	5	4
IF10	G15	4	5	4

VITA

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