แบบจำลองสภาพการณ์ของงานเปลี่ยนแปลงที่มีผลต่อความขัดแย้งในโครงการก่อสร้างในประเทศกัมพูชา

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SCENARIO-BASED MODEL OF CHANGE ISSUE LEADING TO CONFLICTS IN BUILDING CONSTRUCTION PROJECTS IN CAMBODIA

Miss Lakhena Cheang

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Engineering Program in Civil Engineering
Department of Civil Engineering
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Field of Study	Civil Engineering
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ลักขะนา เชียง : แบบจำลองสภาพการณ์ของงานเปลี่ยนแปลงที่มีผลต่อความขัดแย้งในโครงการก่อสร้างในประเทศกัมพูชา (SCENARIO-BASED MODEL OF CHANGE ISSUE LEADING TO CONFLICTS IN BUILDING CONSTRUCTION PROJECTS IN CAMBODIA) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ. ดร. วัชระ เพียรสุภาพ, 135 หน้า.

การเปลี่ยนแปลงของงานเป็นสิ่งที่หลีกเลี่ยงไม่ได้ และเป็นประเด็นที่สำคัญในโครงการก่อสร้าง แม้ว่าเอกสารงานวิจัยต่างๆ จะมีการศึกษาในด้านสาเหตุ ผลกระทบ และบริหารการเปลี่ยนแปลงในโครงการก่อสร้าง แต่การบริหารงานเปลี่ยนแปลงในโครงการก่อสร้างยังเป็นสิ่งที่ยากสำหรับผู้ปฏิบัติในโครงการ แนวคิดใหม่สำหรับการบริหารงานเปลี่ยนแปลงในโครงการก่อสร้างควรมุ่งเน้นในด้านความสัมพันธ์ที่อาจเกิดความขัดแย้ง งานวิจัยนี้มุ่งเน้นเพื่อหาประเด็นสำคัญของการเปลี่ยนแปลงของงานที่เกี่ยวข้องกับความขัดแย้งด้านเวลา ค่าใช้จ่าย และคุณภาพระหว่างเจ้าของและผู้รับจ้างในโครงการก่อสร้างที่ประเทศกัมพูชา นอกจากนี้งานวิจัยยังได้พัฒนาแบบจำลองสถานการณ์สำหรับการเปลี่ยนแปลงของงานก่อสร้างที่อาจส่งผลให้เกิดความขัดแย้งในระดับต่างๆ โดยการเก็บข้อมูลช่วงแรกจะใช้แบบสอบถามที่มีระดับความสำคัญ 5 ระดับ และใช้การวิเคราะห์ one sample t-test สำหรับคำนวณหารายการเปลี่ยนแปลงที่มีความสำคัญต่อความขัดแย้ง ผลการศึกษาพบว่า การเปลี่ยนแปลงตารางเวลาเนื่องจากการวางแผน และการจัดทำตารางที่ไม่ดีของผู้รับจ้างจะส่งผลให้เกิดข้อขัดแย้งด้านเวลาที่สำคัญมาก ในขณะที่การเปลี่ยนแปลงตารางเวลาโดยเจ้าของจะส่งผลให้เกิดข้อขัดแย้งด้านค่าใช้จ่ายที่มีความสำคัญมาก และการเปลี่ยนแปลงของงานเนื่องจากการก่อสร้างที่ผิดพลาดส่งผลต่อความขัดแย้งด้านคุณภาพที่สำคัญมาก สำหรับงานวิจัยส่วนที่สองเป็นการพัฒนาแบบจำลองสถานการณ์สำหรับการเปลี่ยนแปลงของงานโดยใช้วิธีมอร์โฟลอจิคัล ซึ่งงานวิจัยนี้เน้นการค้นหาสถานการณ์ความขัดแย้งที่เกิดจากประเด็นของแบบก่อสร้างที่ไม่ดีและไม่สมบูรณ์ โดยวิธีมอร์โฟลอจิคัลจะแตกรายละเอียดคุณลักษณะและเงื่อนไขที่มีผลต่อความขัดแย้งในประเด็นที่ศึกษา หลังจากนั้นคุณลักษณะและเงื่อนไขดังกล่าวจะถูกใช้จำลองแนวโน้มของสถานการณ์ที่ก่อให้เกิดความขัดแย้งในระดับต่าง ๆ งานวิจัยนี้ช่วยให้ผู้มีส่วนร่วมในโครงการเข้าใจมากขึ้นเกี่ยวกับความสัมพันธ์ระหว่างการเปลี่ยนแปลงของงานก่อสร้างกับระดับความขัดแย้งภายใต้สถานการณ์ต่าง ๆ

ภาควิชา วิศวกรรมโยธา ลายมือชื่อนิสิต .....

สาขาวิชา วิศวกรรมโยธา ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

ปีการศึกษา 2557

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KEYWORDS: CHANGE ISSUE / CONFLICT MANAGEMENT / SCENARIO-BASED MODEL / MORPHOLOGICAL ANALYSIS

LAKHENA CHEANG: SCENARIO-BASED MODEL OF CHANGE ISSUE LEADING TO CONFLICTS IN BUILDING CONSTRUCTION PROJECTS IN CAMBODIA. ADVISOR: ASST. PROF. VACHARA PEANSUPAP, Ph.D., 135 pp.

Change is inevitable and becomes one of the critical issues in construction projects. Although many research papers have been conducted in the areas of causes, impact and management of changes, project practitioners still have the difficulty to manage changes. Novel concept of change management should be proposed by focusing on the relationship of conflict aspect. This research attempts to identify change issues leading to conflicts related to time, cost and quality between owner and contractor in building construction projects in Cambodia. It also aims to develop scenario-based model of a significant change issue leading to different levels of conflict. The questionnaire with five-point Likert scale was selected as a tool for data collection in the first part. One sample t-test was analyzed to identify the level of importance on significant change issues. The research findings reveal that the top change issue leading to time conflict is schedule change due to poor planning or scheduling from contractor. The most critical change issue for cost aspect is schedule change by owner. Change due to construction errors is the most important issue in terms of quality conflict. In the second part, scenario-based model was developed by morphological analysis. This part focused on exploring conflict situations from aspect of change due to poor and incomplete design. The technique breaks down each collected case in order to determine crucial attributes and conditions. Those attributes and conditions were used to simulate the scenarios that created the tendency of conflict in different levels. The scenario-based model provides clear understanding to project parties about the relationship between change issues and conflict levels under different situations.

Department: Civil Engineering Student's Signature .....
Field of Study: Civil Engineering Advisor's Signature .....
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CHAPTER I
INTRODUCTION

1.1 Background of Research

Construction projects frequently end up with cost overrun, extended schedule, quality concerns and other negative impact (Sun and Meng, 2009). The terms of project success is not an easy task to accomplish due to considerable uncertainties in a project life cycle. Change management is one of the most important tasks to implement in order to improve project performance and maintain relationship between projects parties. As evidence, change within construction has been considered as a major concern of a considerable time for government and private-sector client (Fernie et al., 2006). However, changes tend to take place more often in private projects because private owners are often likely to change plans in order to meet their customers' demands. Thus, change or variation is a crucial variable contributing to project success.

In construction context, changes in projects are inevitable (Hwang and Low, 2012). Major and minor changes commonly occur in any project stage by various causes. The project participants including owner, contractor, designer, consultant, and other parties, get directly and indirectly involved in change events which may bring them both harmful and beneficial effects based on the characteristics of the changes (Cor, 1998, Sun and Meng, 2009). The Time of change occurrence of change is also concerned, since the same type of change events may produce different impact due to the different project phases in which the change occurs (Hao et al., 2008). Therefore, changes are complicated or simplified due to the period of change occurrence and the involvement of project stakeholders. For instance, design changes initiated from owner's requirement have quite different impact between time of change occurrence such as before, during and after construction phases. The time and cost compensations are required to evaluate in such cases. Last but not least, quality impact due to change is also concerned.

In generally, changes in construction projects may have undesired impact and harmful consequence for the project performance related to effects of time, cost, quality, and relationship and people (Sun and Meng, 2009). Many research studies illustrate that project changes can provoke major negative impact, including increase in project cost, recruiting new staff, increase in overhead expense, quality degradation, decrease in labor productivity, delay of procurement process, rework and demolition, safety condition, delay in completion schedule, and more seriously change can lead to dispute (Hwang and Low, 2012). In terms of impact, a change is a sensitive issue leading to conflict of time, cost and quality which affect clients' satisfactions. Thus, changes are needed to be managed properly to avoid considerable impact and to reach owner's requirement.

In brief, change in construction is unavoidable and likely to occur in all project phases. Due to the uncertainty of changes, the success of project may be far-reaching if they are not solved properly. While the changes are compensable with the time extension, additional cost and quality concern, the conflicts between parties always arise. However, the magnitude of changes varies depending upon the actual situation of the project. This shows that it is necessary to manage changes properly in order to minimize the impact. To minimize the severe consequences and impact, the identification of the changes leading to conflict must be defined carefully in this study.

Additionally, the various situation of significant change issue is necessary to be studied in details. From this point of view, the project practitioners would gain more understanding of changes and be able to manage effectively the change issues.

1.2 Problem Statement

Change is considered as an important problem in construction projects. As shown in Figure 1.1, many research studies related to changes in construction have been conducted in order to get clearer understanding about changes or variations in construction projects. Consequently, the studies of changes in construction have been focused on causes, effects, and change management, which attempt to provide a better understanding of changes in order to manage and solve those changes. Changes have high negative effects to project performance related to time, cost, quality and

relationship. Previous research papers have focused on impact on time, cost and quality.

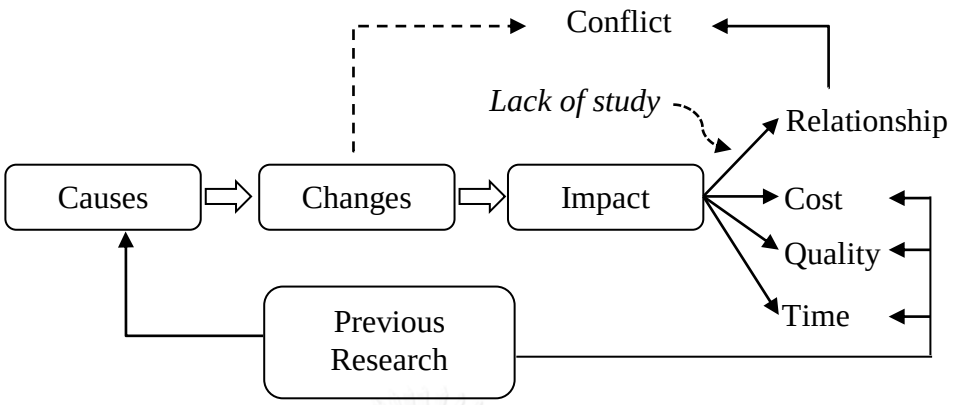

Figure 1.1 Problem statement of research

Although the previous research may help project practitioners in terms of management, but changes still occur and high impact to project performance. Moreover, change has negative impact on relationship between project parties (Sun and Meng, 2009). In terms of relationship, change is essential to be managed promptly because conflict might bring the project failures, slow progress, disputes, damage relationship and so on. Thus, an alternative concept of specific study related to changes should be proposed. Furthermore, detailed study of changes may not be enough to handle the changes, the project participants have to get a clear picture of change issues. In addition, there is still unclear image of change in terms of different situation, especially, for those causing major conflicts. Thus, there should be research related to those scenarios of change issues leading to conflicts.

Clearer insight of change is really needed for project stakeholders to be aware of the changes occurring at the real construction sites. Furthermore, the research is endeavored to provide the scenario of the significant conflicts caused a selected change. It might bring the benefits to the users to realize the situations of changes, thus they can take proactive measures to prevent and to reduce the conflicts, especially, to mitigate their impact affecting project performance.

1.3 Objectives of Research

The objectives of this research are (1) to identify change issues leading to conflicts between owner and contractor related to time, cost and quality in building construction projects, and (2) to develop scenario-based model of a significant change issue leading to different levels of conflict indicators.

1.4 Scope of Research

This research focuses on change issues which can bring to relationship controversy in terms of time, cost and quality in building construction projects. Notably, time, cost and quality (TCQ) are the chief concerned perspectives in the construction project to achieve the owner objectives. The perceptions and information from owner and contractor sides are very important. Regarding to time constraint, the research study will be stressed on the following:

- Investigate Location: Cambodia
- Focused projects: Mid-rise, high-rise, Private building construction projects
- Target respondents: Those getting involved in change decision in their recent previous building construction project. They can be Project Managers, Deputy Project Managers from the contractor side and owner representatives.

Mostly, public construction projects in Cambodia are infrastructure projects, including bridges and roads. Concerning to the building constructions, public projects are schools, offices, and so on. Most of them are low rise. This research focuses particularly on the private building construction projects in Cambodia.

Regarding to the specific types of buildings, several classifications have been made according to their particular purpose. In the standard of American Society of Civil Engineers (ASCE) , wind loads are imposed differently according to the building heights (Engineers, 1994). In that standard, two main types of building heights are considered, low-rise (buildings with $h \leq 60$ feet (18.30 m)) and high-rise (buildings with $h > 60$ feet (18.30 m)). In the same way, building height is also used to classify the types in International building code. A high-rise building is defined as a building with an occupied floor located more than 75 feet (22.86m) above the lowest

level of fire department vehicle access (IBC, 2006). Thus, buildings with high less than 75 feet are set as low-rise building. In the story-based aspect, buildings with 1 to 3 stories are identified as low-rise, while buildings with 4 to 7 stories are counted as mid-rise , and 8 stories up buildings are high-rise (Akkar et al., 2005).

In this research, the types of buildings are defined as low-rise (buildings of 1 to 3 stories with the total height of 9.80 m), mid-rise (buildings of 4 to 7 stories or the total height between 9.80 m to 22.86 m), and high-rise (buildings of more than 8 stories or from 22.86 m up to 100 m).

1.5 Methodology of Research

To accomplish the research objectives, the methodology are designed as below:

1. Review the related literature of change and conflict in construction projects.
2. Identify change issues leading to conflict of time, cost and quality in building construction projects.

2.1 The survey questionnaire is designed for respondents to provide their perceptions of the important change issues leading to high conflicts of time, cost and quality that need to be managed.

2.2 The SPSS is used to analyze the importance levels of change issues provoking to those conflicts. Not only one sample t-test but also Cronbach's Alpha and Kendall's coefficient are performed. The last two tests are to check internal reliability of the used Likert scale and consistency of agreement between respondents.

3. After analysis of change issues, the most critical one containing the highest mean value is selected for further study. Scenario-based model is developed by implementing morphological technique. The conflict levels are clearly defined.
4. To identify the attributes and condition influencing the conflict levels.

4.1 Face-to-face interview is carried out. The participants will be asked to describe the story of selected change issue according to the three levels of conflicts.

4.2 Based on the description, the attributes and conditions influencing each conflict level might be determined.

5. Develop morphological fields (combinations of attributes and conditions) for the selected change related to each conflict level.

5.1 The questionnaire is developed for respondent to draw the morphological fields of conflict at level 1, 2 and 3.

5.2 The previous provided cases are also confirmed by the participants. The following professionals are also asked for other combinations that can lead to same level of conflict.

5.3 The scenarios of the change issues leading to three conflict levels will be determined.

6. Research conclusions

1.6 Expected Benefits

Many research steps are conducted to fulfill the main objectives. After adopting an appropriate methodology, the results are expected to provide substantial benefits to project managers and stakeholders involving in changes.

The first output comes up with lists of crucial change issues provoking conflicts of time, cost and quality in private construction projects. According to the lists, project stakeholders will comprehend the important issues of change occurring in construction projects. Thus, they can pay much more attention on those issues. The outcomes of this task are believed to provide substantial advantages to all parties in projects to have more insight of impact and consequences of changes. Therefore, the project participants can pay more attention when essential change occurs.

This research study also attempts to introduce the novel concept of change management by focusing on scenario study. The second output will be scenario-based model showing important attributes and conditions involving in conflict development. Moreover, different combinations of attributes and conditions are presented to demonstrate three conflict levels. The project participants will be able to see how scenarios of change could influence the development of conflict levels. Thus, the parties are able to take action in advance to prevent and manage the changes because the change issues and the situations of the changes will be shown.

In conclusion, the research is expected to offer great help to users in managing changes properly. The project practitioners will be able to perform efficient actions in order to minimize the high impact of changes.

CHAPTER II
LITERATURE REVIEWS

Relevant reviews of change have been conducted in this chapter in order to provide clearer insight about their types, causes, impacts and management in construction projects. Conflict is also discussed in this part to gain deeper image in management viewpoint. Particular change issues have been formulated for the next step of the research. The limitations of previous research are shown in the research gap part. It helps to figure out the possible ways to fulfill the research objects. The research framework is presented as well to provide the main activity flow of this research study.

2.1 Change in Construction Projects

2.1.1 Definition of Change

Change in the work is a modification in the scope of work established in the contract documents at the time of contract execution (Jervis and Levin, 1988). Moreover, a change may involve with the deletion of work, the addition of new work, or an alteration in the materials or equipment to be used. Furthermore, change is defined as any action, incidence or condition that makes differences to an original plan or schedule (Motawa et al., 2007). In engineering sense, change is considered as modifications of parts, drawings or software which have already been released during the product design process. The change events in construction projects are also studied. It is also described as variation which refers to any types of deviation from an agreed upon, well defined scope or schedule of works (Rust, 2010).

Due to the uncertainties and number of variables in a construction project, it is not surprising that changes take place during any phases of the project. One type of changes can occur in one or several phases of project lifetime which consists of planning, design, procurement, construction and maintenance phases. Additionally, change or variation has been involved by many parties such as owner, designer, architect/engineer (A/E), contractor, vendor and outside parties referring to banker, local authorities, and so on (Thomas and Wilshusen, 1990). Thus, change issues are

caused by many factors which depend on the project participants, time period of changes occurred and other significant conditions.

As changes will never disappear in construction projects, it is very important to manage them properly in order to scale down the negative consequences (Erdogan et al., 2005). Optimizing change is important for achieving good cost, schedule, and productivity (Ibbs and Vaughan, 2012). Therefore, change should be keenly aware from all parties and should be controlled carefully. To handle the change issues, their characteristics which include types and sources, should be well recognized first. Meanwhile, the causes and effects of changes to the project should be discussed.

In this research, change refers to any event which results in modifications of the project work, schedule or cost. They can be change in scope of work, work process, materials, specifications, changes due to site conditions, change due to construction errors and change due to design. Moreover, types of stakeholders are considered as the main cause of changes.

2.1.2 Types of Changes

In overall viewpoint, changes can provide both positive and negative effects which reflect the indirect and direct impact on schedule, cost and quality of construction projects. Thus, two main types of changes are categorized, namely beneficial and detrimental changes (Ibbs, 2012). The positive or beneficial change aims to provide advantages to a project. This kind of change is encouraged by the management team. On another hand, the negative or detrimental changes are discouraged and are those resulting in damaging impact.

In construction projects, directed change is defined as modification ordered and acknowledged in the scope of work by the project owner (Jervis and Levin, 1988). It can be addition or deduction of certain tasks from the original scope. In work aspect, changes can be grouped into two basic categories; directed and constructive. The first type of change, directed change is formally achieved by a release of a change order. The change order is a typical document released by project owner and signed by owner and contractor in order to acknowledge that the contract has been modified. Although the owner of projects can request for change, it does not mean that the

change is possible to process all the times. For instance, it is unable to make any change if a construction contract lacks the change clause. To avoid inequity between parities, a project owner is not allowed to make “cardinal change” which refers to enormous amount of modifications. From another aspect, the constructive change is a modification in the work. The contractor alleges that the work change has been caused by an act or directive of the owner (Jervis and Levin, 1988).

According to the research article of Erdogan and his colleagues, the different classifications of organizational and project changes have been determined in the literature review section (Erdogan et al., 2005). The two major kinds of changes are grouped differently based on the characteristics of changes which were taken into study by many researchers. The summary of several different classifications for changes are shown in Table 2.1.

Table 2.1 Project and organizational changes (Erdogan et al., 2005)

According to	Project Changes (PCs)	
Type of impact	Beneficial Changes	Detrimental Changes
	Reduce cost, schedule or degree of difficulty	Reduce owner value, have negative impact on the project
Need for change	Beneficial Changes	Detrimental Changes
	Implemented to meet the objectives or regulatory/ legal/ safety/ engineering requirements/ standards	Enhance the project, but are not required to meet the original objectives
Initiation Nature/ Responsiveness of change	Emergent/ Reactive Changes	Anticipated/Proactive Changes
	Unplanned, unexpected. The response is after the occurrence.	Expected before it occurs, therefore necessary actions are taken.

Table 2.1 Project and organizational changes in construction (Erdogan et al., 2005) (Cont.)

According to	Organizational Changes (OCs)	
The difference in the organization due to change	Strategic Changes	Non-strategic Changes
	Non-routine, non-incremental and discontinuous, alters the overall orientation of the organization.	Do not affect the overall orientation of the company; do not result in a drastic difference.
Speed of the transformation in the organization	Incremental/ Gradual/Fine Tuning	Radical/ Quantum Changes
	Routinely necessary for any organization to adapt to its environment	Necessitates a thoroughgoing re-examination of all facets of an organization
Initiation Nature	Emergent Changes	Planned Changes
	Driven from bottom up and is an open-ended and continuous process of adaptation to changing conditions	Result of an action research and an analysis of the social and organizational problems in question
Initiation Nature	Emergent Changes	Anticipated Changes
	Driven from bottom up and is an open-ended and continuous process of adaptation to changing conditions	Not planned by the organization but its happening is expected.

The researchers of this journal article also iterate that construction organizations face with many changes, most of which are so-called design changes. Normally, changes in projects are attempted to avoid even if there had been detail studies of project prior to the project phase. Notwithstanding the tactics to handle changes at project level, companies are sometimes required to implement changes at organizational level regarding to management, people, technology and cultural issues (Erdogan et al., 2005).

Table 2.2 Types of changes in construction (Ibbs and Vaughan, 2012)

Type of Changes	Descriptions
Owner Acknowledged Changes versus Constructive changes	• An owner acknowledges change is modification that both parties (contractor and owner) have agreed that it is a change. • A constructive change is a change that the owner does not acknowledge when it occurs, but it still has an impact.
Cardinal Changes versus In-Scope Changes	• A cardinal change is a change to the contract because the size or scope is outside what is included in the contract writing. • An In-scope change is a change to the work that is already being performed. • Contractors are generally not obligated to perform the work of cardinal changes. • In public projects, cardinal changes are illegal and considered new procurement.
Detrimental change versus Beneficial Changes	• While changes on a construction project are generally negative, requiring additional time or money, there are also beneficial changes that have positive impact. • Beneficial changes can reduce cost, schedule, or degree of difficulty. • Detrimental changes reduce value or have a negative impact. • This classification is dependent on your point of view (what is positive to one person could be negative to another).
Required Changes versus Elective changes	• Required changes may be necessary to meet basic business objectives, to meet regulatory or legal requirements or to meet defined safety and engineering standards. • Elective changes are proposed to enhance the project, but are more discretionary.

However, changes in construction are also discussed in field guide by (Ibbs and Vaughan, 2012). Consequently, the common classifications of changes have been described in Table 2.2. The categories of changes types are also attached with the descriptions.

Types of changes have been determined by many research articles. Those types may be defined from different concepts of each researcher's study. Some focus on project changes and some on organizational ones. In addition, they have conducted them by using various frameworks, research scopes, methodologies, and so on. Therefore, the results might be different or similar upon the research concepts and frameworks. On the other hand, it comes up with the fact that not every change results the negative impact, it also provides the favorable achievement.

After the types of changes in construction projects are determined, the deeper perception and causes of changes should be also explored in order to make a clearer insight for the participants to be flexible for further actions against the negative impact.

2.1.3 Causes of Changes

Change causes have been investigated by many researchers in several countries and in different stages of construction projects. The causes of changes may depend on many involving factors, including the natures of projects, the owner's satisfaction, the unforeseen conditions, work operations, authorities, and other important factors. Changes often are the result from the uncertainties associated with the imprecise and vague knowledge of much project information at the early stages of a project lifetime (Motawa et al., 2006). However, the parties participating in the changes in construction projects are owners, contractors, designers, Architect/engineer, vendors, and outside parties which include the authority, bank agency, and insurance (Thomas and Wilshusen, 1990). Actually, change can be caused by any or combinations of many factors (Hao et al., 2008).

According to publication of "Construction Law", written by Jervis and Levin, the change occurs because of two factors; complexity of the process and changes to development plans (Jervis and Levin, 1988). The first factor, complexity of the

process, consists of ambiguity of contract documents and differing site conditions. By the way, the second one, change to development plans, refers to the unexpected problems from the owner, project financing, regulatory problems, and other issues forcing the owner to change.

A study carried out by Erdogan et al. (2005) also investigates the reasons of changes in construction projects. The causes of changes from other researchers have been figured out and categorized by focusing on external and internal factors. Moreover, the types of changes, including project and organizational changes, are also considered. Based on the finding of the task, the external reasons are all factors take place outside the organization or project and cannot be controlled by project team or organization level. Equally important, the internal reasons are those resulting from changes inside the organization and project (Erdogan et al., 2005). The following table presents the reasons for changes at levels of project and organization.

On the other hand, change causes are reviewed by Ming Sung and Xianhai, shown in the Table 2.3. Those causes have been classified by focusing on relevant problems such as project related, client related, design related, contractor related and external factors (Erdogan et al., 2005).

Additionally, taxonomy of change causes is also presented in Table 2.4. It illustrates the ordered scheme of classification of change causes. The table presents the main and two sub-causes of changes (Sun and Meng, 2009). Table 2.4 builds on the previous researches findings by collating information from dispersed sources, then analyzing, and finally, synthesizing it. Based on the finding of the study, the taxonomy of changes causes has been found out by classifying them into different categories (Sun and Meng, 2009). The major levels are contained in external, organizational, and project internal causes. There are many causes involving during the project change management process. It brings a more comprehensive understanding of project changes to the project managers.

Table 2.3 Causes of project and organizational changes (Erdogan et al., 2005)

Reasons for	External Reasons	Internal Reasons
Project Changes	Changes (Cs) regarding economic and financial issues Cs in environmental issues Cs in ecological issues Technology Cs Cs in the standards and regulations Political changes Force majeure	Cs in the organizational culture Cs in the system of project planning Cs in the project plan execution Cs in the overall change control system Cs in the documentation system Ineffective decision making Design improvements Unexpected weather conditions Design error Designer change of mind Changed design parameters Contract disputes Cs in the project
Organizational Changes	Cs in environment New technologies Cs in the market place Changing customer expectations Cs in competitor activities Cs in quality and standards Cs in legislation Cs in prevailing political values Cs in the economy Demographic changes Ecological changes Cs in cultural factors	Cs in goals and values Cs in the technical system Cs in organizational structure Cs in the management philosophy Cs in the psychological system Cs in the managerial systems of internal power and control

Table 2.4 Taxonomy of change causes (Sun and Meng, 2009)

Level 1	Level 2	Level 3
External causes	Environment factors	Conservation restrictions
		Weather conditions (Wind, temperature, rains, etc.), natural disaster (food, earthquake, etc.)
		Geological conditions, Unforeseen ground conditions
	Political factors	Changes in government policies (environmental protection, sustainability, waste recycle, brown field use, etc.)
		Changes in legislations on employment, and working conditions
		Delays in planning permission approval
	Social factors	Demography change and its impact on labor demand and supply skill shortage on certain trades
		Opposition of neighboring community
	Economic factors	Economy development cycle and its impact on demand
		Inflation impact on material , equipment and labor price fluctuation market competition
	Technological factors	New materials, New construction methods
		Technology complexity
Organizational causes	Process related	Organization business strategy
		Business procedures, including payment practice
		Quality Assurance procedures
	People related	Competence and skills
		Cultures and ethics
	Technology related	IT and communication systems
		Technical supports
Project internal causes	Client generated	Requirement change and variation
		Funding change, i.e., shortage of funding
		Slow decision making, Payment delays
		Difficulty in site acquisition
	Design consulting generated	Poor and incomplete drawings
		Design change due to poor brief, errors and omissions
		Inconsistent site conditions
	Contractor/ subcontractor generated	Poor project plan/ schedule
		Poor site/ project management skills
		Delays in appointing subcontractor
		Delays of subcontractor's work
		Poor workmanship
		Low productivity, Poor logistic control
	Others	Poor interdisciplinary communication
		Team instability, i.e. disputes, bankruptcy, etc.
		Inappropriate project organizational structure

2.1.4 Impact of Changes

Table 2.5 Taxonomy of change effects (Sun and Meng, 2009)

Level 1	Level 2	Level 3
Time effect	Time extension	Additional work
		Deletion of work
		Rework/redesign
		Work duration extension
	Loss of productivity	Productivity degradation
		Procurement delays
		Logistic delays
		Unbalance rhythm
	Increased risk	Acceleration measures
		Interruption of work flow
		Loss of float
		Increased sensitivity to further delays
Cost effect	Direct Cost	Waste on abandoned work
		Demolition cost
		Increase in overheads
		Additional equipment and materials
		Additional payment to contractors
	Indirect cost increase	Interrupted cash flown
		Increased retention/contingency sum
		Overtime costs
		Litigation costs
Relationship and people effect	Relationship related	Claim and dispute
		Arbitration and litigation
		Team change
		Poor co-operation
	Working conditions	Revision to work method
		Site congestion
		Poor safety conditions
	Staff related	Loss of learning curve
		Lower morale
		Staff turnover
	Quality	Quality degradation
		Damage to reputation

Changes have direct and indirect impact on the project. The change effect is known as the series of consequences happening after the change occurs. However, the negatives and positives results may be included to the effect of changes. While the occurrence of change is common in a construction project, its impact might be varied from one to another project according to the uniqueness of a project and actual presence of change.

The study of change effect taxonomy is also carried out. The research is conducted by reviewing many articles of change effects, and groups them by applying taxonomy theory. The hierarchy framework is conducted to provide the clear insight for the stakeholders or team to have the same understanding. The finding of the task is shown in Table 2.5. The table of taxonomy demonstrates classification of change effects. The classification reveals crucial impact of change at each level. The main effects of change are effects related to time, cost, and relationship and people.

Besides, findings of another research also empathize change effects by gathering the results from other articles and making a discussion. This previous research also reveals the impact of change, including increase in project cost, recruiting new staff, increase in overhead expense, quality degradation, decrease in labor productivity, delay in procurement process, rework and demolition, safety condition, and delay in completion schedule (Hwang and Low, 2012).

Change can be studied in project or organization levels. However, this research will focus on change in construction projects. Based on the above discussion, changes in construction are very significant in terms of management because changes cannot be eliminated. They provide the major impact on project performance. Serious, it can damage relationship between parties in the conflict viewpoint. Thus, the conflict in construction should be reviewed.

2.2 Conflicts in Construction Projects

2.2.1 Phenomena of Conflict

The term of conflict in construction is inevitable and often undesirable. The conflicts are defined as “any divergence of interest, objectives or priorities between individuals, groups or organization, or non-conformance requirements of a task, activity or process” (Gardiner and Simmons, 1992) Conflict can be natural, functional and constructive or unnatural, dysfunctional, destructive and unproductive. Conflict occurs when two or more parties believe their interests to be incompatible, express hostile attitudes, or take accounts that damage the other’s ability to pursue it interest (Gardiner and Simmons, 1998).

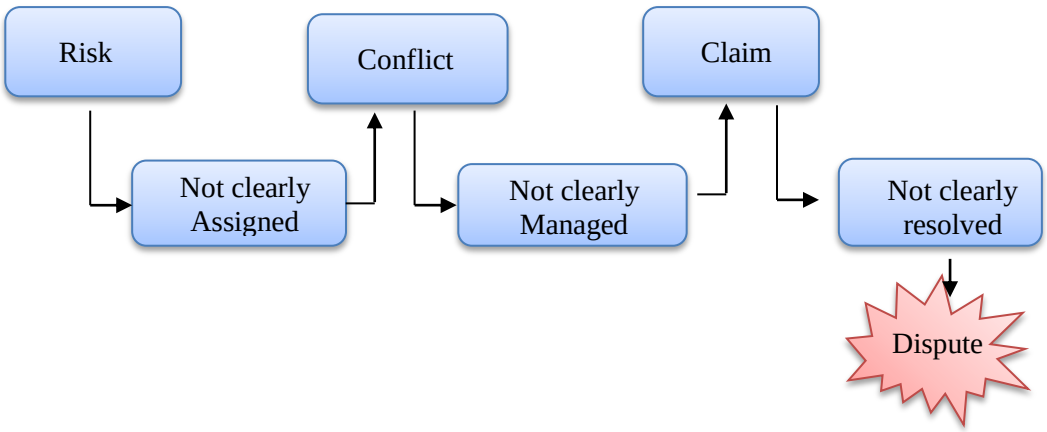

Figure 2.1 Phenomena of risk, conflict, claim and dispute (Acharya et al., 2006)

During construction phases, there are important four terms of management, including risk, conflict, claim, and dispute. The four terms can occur while there is a disagreement between participants. The risk is determined as the occurrence of uncertain events that might bring possible damages or loss to the projects whereas the uncertainties are the undefined risks and can occurred at any point of times of project durations. Conflict in a project starts with the unsolved problems that can face between two or more parties. The instant result of increasing conflict issues can lead to high level of conflict and claim. The claims over the time and left unsatisfied will become a dispute.

In brief, conflict exists whenever there is incompatibility of interest between parties. The conflicts in construction context are hard to fix sometimes due to the degree of the conflict itself. For a clearer insight, the levels of conflicts are presented in the next part.

2.2.2 Levels of Conflict

Moura and Teixeira (2013) have mentioned about the simplest classification which is divided based on participation levels. The classification is done by differentiating the boundary of parties' involvement. Conflicts are distinguished into six levels, including intra-personal conflicts (within the individual), inter-personal (between individuals), intra-grouping (conflict deflates in a restricted grouping), inter-group (between different groups), intra-organizational (within an organization), and inter-organizational (between organizations).

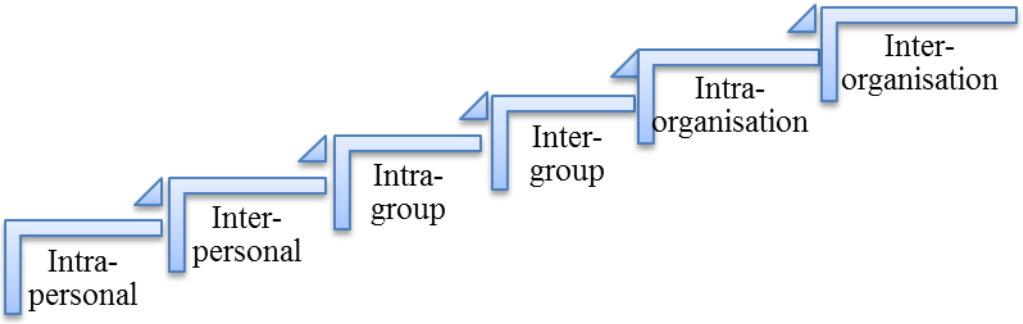

Figure 2.2 Conflict levels distinguished Gordon (Moura and Teixeira, 2013)

Figure 2.2 illustrates the different boundaries of the six conflict levels. These conflict levels are categorized according to the stakeholders' involvement. Personal, group and organization play very important roles in this classification. Accordingly, the conflicts in distinct degrees might require different resolutions.

Furthermore, the conflicts can be categorized into five levels. Table 2.6 illustrates the substantial degrees of conflicts which consist of five levels, such as (1) incompatibility, (2) disagreement, (3) antagonism, (4) frustration, (5) dispute (Hellard and Baden, 1992). The meaning and description of each conflict degree are clearly defined as well. Different situations in which change occur may bring to different levels of conflicts.

Table 2.6 Conflict levels in construction projects (Gardiner and Simmons, 1998)

Level of Conflict	Meaning	Description
Level 1 Incompatibility	Different opinions on task or activity or methods and sequencing of activities.	The parties have different ideas on the tasks. It is often ignored.
Level 2 Disagreement	Confusion of opinions over process or methods, techniques, and activities that has tended to deviation of works.	The project participants get confused over the work which is likely to have variation of work. However, it is sometimes still ignored.
Level 3 Antagonism	Severe mishaps and observed deviations/ variations, issues are about the request for claims and rights.	As the unexpected things or deviations of work happen, one party might ask for claim and rights. It is necessary to take action and cannot be ignored.
Level 4 Frustration	Tension and frustration due to substandard output, delay, unsatisfactory performance, fighting for claims and hindrances, abandonment of site.	In this case, the situation might be serious and the damage may happen. It leads to delay, cost overrun, and poor quality. They might fight for the claim.
Level 5 Dispute	Involved arbitration or litigations/ lawsuits due to unsatisfied claims, work suspensions/ stoppages/ terminations or breach of contract.	The magnitude of conflict in this level is very severe. The intervention from one or many parties may arise to coordinate the project.

2.3 Conflicts Related to Time, Cost and Quality

In management process, conflict should not be simply characterized as functional or dysfunctional components (Leung et al., 2005). Obviously, it is recognized as a principal reason of inefficiency and limited performance of construction project (Zouher Al-Sibaie et al., 2014). Conflicts might be caused from various resources, in which changes are also included. In general, change issues have direct and indirect affect to the project performance which refers to time, cost, and

quality. In this research, the task and relationship conflicts among time, cost and quality of a construction project. Conflict of time is about non-conformance of participants over the time. In construction context, conflict of time might relate to activities or procedures leading to the time extension and delay, or affecting to the schedule of work. Conflict of cost refers to activities which affect to the project cost. A party may ask for additional cost or cost reduction. Additionally, those kinds of procedures or process can lead to the project cost overrun. Conflict of quality is the effect of a change issue on the quality of work. It might be related to low standard of product quality.

The changes in construction normally can arise at any phase of project lifecycle. The detrimental change has very high impact on construction labor productivity which leads cost overrun, delay, and quality problems (Ibbs et al., 2003). The project participants also involve in the change processes. A change issue has effect differently at a construction phase and can be involved by different project parties. As there are many root causes of changes, the factors of changes provoking the conflict problems will be vary upon the nature of changes. In particular, the liaison between change issues and conflicts are hardly to predict in terms relationship aspect.

In brief, changes may lead to the conflicts related to time, cost and quality. Change may occur at any construction project phase. Sometimes, changes are hard to manage due to the lack of knowledge of magnitude, information, sources of changes and time when a change event occurs. It would be much better if the changes are detected before the construction starts.

Many research studies have attempted to explore the influence of changes on construction projects. There are two limitations of previous research. First limitation is that the term of change in previous research is broadly discussed by focusing on causes, impact and types of change. For the second limitation, impact of change on construction in previous studies was not classified into time, cost and quality. Therefore, the knowledge regarding to the conflicts caused by change issues is important. To gain more insight of the effective change management, the detailed study of specific change issues is needed in the conflict point of view.

2.4 Exploration of Change Issues in Construction

The effects of a change might vary. It depends on the originator of that change. For instant, owners and designers frequently initiate changes during design development to reflect changes in project scope or preferences for equipment and materials other than those originally specified. In addition, contractors often originate changes when interferences are encountered, and when designs are found to be not constructible, or other design errors are found. Therefore, effects of change are varied. From this point of view, a particular change issue is formed by considering the originators and characteristics of the change. Figure 2.3 illustrates the formation of specific change issues. The originators of changes refer to those making changes and can be the owners/clients, designers, contractors, and outside parties (Mitkus and Mitkus, 2014). The examples of characteristic of change are schedule changes, design changes, scope changes, and so on (Cor, 1998). However, some unavailable change issues were eliminated during the pilot survey.

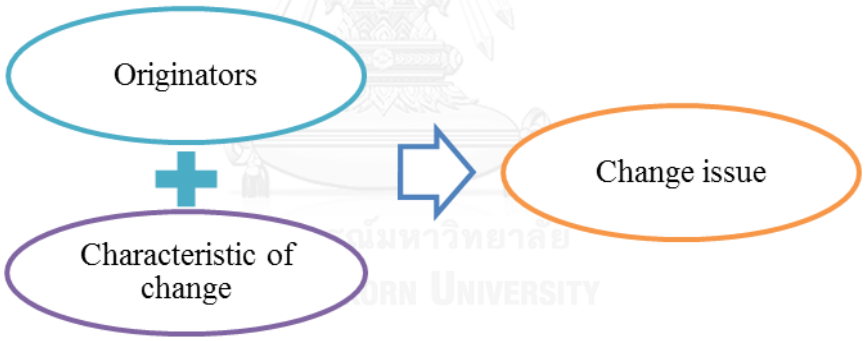

Figure 2.3 Formation of specific change issues

The table below represents the change issues integrated between the literature review and pilot survey. The sixteen change issues were summarized and grouped into: (1) changes originated by owner/client (coding: O), (2) changes originated by designer (coding: D), (3) changes originated by contractor (coding: C), and (4) changes originated by other parties such as local authorities, suppliers and so on (coding: S).

Table 2.7 Exploration of change issues

Originators	Coding	Change issues
Owner/Client	O1	Scope change by owner
	O2	Design function change due to client's requirement
	O3	Schedule change by owner
	O4	Change in material specifications by owner
Designer	D1	Change due to design errors by designer
	D2	Change in specifications by designer
	D3	Change due to poor and incomplete design by designer
	D4	Design change due to inconsistent site conditions
Contractor	C1	Change in construction method in order to improve constructability
	C2	Schedule change due to poor planning or scheduling from contractor side
	C3	Contractor's change due to construction errors
	C4	Contractor's change due to unavailable resources
	C5	Contractor's change in unavailable material specification
Other parties (Supplier, Local authority, etc.)	S1	Change in design initiated by a supplier
	S2	Regulation change
	S3	Change in material costs by supplier

O = Change originated by owner/client, D = Change originated by designer
C = Change originated by contractor, S = Change originated by other parties such as local authorities, suppliers, etc.

Sixteen change issues are extracted from the literature review and are brought to discuss with respondents during pilot survey. Those issues are the current problems in their construction work. Each specific change issue needs to be defined clearly in order to differentiate its impact and cause. The descriptions of sixteen change issues are following;

- Scope change by owner (O1): It includes additional or deduction work directed by owner/client. Such modification may affects to time and cost of construction projects. The change is requested directly from the owner. Scope changes have a considerable adjustment on cost and time of projects, and negative consequence to quality (Ayal, 2005, Khan, 2006). Such change provides ground for disputes in construction industry, mostly when the change becomes cardinal modification (Cushman et al., 2000).
- Design function change due to client's requirement (O2): It refers to modification of design initiated by the occupier and/or client representatives. It can be the whole or a part of a building. The occupiers request to change some decoration or something else which may be related to the structural design. In this case, designer has to modify the structural design. This affects to the project performance. Changes initiated by the client were found to be the primary cause of rework and demolition (Love and Li, 2000).
- Schedule change by owner (O3): Owner requests for make change to completion date as a whole project or some parts of a project. This change put much pressure to the contractor if he accepts the change. In addition, it might lower the productivity if the schedule becomes unorganized. This kind of change results in cost cutting, re-sequencing of work, acceleration and defective work (Chester and Hendrickson, 2005). Those consequences have impact on time, cost and quality.
- Change in material specifications by owner (O4): It is directly requested by owner to change the material specifications. Owner attempts to change the materials which are different from the one stated in the contract document. Although owner has right to change, however some changes may bring difficult to contractor. In owner's opinion, high quality with low cost material is preferred. Sometimes, contractor cannot find the equivalent materials due to the limitation of material supply in the country. It is commonly related to cost and quality aspect in this case. Moreover, change in material specification may disrupt the construction activity if the owner requests to change at the middle of

construction stages. Rework and demolition will occur. This mean that project timeline will suffer. Thus, conflicts among owner and contractor may occur.

- Change due to design errors by designer (D1): The errors refer to the designer's faults by imposing the wrong loads, miscalculating the required loads and so on. Due to errors from designer during design stage, it can lead to some modifications in construction stages. It includes structural change, architectural changes and various variations. Design error induces rework and demolition, which affect badly to the project performance (Love et al., 2000). Time, cost and quality will be discussed when change due to design errors exists.
- Change in specifications by designer (D2): Designer might ask to change the specification. It can be partial or a whole modification of structural or architectural specifications. The change in specifications emerge the modifications related to drawings, materials, quantity and construction process. At the meantime, cost variation, quantity deviation and time consumption for producing changed works can cause the conflicts between contractor and owner.
- Change due to poor and incomplete design by designers (D3): Lack of information, unclear drawings, unclear specifications and incomplete designs from designers are one of the main change causes in construction projects. Those modifications are work sequence, deviations of quantity, work process, materials and so on. Regarding to change caused by poor and incomplete design, cost and time compensation may occur. The quality of work is also concerned.
- Design change due to inconsistent site conditions (D4): It refers to modification of design made in order to match to the actual works at a construction site. This change is related to unforeseeable elements such as underground structures, soil conditions and so on. Enormous quantity deviation could incur. It indicates that the major impact on time and cost could exist. If there is no clear clause stated about such things in contract, conflicts between contractor and owner may occur inevitably.

- Change in construction method in order to improve constructability (C1): Contractor asks to change some technical work process/ method to improve current construction tasks. Although it is to facilitate the construction work, the additional cost may occur. The contractor may request for extra payment related to material, equipment and other stuff. However, owner may not agree with the payment. Moreover, owner also concerns with the quality of work produced by the change method proposed. Owner side may hesitate for the change method. It is noticed that this change can bring to cost and quality conflicts between bother parties.
- Schedule change due to poor planning or scheduling from contractor side (C2): Because of failure in performing the work, schedule is getting worse. Actual plan and schedule are needed to be improved. Such change affects work productivity. The well-organized schedule and planning are needed. However, some work activity may be disrupted. Idle time may occur. Since such change caused by contractor's fault, owner may complain on the late schedule, cost overrun of the project and quality of work. The conflicts between both parties may arise.
- Contractor's change due to construction errors (C3): In this case, contractor makes mistakes in his work and asks to change or modify the drawing, schedule, quantity or work and so on. Owner might not be happy with such change. Conflicts between both parties may occur. Owner would complain and penalize the contractor. It would be become serious if it leads to delay the project time.
- Contractor's change due to unavailable resources (C4): Raw materials cannot be provided by contractor because of some reasons such as location of construction site, shortage of resources, change in authority policy, etc. It refers to gravel, sand, rebar, steel, cement, and so on. According to shortage of raw materials, contractor requests to change to available materials. Disagreement would happen between both parties. The owner may mention about the contract documents over the stated materials. Related to cost and quality, discussion would be harder because each party has its own reason.

- Contractor's change in unavailable material specifications (C5): Contractor is not able to afford/find some materials stated in contract. Thus, he requests to change to available ones. Cost and quality are mostly concerned in this case. Owner always has high requirement of used materials. If contractor fails to find out the equivalent with acceptable price, owner may not agree.
- Change in design initiated by a supplier (S1): The root cause of such change is from supplier. To comply with his new proposal, some specific designs are needed to change. This type of change is caused by the third party. Those changes may bring to the variations of time, cost and quality concern. In some cases, contractor may request for additional cost, which owner may not be happy to pay for that. They have different ideas for the same issue. Therefore, conflicts mostly regarding to cost and quality may arise.
- Regulation change (S2): It covers change in government codes, or changes caused by local authority or relevant public parties. This change issue can affect the construction projects, especially if the designs are based on the obsolete regular. This change may bring to work disruptions, which can postpone the project time. Although it is the obligation of owner to solve this problem, it also has impact on time and cost to the contractor team work. At the meantime, contractor may request for extra cost and more time for project completion. Both parties have to understand the problem and each other well, otherwise conflicts would occur.
- Change in material costs by supplier (S3): Supplier requests to change the price of the materials. This change is about cost. Normally, it is the problem between contractor and supplier. In some cases, it also leads to the serious issues when the supplier is nominated by the owner.

Based on the explanation of each change issue, the impact caused by change might differ in terms of time, cost and quality. To manage effectively the change, the studied in details of those changes need to be conducted.

2.5 Gaps of Research

Regarding to the detailed literature reviews, several research gaps have been found. Those will be described in the following parts.

According to the previous research, causes and impact of changes were already studied to quantify of loss productivities. Common changes are brought into study in terms of cause and impact. Moreover, study of change in terms of relationship has not been found. Conflict in construction is very important because if conflict is not controlled well, the considerable impact might occur. Conflict caused by change may leads to slow progress of work, project failure, damage relationship between parties and so on. Therefore, the specific change issues should be focused in detail in terms of conflict. Moreover, relationship between specific change issues and conflicts in aspects of time, cost and quality needed to be studied. According to the previous section, all change issues are explained. Each change has different impact on the different categories of conflicts related to time, cost and quality. However, it still remains unknown about the level of importance containing in each change issues. Therefore, the clear identification of each change issues in terms of time, cost and conflicts should be conducted.

The contract is using as a tool to manage change in construction and IT projects (Bröchner and Badenfelt, 2011). In addition, change management is also brought in to research. As a result, many methods and models are proposed in order to minimize the consequence of change. However, it remains insufficient for the project practitioners to understand clearly how to manage the change issues promptly. Thus, managing change issues is still prevalent and necessary. The impact of a change issue varies due to many relevant factors such as situation of the project and the nature of the change. In addition, knowledge of specific change issues might not enough, the new perspective by looking in terms of scenario studies should be useful for change management. By reviewing previous researches, there is lack of situation study of conflict issues causing the conflict of time, cost, and quality.

Equally important, many methods and techniques are proposed in the researches, such as system dynamic for a better understanding of change (Cor, 1998), integrated system for managing change and evaluating change effects (Motawa et al.,

2007). Accordingly, morphological method used in scenario-based model is the effective and efficient methodology for understanding the situation of change issues in building construction projects.

2.6 Research Framework

In order to accomplish the research gaps, research framework of the scenario-based model of the significant change issues is designed as below:

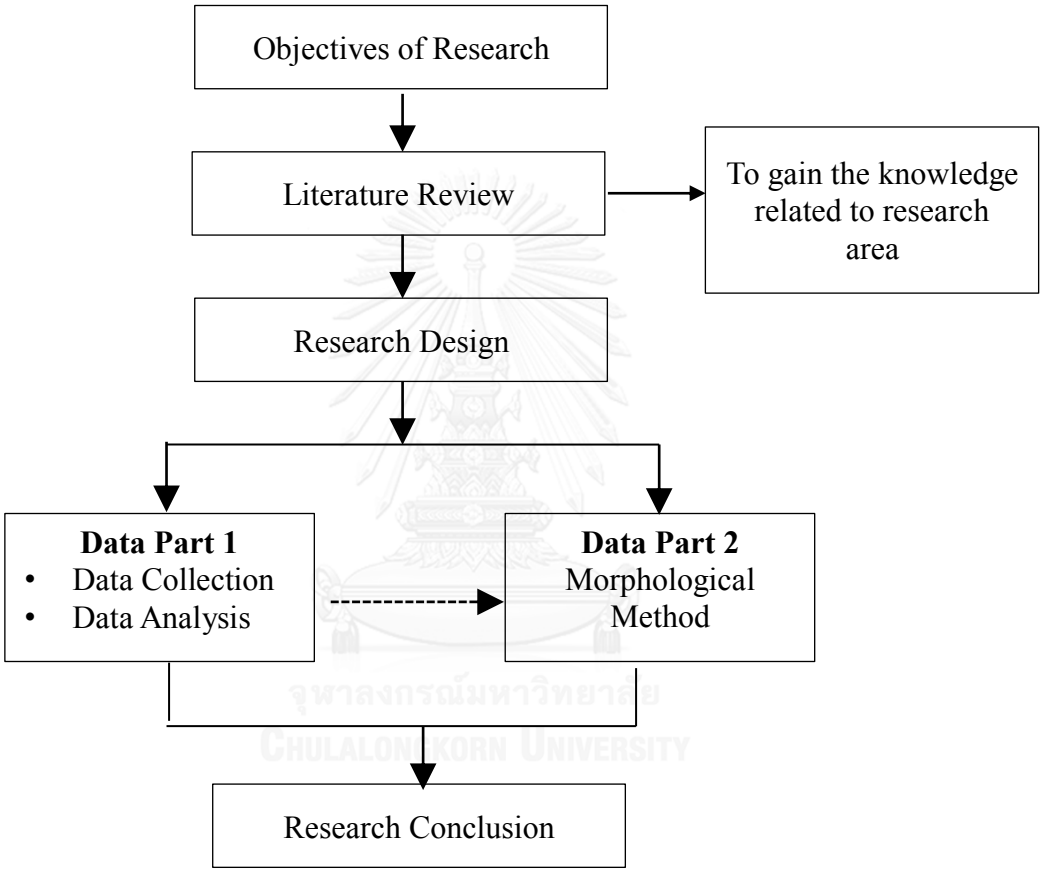

Figure 2.4 Research framework

The review of the relevant research articles are necessary to be done in order to provide more knowledge related to research area, after the main objectives are clearly defined. Next, the research design will be set up by carrying out two parts of data sets. Data part 1 refers to change issues leading to conflicts of time, cost and quality. The data will be collected and analyzed. Then, data part 2 will be the scenario or the situation of the selected change issue. Morphological method will be used in this part to develop scenario-based model of change issue causing conflicts in different criteria. Finally, research conclusion will be determined.

2.7 Summary

This chapter describes and review research artifices related to key points of this research study. First, change and conflict are reviewed in detailed to provide deeper insight to the project practitioners. Changes can be caused by various sources and have high impact on project performance, especially to the party relationship. Change can damage relationship between partners in the image of conflict. Moreover, previous review related to change leading to conflict is still not studied in detail. Last but not least, change management should be improved in the aspect of relationship, since many project parties still cannot control the change properly. Thus, it contains research gaps to propose a detailed study about change and a novel concept to reduce the conflicts caused by change. The research framework is designed and presented as well in Figure 2.4 to cope with the research gaps. The detailed research methodology is discussed in the following chapter.

CHAPTER III
RESEARCH METHODOLOGY

This chapter attempts to describe the proposed research method for change issue identification and development of conflict scenarios. First, the chapter begins with a brief description, research type and approach of this study. Next, the research design which introduces the process of conducting research is explained. After that, the brief description of scenario-based model is also presented. Then, the data collections of part 1 and 2 are drafted to see how the data are going to be collected and what techniques are described for implementation. Finally, the data analysis is illustrated.

3.1 Research Type and Approach

Several research types and approaches have been carried out to develop the model for anticipating the scenario and the future events. Since this research study stresses on the experience, knowledge, and perceptions of the experts, the qualitative approach is taken into consideration (Kothari, 2004).

The second objective is about scenario study. It helps in terms of project management because it provides the beneficial outlook of communication function, goal-setting function, and decision-making and strategy formation function. Additionally, it also appears advisable to view the limitation of situation which can be achieved with them (Eriksson and Ritchey, 2002IB).

In this research, the qualitative approach is used to identify change issues that affect the conflicts between owners and contractors. The data collection could be obtained by pilot survey, questionnaire and interview. Moreover, this research also aims at developing scenario-based model of significant change issue in building construction projects. The model is developed based on scenario study technique. The morphological method is highly appropriate for complex cases (Eriksson and Ritchey, 2002IB). This method is well suited for developing scenarios in this research. The data collection for the second part would be done by questionnaire, in-depth interview, and documents form participants.

3.2 Research Design

Regarding the problem statement, research methodology for this study is designed at the initial stage. Thus, the research process can be clearly explained in response to the research objectives. This process is defined as the followings:

The research methodology is designed as below:

1. Review the related literature of change and conflict in construction projects
2. Explore the change issues leading to conflict of time, cost and quality in building construction projects. It is done by literature review and pilot survey.

2.1 The survey questionnaire is designed for asking respondents to provide their perceptions of the important change issues leading to different conflicts of time, cost and quality.

2.2 The SPSS is used to analyze the importance levels of change issues provoking to those conflicts. Not only one sample t-test but also Cronbach's Alpha and Kendall's coefficient are performed. The last two tests are to check internal reliability of the used Likert scale and consistency of agreement between respondents.

3. After the list of change issues are obtained, the most critical change issue with the highest overall important (highest mean value) is selected for further study.
4. Identify the attributes and condition influencing on the conflict levels.

4.1 Face-to-face interview is carried out. The respondents will be asked to describe the story of selected change issue according to the three levels of conflicts.

4.2 Based on the description, the attributes and conditions influencing on each conflict level might be determined.

5. Identify morphological fields for the selected change related to each conflict level

5.1 The questionnaire is developed for respondents to draw the morphological fields of conflict at level 1, 2 and 3.

5.2 The previous provided cases are also confirmed by the respondents. The following respondents are also asked for agreement or disagreement over the morphological fields given by the previous respondents.

5.3 The morphological fields of each conflict degree will be validated in order to improve.

6. Research conclusion

3.3 Scenario-Based Model

To understand scenario study, the term “scenario” should be defined well. A scenario can be defined as a description of a possible future situation, including the path of development leading to that situation. It is not intended to represent a full description of the future, but rather to highlight central elements of a possible future and draw attention on the key factors that will drive the future developments. In brief, scenario is known as a description of a possible future situation (conceptual future), and from another aspect, it is defined as including paths of development which may lead to the future situation (Kosow and Gaßner, 2008). Morphological method is a non-quantitative technique for the structuring and evaluation of the set of relations inherent to a complex multidimensional problem. It is considered as problem-solving method for defining, linking, and evaluating problems that are inherently non-quantitative (Plauché et al., 2010).

Morphological analysis works through very simple process by using the concepts of breaking down and association of the elements. Morphological Analysis (MA) is a structured method which is found useful for scenario development (Velte et al., 2004). This method is regarded as a systematic creative technique with clear visualization and documentation. Moreover, the process is believed to provide high level of analysis and synthesis.

The Morphological Analysis (MA) is a structured method which is found useful for scenario development. The method is regarded as a systematic creative technique with clear visualization and documentation. Moreover, the process is believed to provide high level of analysis and synthesis. On the other hand, this technique also has disadvantages because there are some limitations related to the number of factors and participants.

The four main steps to conduct scenario-based model by using morphological analysis are presented below:

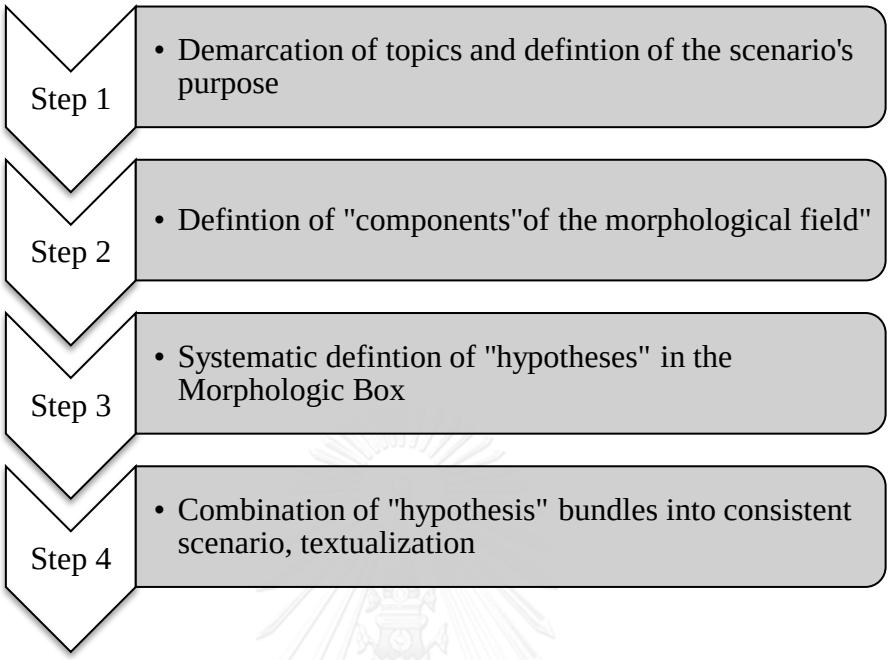

Figure 3.1 Four main steps of morphological method (Kosow and Gaßner, 2008)

Based on the actual time constraints of research, it is necessary to modify or normalize the steps of method in order to response to the current problem of data collection.

3.4 Data Collection

Data collection is a crucial part for research study because it influences on the reliability and validity of the research results. In this task, data collection aims to gather the information related to respondents' perceptions and opinions regarding to the change issues in construction and scenarios of change.

3.4.1 Sample Size

The sample size determination is important to reflect the actual environment of building constructions. In this research, the experience from construction professionals is very crucial for data collection. The sample size needed to identify change issues is at least 30 respondents (Pallant, 2001). For the second main part data, the target sample sized used to develop scenario-based model is between 12 and 15.

3.4.2 Data Collection of Part 1

In the part 1 of data collection, there are two main steps to conduct.

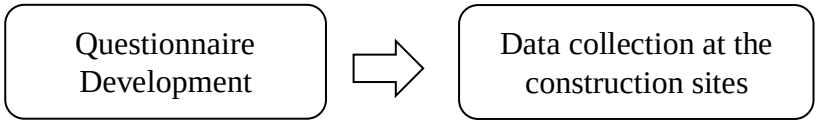

Figure 3.2 Summary of data collection in part 1

In order to conduct the data collection in part 1, there are three important steps in this research. First, literature review is conducted to investigate and gather necessary information. It might be gathered from many sources, such as text books, articles, journals, international conference papers, and internet. The aim of literature is to collect important data concerning to the topic and to deepen the understanding of the change issues in construction.

Additionally, the literature review in this research is conducted to explore the potential change issues leading to conflict of time, cost and quality. Pilot survey is carried to pretest questionnaire. In the main questionnaire, five-point Likert scale is used for scoring.

Table 3.1 Five-point Likert scale

Scale	Description
1	Strongly disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly agree

Table 3.2 Example of questionnaire for data collection part 1

Identify and explore change issues leading to conflicts between owner and contractor related to time, cost, and quality																
Coding	List of change issues	Time					Cost					Quality				
Coding O	Changes caused by Owner/Client	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
O1	Do you agree that *scope change* could lead to conflicts between owner and contractor related to...? (Scope change: additional work, deletion work, etc.)															
O2	Do you agree that *design function change due to client's requirement* could lead to conflicts between owner and contractor related to…? (It refers to design change initiated by the occupier and/or client representative.)															

The respondents are asked to provide their opinions on the importance of change issues that are required to be managed. It expresses from strongly disagree to strongly agree. The term "to be managed" includes frequency and effect of the change issues. For instance, one respondent may has different ideas of the importance of change issues. Over one type of change issue, he might have different opinion about the conflict of time, cost and quality. Related to schedule change, he may strongly agree this kind of change issue influences to time conflict, but disagree that this type of change can lead to the conflict of cost and quality.

The pre-testing pilot of questionnaire is also carried out in order to check if it is easy for respondent to understand and respond to the questionnaire. And then, the questionnaire is finalized.

Next, the collection data is requires to define well the respondent's profile, number of respondents, types of construction projects. Accordingly, the target respondents are project managers, deputy project managers, who are from the contractor sides and have experience about change issues over the two or three construction projects. Moreover, the owner and his representatives are also the target of data collection. The 30 respondents will be asked to do the survey questionnaire. Last but not least, the building construction projects are focused on.

Finally, the collection of data at the real construction sites is done by using the developed questionnaires.

3.4.3 Data Collection of Part 2

The information in this part is crucial in developing the model. After the most significant change issue is selected, the part 2 data collection will be carried out by following the process below:

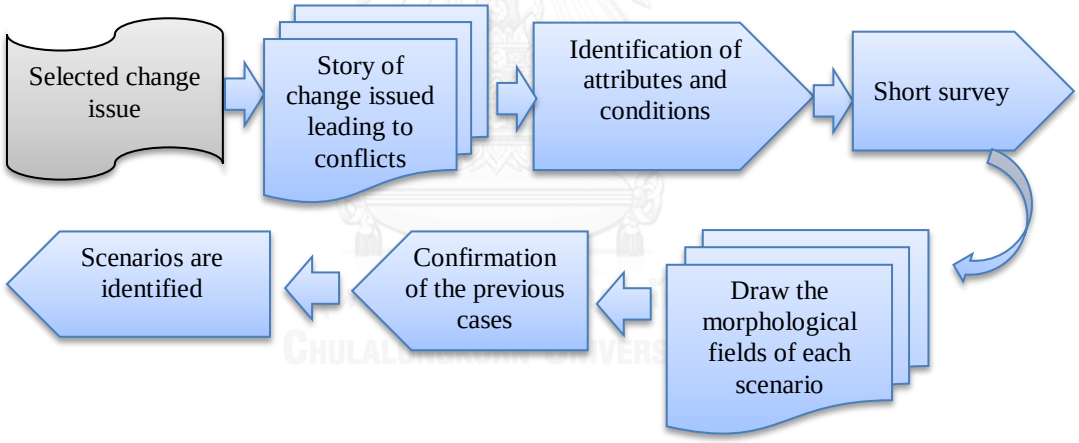

Figure 3.3 Summary of data collection of part 2

The figure above presents the process of data collection part 2 which consists of several steps. After the significant change issues are selected, the respondents are requested to describe the story or situation of each change issue. Based on the cases provided, the attributes and conditions of the change issue are identified. Questionnaire is developed based on morphological concept. The respondents are asked to draw the morphological fields which combine several attributes and conditions leading to different scenarios. They are also asked to confirm with the previous cases to illustrate the other involving components. Last, the morphological fields with alternative combinations of parameters umber is defined for each scenario.

3.5 Data Analysis

3.5.1 Data Analysis of Part 1

In this step, different change issues are ranked and scored by every respondent. Applying Statistical Package for Social Sciences (SPSS), three main data analyses are conducted for the data collected in part 1. Those are concordance analysis, analysis of reliability or internal consistency of scales, and one-sample *t-Test*. These three data analyses are explained in detail in the following sections.

3.5.1.1 Cronbach's Alpha

Cronbach's Alpha is designed as a measure of internal consistency (Gliem and Gliem, 2003) . It is to ask the question "do all items within the instrument measure the same thing?" It is also used to measure the reliability of the questionnaire. The normal range is between 0.0 and +1.0. The closer the Alpha is to 1, the greater the internal consistency of items in the instrument being assumed. The formula for the standardized Cronbach's Alpha can be written:

$$\alpha = \frac{k.r}{1+(k-1).r} \quad (1)$$

Where k: Number of items (change issues);

r: Average of the inter-item correlation

Based on the rule of thumb for describing internal consistency using Cronbach's Alpha, the internal consistency is expressed below:

Table 3.3 Cronbach's Alpha and internal consistency (Enshassi et al., 2009)

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.7 \leq \alpha < 0.9$	Good
$0.6 \leq \alpha < 0.7$	Acceptable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

3.5.1.2 Kendall Coefficient of Concordance

Kendall's coefficient of concordance is an important non-parametric measure of relationship. In fact, it is used for determining the degree of association among several set of ranking of N objects or individuals (Kothari, 2004). Moreover, it provides a measure of the agreement between the respondents for their judgments on each factor (Elhag and Boussabaine, 1999).

This concordance test is based on chi-square distribution with (N-1) degrees of freedom (Siegel and Castellan, 1988). The test is given by:

$$\text{Chi square } (\chi^2) = m(N-1)W \quad (2)$$

Where m: Number of respondents; N: number of change issues

3.5.1.3 One sample t-test

One sample t-test is a statistical procedure often performed to test the mean value of a distribution. It can be used under the assumption that sampled distraction is normal. In order to determine the importance of each change issue, one-sample t-Test is applied by calculating the statistical significance of the mean score of each change issue. Based on some previous researches, a mean score of 3.0 and above is chosen as the predetermined cut-off point in this research. According to this mean score, one-tailed t-Test is conducted to check whether the mean score of each change issue is significantly greater than 3.0 at 95% confidence level. Sample size of 30 is considered appropriate enough for t intervals to have proper and confidence interval coverage (Pallant, 2001).

3.5.2 Data Analysis of Part 2

In morphological analysis, the concept of data collection is to define the most preference morphological fields. Because of time limitation, some specific techniques in the original set method of morphology are needed to modify to reply to the actual research possibility. For instance, the original technique is required to make a workshop for respondents to discuss. Unfortunately, the technique cannot be done due to some limitations of participants and other inconvenience.

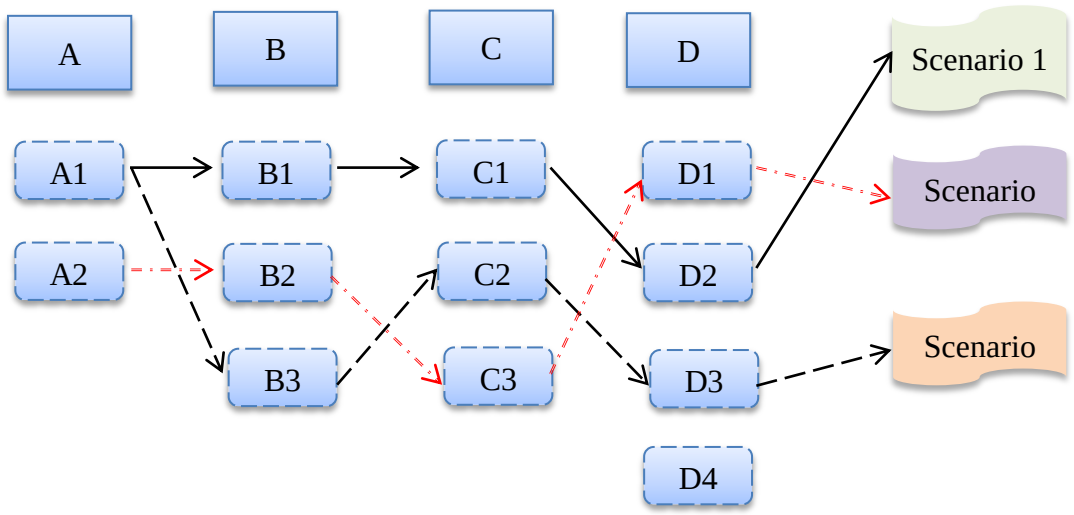

Figure 3.4 Morphological concept

Figure 3.4 shows the morphological concept about drawing morphological fields. A, B, C, and D are the attributes. A1, A2, B1, until D4 are the conditions which are defined in previous step. Scenario 1, 2, and 3 are the possible future events based on the drawing of morphological fields. The arrows fixing from A1, B1, C1, and D2 present morphological fields of scenario 1. For scenario 2, the set consists of A2, B2, C3, and D1. Finally, A1, B3, C2, and D3 present the set of scenario 3.

All attributes and conditions are going to be defined based on the cases provided by participants. By considering all attributes and conditions, scenarios are developed (Velte et al., 2004).

3.6 Summary

Chapter III provides a concept of proposed method for this research study. It explains the process or steps to realize the work to reach the main objectives. Firstly, identification and exploration of change issues leading to conflicts of time, cost and quality are conducted. The second part explains about the development of scenario-based model of selected change issues. The concept of model development follows the Morphological method. The data collection tools and analysis techniques are also defined well in this part. The survey questionnaire will be selected to implement in both part of data collection. By the way, the morphological analysis will be specially applied in the second part of data. The involvement from the respondents is crucial in this research study.

CHAPTER IV
IDENTIFICATION OF CHANGE ISSUES LEADING TO CONFLICTS

This chapter presents data analysis and findings from survey questionnaire. First, it starts with descriptive analysis of data collection. Second, it is followed by the analysis of change issues leading to conflicts between owner and contractor related to time, cost, and quality. In this second part, the reliability of test and concordance are determined. Moreover, the investigation of mean scores is also carried out with the aid of one sample t-test. Third, the section of discussion continues from the finding of the survey questionnaire.

4.1 Description of Data Collection

The objective of this analysis was to answer the question, "what are the current essential change issues leading to conflicts between owner and contractor related to time, cost, and quality? " The study depends on the perceptions and experience of respondents on change issues that lead to conflicts between owner and contractor. Therefore, the findings will correspond to the current practice in Cambodia's construction section.

4.2 Description of Survey

The questionnaire of this research section was structured into two parts. First, each respondent was asked to fill in their information related to experience in working on building projects, position and company. Second, they were asked to express their opinions of change issues over the aspects of time, cost and quality by using five-point Likert scale. To be consistent with the current problems of change issues regarding to building construction in Cambodia, the respondents from owner and contractor sides are requested to fill in survey questionnaires. The respondents from owner side can be owners' representatives, consultants, designers and those who work for owners.

A pilot survey was carried out for three purposes. First, it aims to pre-test the performance of the scale, so the problematic or redundant items are identified.

Secondly, the test also helps to adjust the length of the instrument. Lastly, the survey attempts to collect comments from respondents for further improvements on the instrument. The pilot study was done by a small random of three people from contractor side and two from owner side.

They were asked to consider change issues in questionnaire items and to comment on clarity, understanding and readability of each item. According to the response and appropriate comments, the survey questionnaire was improved. Respondents are invited to complete the main questionnaires. The respondents are project managers, site managers, site engineers. However, they might be the one who get involved in decision making in when change issues occur in their current and previous building projects. Table 4.1 and Figure 4.1 show the breakdown of respondent number based on their work experience regarding to building construction projects. The data collection was carried out through survey questionnaires from 53 respondents with 53 % having less than 5 years of experience, 30% in 5-10 years' experience. Experience of interviewees at building construction projects is very important for them to provide their clear perception on the questionnaires.

Table 4.1 Work experience of respondents

Experience of building construction project	Number of respondents	Percentage	Cumulative Percentage
Less than 5 years	28	53%	53%
5 to 10 years	16	30%	83%
More than 10 years	9	17%	100%
Total	53	100%	

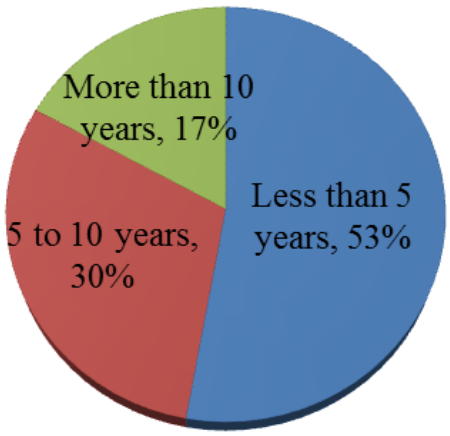

Figure 4.1 Percentage of respondents' experience

The respondents were from two groups, which are owner and contractor sides. The first group refers to those who have worked for owners, including their representatives, designers, consultants, and so on. The second group assigns for people who have worked for contractor side, including people working at construction sites and offices. However, only respondents involving in change issues were invited to complete the main questionnaires. As a result, there were 20 people from the first group, and 33 from the second group. As shown in Table 4.2 and Figure 4.2, nine types of respondents participated in the survey questionnaire. The highest numbers of participants is Project Manager (28 %) from contractor. Moreover, the second high percentages are Site Engineer and Structural Engineer. They involve closely to projects, both construction tasks and designs. Thus, it might be very significant for the questionnaire answer.

Table 4.2 Position of respondents

Position	Number of Respondents	Percentage	Cumulative Percentage
Director	5	9%	9%
Project Manager	15	28%	38%
Technical Manager	2	4%	42%
Site Manager	7	13%	55%
Site Engineer	9	17%	72%
Design Manager	2	4%	75%
Structural Engineer	9	17%	92%
Consultant	2	4%	96%
Site supervisor	2	4%	100%
Total	53	100%	

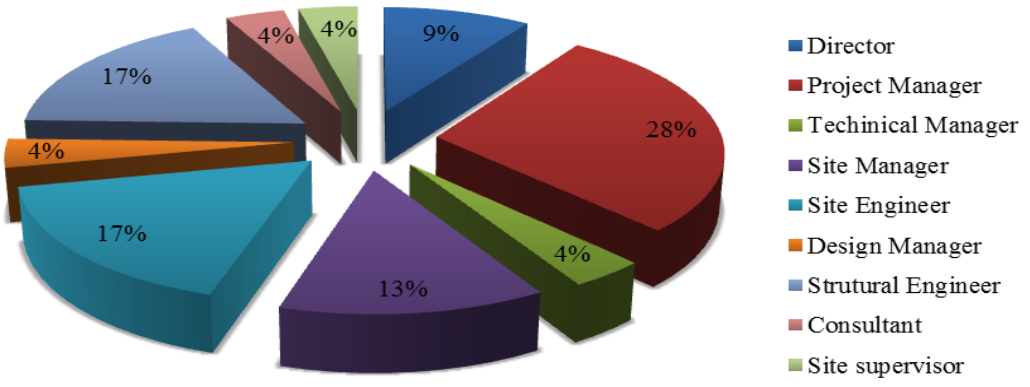

Figure 4.2 Positions of Respondents

The average experience of all respondents is 5-6 years. It reveals that respondents have worked several years in building construction projects. Therefore, their perceptions over change issues are very important and reflect the current situations of projects in Cambodia.

4.3 Analysis of Change Issues

The data were analyzed into three steps respectively. First, the internal consistency of Likert scale is checked by calculating Cronbach's Alpha. Next, Kendall's coefficient of concordance is determined the measurement of agreement between respondents for their judgments on change issues. Finally, the importance of a change issue is presented by conducting one-sample t-Test. The three steps of calculation were done by using Statistical Package for Social Sciences (SPSS).

4.3.1 Reliability of Test

The reliability of five-point Likert scale used in the survey questionnaire was tested for internal consistency by using Cronbach's Alpha (Siegel and Castellan, 1988). Cronbach's Alpha is computed based on three sets of data regarding to time, cost, and quality.

Table 4.3 Values of Cronbach's Alpha (α)

Data set	Time	Cost	Quality
Cronbach's Alpha (α)	0.815	0.735	0.855
Internal consistency	Good	Good	Good

According to Table 3.3 in chapter III, the value of Cronbach's Alpha value between 0.7 and 0.9 presents good internal consistency (Enshassi et al., 2009). As a result, the obtained values of Alpha in Table 4.3 indicate good reliability of the used scale to measure the importance in terms of time, cost and quality.

4.3.2 Concordance Analysis

To obtain a measure of consistency among respondents, a statistical test was applied by calculating the Kendall's Coefficient of Concordance between respondents in prioritizing the sixteen change issues in terms of time, cost, and quality. In order to

investigate the concordance between respondents, the null hypothesis and the alternative hypothesis were employed as follows:

H_0 = There is no agreement among respondents on change issues that leads to conflict between owner and contractor on time aspect ($\mu_0 < 3$)

H_1 = There is agreement among respondents on change issues that leads to conflict between owner and contractor on time aspect ($\mu_0 \geq 3$)

Table 4.4 Values of Kendall's coefficient of concordance (W)

Data set	Time	Cost	Quality
Kendall's coefficient of concordance (W)	0.184	0.058	0.076

Note: Level of significance: 0.00

Table 4.4 shows that the values of W are low, and it indicates that the respondents prioritized change issues differently. However, the level of significance is 1%, it suggested that there is a significant amount of agreement among the respondents (Yeung et al., 2007).

4.3.3 Importance of Change Issues

Before one sample t-test performance, the independent t-Tests are conducted to check the perceptions among contractor and owner sides. The values of sig (2-tailed) are greater than 0.05, which implies that there is no significant different between both groups (Pallant, 2001). From this reason, the data from both parties can be integrated and used in one sample t-test. The independent t-Test analysis can be found in APPENDIX B.

With the use of SPSS, a statistical analysis called one sample t-test was performed to determine whether the population agreed on a particular change issues as a strong reason or not. One sample t-test tends to compares mean scores found in an observed sample to a hypothetically assumed value. It is to investigate if the sample mean is significantly different from a population mean. By following the central limited theorem, a normal distribution can be assumed when the sample size is more than 30. Thus, the central limited theorem can be applied with a sample size of

53. One sample t-test is applied by comparing the score of every sample of one change issue with the predetermined cut-off point which is equal to 3.0.

To identify the significant change issues, the t-Test was computed at a 95% confidence interval. The null hypothesis is rejected when the p-value obtained is less than 0.05, level of significance. The data sets of time, cost and quality are used as input in applying one-tailed one sample t-test. The significance value (p-value) provided by SPSS is for a two-tailed test. However, the research interest is in one-tailed where we look for only sample means greater than the population mean (i.e. $\mu \geq \mu 0$). To get one-tailed p-value, the two-tailed p-value is divided by two. Small p-values provide evidence against the null hypothesis because the observed data are unlikely when the null hypothesis is true (Chan et al., 2011).

4.3.3.1 Important Change Issues Leading to Time Conflict

The results in Table 4.5 indicate that fifteen change issues have mean values more than 3.0, and fourteen contain p-values less than 0.05. Thus, it indicates that fourteen change issues are important and have sufficient evidence to reject the null hypothesis. From the analysis of change issues leading to conflicts between owner and contractor in time aspect, the important and significant change issues are schedule change due to poor planning or scheduling from contractor side (C2, Mean = 4.47), schedule change from owner/client (O3, Mean =4.09), change due to poor and incomplete design (D3, Mean =4.09), Scope change by owner (O1, Mean =3.98), contractor's change due to construction errors (C3, Mean =3.94), design function change due to client's requirement (O2, Mean = 3.81), change due to design errors (D1, Mean = 3.79), design change due to inconsistent site conditions (D4, Mean= 3.66), change in design initiated by a supplier (S1, Mean= 3.47), regulation change (S2, Mean= 3.47), change in material specifications by owner (O4, Mean= 3.45), contractor's change due to unavailable resource (C4, Mean= 3.42), contractor's change in unavailable material specifications (C5, Mean= 3.4), and change in specification (D2, Mean= 3.23).

Table 4.5 Result from one sample t-test of changes leading to time conflicts

Coding	Mean	Std.	Sig. (2-tailed)	Sig. (1-tailed)	Importance
C2	4.47	0.91	0.00	0.00*	Yes
O3	4.09	0.97	0.00	0.00*	Yes
D3	4.09	0.95	0.00	0.00*	Yes
O1	3.98	0.82	0.00	0.00*	Yes
C3	3.94	1.03	0.00	0.00*	Yes
O2	3.81	1.00	0.00	0.00*	Yes
D1	3.79	0.91	0.00	0.00*	Yes
D4	3.66	1.14	0.00	0.00*	Yes
S1	3.47	1.01	0.00	0.01*	Yes
S2	3.47	1.25	0.01	0.01*	Yes
O4	3.45	0.80	0.00	0.00*	Yes
C4	3.42	1.15	0.01	0.01*	Yes
C5	3.40	1.10	0.01	0.01*	Yes
D2	3.23	0.87	0.06	0.03*	Yes
C1	3.21	0.99	0.13	0.07	No
S3	2.89	1.31	0.53	0.27	No

*Marked for p-value less 0.05

The results in Table 4.5 indicate that fifteen change issues have mean values more than 3.0, and fourteen contain p-values less than 0.05. Thus, it indicates that fourteen change issues are important and have sufficient evidence to reject the null hypothesis. From the analysis of change issues leading to conflicts between owner and contractor in time aspect, the important and significant change issues are schedule change due to poor planning or scheduling from contractor side (C2, Mean = 4.47), schedule change from owner/client (O3, Mean =4.09), change due to poor and incomplete design (D3, Mean =4.09), Scope change by owner (O1, Mean =3.98), contractor's change due to construction errors (C3, Mean =3.94), design function change due to client's requirement (O2, Mean = 3.81), change due to design errors (D1, Mean = 3.79), design change due to inconsistent site conditions (D4, Mean= 3.66), change in design initiated by a supplier (S1, Mean= 3.47), regulation change

(S2, Mean= 3.47), change in material specifications by owner (O4, Mean= 3.45), contractor's change due to unavailable resource (C4, Mean= 3.42), contractor's change in unavailable material specifications (C5, Mean= 3.4), and change in specification (D2, Mean= 3.23).

Based on respondents' perceptions, the most significant change issue which can cause time conflicts between owner and contractor is schedule change due to poor planning or scheduling from contractor side (C2). The contractor fails to perform their works in construction projects. Thus, contractor may make schedule changes which can lead to project delay. At the meantime, owner is not happy with contractor's performance; owner may not want to delay the construction work or the project duration is fixed in advance. In this case, conflicts between parties from aspect of time can occur unavoidably.

Actually, time is a key constraint in construction projects. The schedule may be revised several times to match the actual situations. However, when schedule change (O3) is made by owner during construction phase, it is regarded as a serious issue. Contractor may fail to perform well in order to comply with owner's request. Owing to schedule change, contractor might meet some problems because it may result in major reallocation of resource. For instance, time should be taken into proper consideration when owner asks to complete some parts of the project that affects the construction sequences. Contractor has to evaluate and quantify the schedule changes by owner carefully, and make sure that it can be accomplished with the acceptable quality. Contractor must prepare for the change; otherwise, the project time can be extended. Hence, the conflicts between owner and contractor will appear inevitably. If contractor accepts the schedule change, contractor has to ensure the project completion on time. It implies that contractor has to increase productivity by many ways, such as increasing of skill labor, equipment, and especially taking overtime. Construction materials is also the concerning problem because it depends on supplier to deliver them on time. It requires good management from project team members and full cooperation from suppliers. Lastly, contractor may check the effect from schedule change by owner on equipment cost because the schedule change may effect on construction sequence that makes the idle time of equipment.

Although designers are the owner's representatives, change originated by designer also produces conflicts between owner and contractor. For example, change due to poor and incomplete design (D3) always occurs in many construction projects in Cambodia. It causes many problems during construction phase. At all times, contractors claim about this issues because it can affect their project schedule seriously. Sometimes, they have to wait for the complete design in order to produce clear shop drawings and material procurement. Designer always needs times to revise the drawings based on the actual works. Therefore, the cooperation from the designer is very important for smoothing the change process.

As the finding of one sample t-test, scope change from owner is found as 4th ranking important and significant in terms of time conflict. When owner asks to make additional or deduction work, conflicts related to time between both parties occur. Such change might influence to project timeline. Contractor and owner may have different opinions concerning completion date. However, owner might not want his project delay, and sometimes, contractor cannot manage the time although it is additional or deduction work.

Last but not least, contractor's change due to construction errors (C3) is prioritized as the 5th ranking among sixteen change issues leading to time conflict. While construction errors occur, owner might complain for sure. Contractor might spend time for rework and demolition work to rectify the mistakes. It may bring the project delay. Dissatisfaction will happen between both parties.

4.3.3.2 Important Change Issues Leading to Cost Conflict

By implementing the SPSS, one sample t-test was conducted. The results in Table 4.6 indicate that all change issues have mean values more than 3.0, and only fifteen contain p-values (one-tailed) less than 0.05. Thus, it can be concluded that fifteen change issues are important and have sufficient evidence to reject the null hypothesis. Based on data analysis, there is not enough evidence to reject the null hypothesis of change in construction method in order to improve constructability (C1). The null hypothesis of C1 is accepted. It indicates that there is no different perception between respondents on that change issue.

Table 4.6 Result from one sample t-test of change leading to cost conflicts

Coding	Mean	Std.	Sig. (2-tailed)	Sig. (1-tailed)	Importance
O3	4.04	0.94	0.00	0.00*	Yes
O1	4.02	0.82	0.00	0.00*	Yes
D3	3.96	1.00	0.00	0.00*	Yes
O2	3.85	0.84	0.00	0.00*	Yes
O4	3.79	1.01	0.00	0.00*	Yes
C2	3.77	1.10	0.00	0.00*	Yes
D4	3.74	1.09	0.00	0.00*	Yes
C4	3.74	1.09	0.00	0.00*	Yes
D1	3.70	0.80	0.00	0.00*	Yes
C5	3.70	1.08	0.00	0.00*	Yes
C3	3.66	1.04	0.00	0.00*	Yes
S3	3.66	1.30	0.00	0.00*	Yes
D2	3.55	0.91	0.00	0.00*	Yes
S2	3.42	1.26	0.02	0.01*	Yes
S1	3.30	1.07	0.04	0.02*	Yes
C1	3.23	1.09	0.13	0.07	No

*Marked for p-value less 0.05

The analysis of change issues leading to conflicts between owner and contractor in cost aspect reveals that the important and significant change issues are schedule change by owner (O3, Mean = 4.04), scope change by owner (O1, Mean =4.02), change due to poor and incomplete design (D3, Mean =3.96), design function change due to client's requirement (O2, Mean =3.85), change in material specifications by owner (O4, Mean =3.79), schedule change due to poor planning or scheduling from contractor side (C2, Mean=3.77), design change due to inconsistent site conditions (D4, Mean= 3.74), contractor's change due to unavailable resource (C4, Mean= 3.74), change due to design errors (D1, Mean= 3.70), contractor's change in unavailable material specifications (C5, Mean=3.70), contractor's change due to construction errors (C3, Mean= 3.66), change in material costs by supplier (S3, Mean= 3.66),

change in specification (D2, Mean= 3.55), regulation change (S2, Mean= 3.42), change in design initiated by a supplier (S1, Mean= 3.3).

According to Table 4.6, the most important change issue leading to cost conflicts between owners and contractors is schedule change by owner (O3). This change issue refers to modifications of a schedule requested by owner. For instance, owner may ask to change the date of the hand-over (shorten or extend the project's duration). An employer may want contractor to hand over some floors of the building. However, this partial handover is not a part of the original plan. This change may put pressure on the contractor to revise the actual plan and carry out the work to fulfill the owner's request. Sometimes, the contractor attempts to exempt the claim on costs, because the contractor wants to maintain relationship with the employers. Eventually, the contractor may encounter difficulties due to schedule change via owner because sometimes the work has to be accelerated. Moreover, the contractor has to ensure the good quality. Thus, contractor may request some additional costs to complete the work on time. Yet, the owner may refuse such a request. The owner may insist that the contractor obligates to complete the work anyway. Different opinions over this type of change often provoke conflicts regarding costs. Both parties have to understand the situation of this change issue.

Scope change caused by the owner (O1) refers to the addition or deletion of work from the contract due to inadequate planning or the lack of involvement on the part of the owner at the design stage. The consequences of scope change depend on at which stage the change occurs. For example, the scope change might seriously affect the project costs if the owner is asked to change the scope after the contractor has finished the work, leading to rework, additional construction costs, etc. Meanwhile, this may provoke minor effects on the project's costs if the scope change is made before construction. In another case, a scope change by the owner may also bring changes in design, quantity, and cost variations. During this time, construction work can also be interrupted. In this situation, the owner and contractor may have different opinions over the new costs or quantities. In addition, the interruption of the scope change can lead to increased waiting time and additional work while the project time may not be extended. The contractor may have to accelerate the work based on the

original plan. If the scope change is too much, conflicts related to cost will inevitably arise.

At construction sites, change due to poor or incomplete design (D3) occurs almost in every project. The lack of information and complete design also create changes in design, quantity and technical process, resulting in cost variations. Normally, when there is an unclear and/or incomplete design, contractors have to request more information from the designer. It is common that such issues affect the project's time, as idle time is incurred waiting for the designer's reply. There are also additional costs when the scope of the work is not clear. In some cases, the contractor may claim an incomplete design even though the work item is the responsibility of the contractor to complete the construction. Therefore, the scope of the work item should be clearly defined whether or not it was part of the original scope in the contract. Furthermore, due to unclear information in the contractor's bidding document, the contractor might quote a price for a work that it is different from the owner's expectations as the price is not competitive with those of other contractors. A conflict related to cost arises when the price of the owner's favorite item is different from the one quoted by the contractor. If the owner does not want to pay, then a conflict occurs. Therefore, clear information and complete design is very important in order to reduce the conflicts about costs during construction.

Managing change due to the client's requirements (O2) is not easy, because there are various reasons for changes, such as marketing, client's demands, owner's finances, etc. The contractor must put in a lot of effort to satisfy the owner and the client. Consequently, such changes bring difficulties to the contractor. The impact of the change also depends on the time when the change occurs. In some cases, if the owner requests to change the function of a whole or a part of a building project when the work has already started, demolition work would be needed to adapt the actual work. Therefore, the contractor may claim additional costs. Meanwhile, the owner might not agree and might ask to renegotiate the price. The unit costs of labor works, such as coring work or demolition, may not have been defined in the original contract. This creates a conflict on the unit prices used for calculating costs. Thus, the requirements of the client should be well-defined in advance.

Regarding the change in material specifications (O4), conflicts over costs often emerge when the owner requests to change materials. Conflicts that arise would mainly be about the costs of the new materials. The conflict is more serious when material deposit is strictly provided to supplier by contractor. The owner has to be responsible for the impact of requesting such a change. In addition, the owner has to pay for the extra costs resulting from changes in material specifications. In some case, the conflict occurs over labor because the change in material specifications may require different labor skills than did the previous specifications. Thus, the responsibility for such changes should be well-defined in contract clauses.

4.3.3.3 Important Change Issues Leading to Quality Conflict

Table 4.7 Result from one sample t-test of change leading to quality conflicts

Coding	Mean	Std.	Sig. (2-tailed)	Sig. (1-tailed)	Importance
C3	4.04	1.02	0.00	0.00*	Yes
D3	3.66	2.98	0.11	0.06	No
O3	3.53	1.08	0.00	0.00*	Yes
C4	3.42	1.10	0.01	0.00*	Yes
D2	3.38	1.02	0.01	0.00*	Yes
D1	3.34	1.11	0.03	0.02*	Yes
C2	3.30	1.15	0.06	0.03*	Yes
C5	3.28	1.04	0.05	0.03*	Yes
D4	3.23	1.07	0.13	0.06	No
O2	3.19	1.19	0.26	0.13	No
C1	3.15	1.08	0.31	0.16	No
S1	3.15	1.12	0.33	0.16	No
S3	3.11	1.24	0.51	0.08	No
O1	3.09	1.18	0.56	0.28	No
O4	2.98	1.04	0.89	0.45	No
S2	2.96	1.22	0.82	0.41	No

*Marked for p-value less 0.05

According to the finding above, there are eight change issues containing mean score more than 3.0 and p-value (1-tailed) less than 0.05. Those issues are contractor's

change due to construction errors (C3, Mean= 4.404), schedule change by owner (O3, Mean= 3.53), contractor's change due to unavailable resources (C4, Mean=3.42), change in specifications by designer (D2, Mean=3.38), change due to design errors (D1, Mean=3.34), schedule change due to poor planning or scheduling from contractor side (C2, Mean= 3.30), contractor's change in unavailable material specifications (C5, Mean= 3.28).

Table 4.7 illustrates the importance and significance of each change issues by presenting the values of mean and sig. (1-tailed). The top five change issues are discussed in the below part.

Contractor's change due to construction errors (C3) was found as the most critical change issues leading to conflicts between owner and contractor related to quality. When this issue occurs, owner side might complain mostly about the quality of the construction. However, contractor has to take care of this problem. This issue can lead to rework and/or demolition and other changes. Equivalent or better quality is required. Technical process, material, skill labor may be changed in order to reach the requirement. When rework and demolition occur, the quality of work becomes more sensitive for contractor. Thus, he has to be careful and produce the work more productively in terms of quality.

Schedule change from owner (O3) was seen as the second important and significant change issue in quality point of view. The quality problems often occur when owner asks to modify the schedule. For instant, when schedule is very tough, contractor may not have enough time to do the work with the high quality as expectation. Some works may be produced without recheck. So rework or rectification may occur later. In that case, quality becomes more serious in owner's viewpoint. Owner will complain or reject on quality of work done by contractor. Since the request to modify the schedule change is made by owner, contractor might have reason to fasten the work. And sometimes, the conducted work is in very low quality condition. In that situation, conflict between both parties might emerge inevitably.

Contractor's change due to unavailable resources (C4) and change in material specifications (D2) are respectively ranked as the third and the fourth important and

significant change issues. Both issues refer to changes in materials which are the crucial point to define the quality; however, they are originated by different parties. In general, materials stated in contract documents are approved by designers and be confident that they reach the quality requirement. Yet, when the contractor cannot find or afford the wanted materials, problem may happen concerning the quality. It would be accepted if the contractor changes to higher quality material. But the problem later is cost, which is the most critical for contractor's opinion. Therefore, contractor sometimes is difficult to find the equivalent quality for new materials.

Design errors by designers (D1) cause change in construction work. Such modification might provoke some issues related to quality. It will become serious when contractor already finished that work. In that cases, rework and demolition will be conducted to correct the failure. Since this change was caused by designer, contractor might complain about the change consequences.

4.3.3.4 Overall Important Change Issues

After the findings of all aspects have been determined separately, the overall point of view is followed by focusing on the three aspects of conflicts. The above figure illustrates the different levels of importance and significance of each change issue regarding to time, cost, and quality.

Different colors represent various important levels which have three types of mean value intervals. The grading scale for importance levels is developed based on the simple grading method for student scores (Creswell (2002)). Since the cut-off point is 3.0, the starting point for importance level should begin with 3.0 to 5.0. In this research, levels of importance are divided into three, including very important level ($4.33 < \text{Mean} \leq 5$), important level ($3.66 < \text{Mean} \leq 4.33$), and moderate important level ($3 < \text{Mean} \leq 3.66$). On the other hand, change issues which have sig. (1-tailed) greater than 0.05, will be set as unimportant.

It is noticed that some change issues are not important in all three aspects, for example, change in construction method in order to improve constructability (C1). Such change is considered as a beneficial change. When contractor requests to change the method to improve the constructability, the contractor is sure that he can finish the

work productively. At the meantime, contractor's change due to construction error (C3) is very important in the terms of time, which is presented by the mean value of 4.04 (locating in the internal of very important change issue). Contractor is responsible for construction work. When contractor fails to perform or cause the error of his works, the owner side will complain about the quality. Seriously, he can be penalized by cost compensation. Furthermore, it is noticed that eight change issues are very important in terms of time and cost. In conclusion, one change issue might have different level of importance and significance regarding to the impact of time, cost, and quality. Some issues influence badly to time and cost conflict, while some have moderate impact only on those two aspects.

Coding	Change Issues	Time	Cost	Quality
C1	Change in construction method in order to improve constructability			
C2	Schedule change due to poor planning or scheduling from contractor side			
C3	Contractor's change due to construction errors			
C4	Contractor's change due to unavailable resources			
C5	Contractor's change in unavailable material specification			
D1	Change due to design errors			
D2	Change in specifications by designer			
D3	Change due to poor and incomplete design			
D4	Design change due to inconsistent site conditions			
O1	Scope change by owner			
O2	Design function change due to client's requirement			
O3	Schedule change from owner			
O4	Change in material specifications			
S1	Change in design initiated by a supplier			
S2	Regulation change			
S3	Change in material costs by a supplier			

Figure 4.3 Importance levels of change issue in terms of time, cost and quality

Note:


Denote for change issues which are not important, (sig.(1-tailed) > 0.05)


Denote for change issues which are moderate important and significant, (3 < Mean ≤ 3.66 and sig.(1-tailed) ≤ 0.05)


Denote for change issues which are important and significant. (3.66 < Mean ≤ 4.33) and sig. (1-tailed) ≤ 0.05)


Denote for change issues which are very important and significant. (4.33 < Mean ≤ 5 and sig. (1-tailed) ≤ 0.05)

4.4 Conclusion

Based on results from the tests in SPSS, it is found that the five-point Likert scale used in the questionnaire was a good internal consistency. In overall point of view, there is a significant degree of agreement among respondents on change issues. At last, change issues were determined. The result comes up with important and significant change issues leading conflicts in construction projects. Obviously, analysis of the first part data aims to explore and identify changes which can lead to conflicts between owner and contractor. The degree of conflicts may depend on change originating parties.

Sixteen specific change issues are found and taken into study for caused conflicts. According to the three types of data set, identifications of change issues are shown separately in terms of time, cost, and quality. The finding in each aspect provides the useful information for project participants to consider and prioritize change issues. Each change issues influences differently to those three aspects. The overall ranking gives the critical change issue for the next step study.

CHAPTER V
SCENARIO-BASED MODEL OF CHANGE ISSUE LEADING TO CONFLICTS

This chapter describes the process of the scenario-based model development which aims to improve the change management in in building construction projects. Based on the analysis of important levels of change issues in previous chapter, change due to poor and incomplete design is selected as the case study to develop a scenario-based model. In this research, the morphological analysis is set as a tool to develop this model by using the combinations of attributes and conditions of the collected cases. This study does not only identify the situation of conflict, but it is also necessary to determine the relevant information of change issues leading to different conflict levels. First, data description is discussed, followed by the four steps of model development. Last, the results and discussion are explained.

5.1 Description of Data Collection

The relevant information described in this chapter was gathered from the respondents in order to accomplish the second main objective which aims to formulate a scenario-based model of a significant change issue. The significant change issue refers to the issue of change which is found as the most important issue from the previous study in chapter IV. The reason for this selection is explained in the following parts.

To obtain the scenario-based model of the most significant change issue, the questionnaire was then formulated to ask the respondents about the cases of this change issue that they have experienced. In data collection, pilot survey was conducted to find out the definitions of conflict levels related to time and cost. The discussion on conflict levels is very important for the study of scenario bases. The main data used in this part was gathered from fifteen participants in Cambodia. The professionals were asked to brainstorm the cases related to significant change and to describe the situation and conditions of those cases. The participants were selected from those involving in the survey questionnaire in the first part. They are project

managers, site managers, and site engineers. In addition, they have detailed viewpoints on the significant change issue. Face-to-face interview is the instrument for this data collection. Furthermore, there is also another survey which aims to determine the important scenario of change agreed by eight participants.

5.2 Development of Scenario-Based Model

Scenario-based model is a rapid prototyping technique (Hsia and Asur, 1991). The concept of scenario analysis is to break down the collected case studies into parameters that are then used to form the important scenarios of the cases. Even though there are many approaches of scenario studies, morphological technique is selected for data collection of this research. This technique is suitable to be applied because target data of this technique are possible to collect from Cambodian participants. Face- to-face interview is selected as a tool for data collection in this part.

The method of morphological analysis was described in chapter III. However, all steps are specifically shown in this chapter in which the study is conducted on of the different levels of conflict caused by change due to poor and incomplete design from designers.

5.2.1 Change due to Poor and Incomplete Design and Related Conflicts

In the primary step of morphological method, the main target is to define clearly the scope of area to implement this technique. The purpose is to understand in details about the selected change issue and conflict influencing by that change. According to the results from one sample t-Test, important change issues are brought into discussion in this part. Table 5.1 shows the average mean values of important change issues based on the aspects of time, cost and quality. In this part, only the mean values of important change issues are taken into calculation. It indicates the overall ranking of change issues leading to conflicts between owner and contractor. The most critical change issue affecting project performance is change due to poor and incomplete design by designer. This change issue affects badly to time, cost and quality of the projects. Additionally, it can create the conflicts between parties. The finding above implies that the scenario bases of the change due to poor and incomplete design

should be further studied for deeply understanding about its conflict levels in different situations.

Table 5.1 Ranking of important change issues from three aspects

Coding	Change issue leading to conflicts	Average mean	Rank
D3	Change due to poor and incomplete design	4.03	1
O1	Scope change from owner	4.00	2
O3	Schedule change from owner from owner	3.89	3
C3	Change due to construction errors	3.88	4
C2	Schedule change due to poor planning or scheduling from contractor side	3.85	5
O2	Design function change due to client's requirement	3.83	6
D4	Design change due to inconsistent site conditions	3.70	7
O4	Change in material specifications	3.62	8
D1	Change due to design errors	3.61	9
C4	Change due to unavailable resources	3.53	10
C5	Contractor’s change in unavailable material specification	3.46	11
S2	Regulation change	3.45	12
D2	Change in specifications	3.39	13
S1	Change in design initiated by a supplier	3.39	14
S3	Change in material costs by supplier	3.28	15

For building construction projects, poor and incomplete designs commonly occur during construction phases. This change issue can lead to various problems such as unclear drawings/ specifications from designer, incomplete design, and lack of information for construction. It can cause several modifications of material specifications, technical process, reallocation resources, demolition, rework, variation and deviation related to quantity, cost variation, work consequences, and so on. Those modifications may result in negative impact in terms of time, cost, and quality. Both parties, owner and contractor, may dissatisfy with and complain about these negative impacts which can be any loss, claims, and disputes, and so on. In conclusion, change due to poor and incomplete design can create different levels of conflicts. Figure 5.1

briefly illustrates the phenomena of change due to poor and incomplete design leading to conflicts between parties.

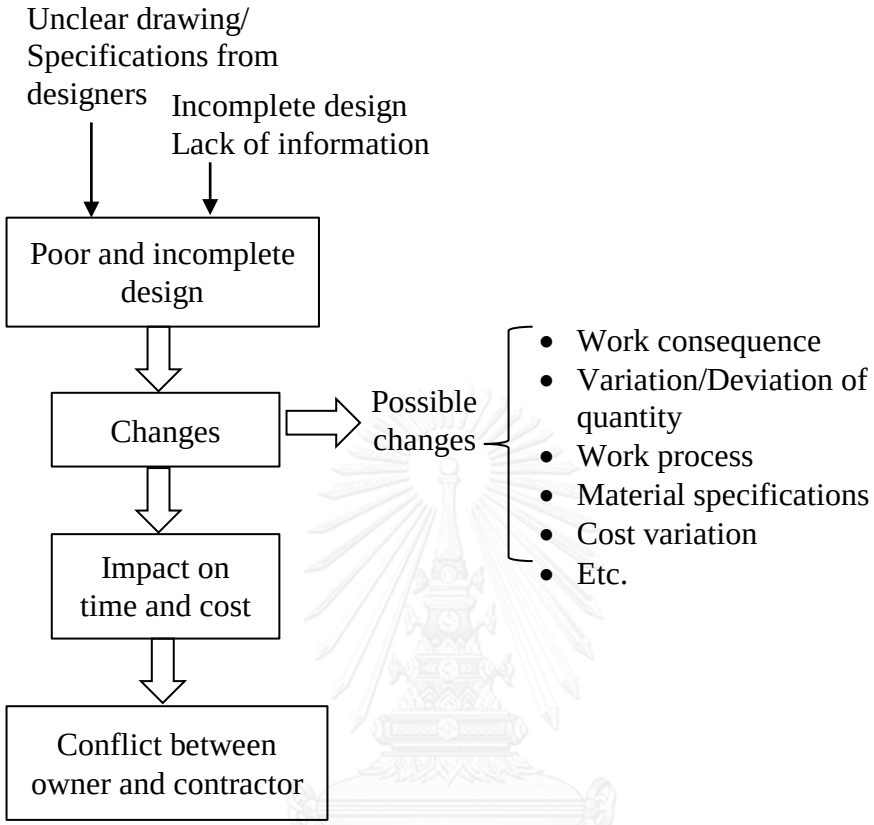

Figure 5.1 Change due to poor and incomplete design leading to conflicts

Conflict in this study refers to the actions of disagreement, clash, and dispute during the process of request for claims and rights. Types and degrees of conflict are brought for discussion in order to assure the consistency between respondents. Types of conflict in terms of time and cost are mentioned in the following part. For quality aspect, such change is less important. Furthermore, from the literature review, conflict consists of five levels (Moura and Teixeira, 2013). The integration of types and degree of conflict are examined and discussed during interview in data collection of part 2. The five levels of conflicts from literature review were discussed based on the actual practices and perceptions from experts. They have distinguished the five conflict levels and applied them into the actual situation of this change issue. After this discussion, the conflicts were grouped into three levels (level 1, 2 and 3) in order to facilitate in determining the scenarios of change. The following sections describe about these three levels of conflicts in terms of time and cost.

- **Time aspect**

  - Time conflict at level 1:

This conflict degree is the different opinion and/or disagreement between owner and contractor over the issues of time. It may slightly affect the project timeline. Sometimes, one party decides to absorb the consequence without any complaint. Anyhow, both parties may know that such modification may tend to deviation of works which can cause change of work consequences; and any party may dissatisfy with this change. In some cases, contractor may issue a letter to inform the owner about the effect of change on time. Later on, it may also leads to project delay.

  - Time conflict at level 2:

When changes due to poor and incomplete design caused by designers arise, contractor might ask for time extension. According to the opinions of contractors, extra time should be compensated because of the occurrence of change. Contractor needs to prepare the detailed documents and evidences to get the claim approval from owner. Both parties may face tough situation at the early negotiation of this claim. However, several meetings are hold to discuss and negotiate about the claim amount. Finally, the claim is settled.

  - Time conflict at level 3:

There is argument over the request for time extension caused by change due to poor and incomplete design. One party, mostly owner, does not agree with this request from contractor. Owner may be able to provide only the specific amount of the requested claim. However, contractor may not satisfy and tries to fight with the owner to request for time extension many times. Unfortunately, the situation creates the tension and frustration between parties. The hard situation can cause contract termination or change of contractor. Seriously, it can lead to lawsuits due to unsatisfied claims.

- **Cost aspect**

  - Cost conflict at level 1:

In terms of cost, low conflict refers to the situations in which change can create slightly deviation of project cost. Both sides may have different ideas about the cost

occurrence. However, one party does not ask for additional cost. He just shows his dissatisfaction to another party.

- Cost conflict at level 2:

When changes due to poor and incomplete design caused by designer arise, one party might ask for additional cost. One party, mostly contractor, thinks that extra cost from variation of works should be given. The issues are about raising extra cost. In this conflict degree, the contest among parties arises. Before reaching the agreement, both parties might have some frustrations or hard situations with each other. After the negotiation, both parties agree with a specific amount of request. Therefore, the request is approved.

- Cost conflict at level 3:

There is controversy of additional cost due to changes caused by poor and incomplete design by designer. However, there is no agreement on this request. The requested extra cost is rejected several times. The fight for claim from one party becomes serious. The altercation with tension and frustration would happen. It can lead to contract termination. Moreover, this situation can bring to the court.

5.2.2 Identification of Attributes and Conditions

The purpose of this step is to identify and characterize all the parameters toward a conflict level. To determine relevant attributes and conditions, cases of changes due to poor and incomplete design were collected from the target interview participants. The experts have been interviewed and asked to describe the cases of change issues in order to define the attributes and conditions. The concept of this step is to breakdown the cases, so the attributes and conditions are extracted. Different components might be found from different cases.

5.2.2.1 Identifying Attributes and Conditions of Time Conflict

The cases of time conflict are collected from respondents by asking them to consider about different level of conflicts. The cases are presented in the tables below:

Table 5.2 Cases of significant change leading to time conflict at level 1

Cases	Description of cases of change due to poor and incomplete design leading to time conflict at level 1	
Case1	In a supermarket project, the canopy drawings from the designer are not clear and have many clashes between the drawings. To avoid mistakes during construction, contractor needs to check all drawings and revise detailed drawings again. Although contractor knew that the drawing was not clear at the early of the project, but they spent much times to check the drawings. The contractor is not happy with such wasting time because he thinks that it can cause project delay later on.	
	Attributes	*Conditions*
	Time of change occurrence	Before construction
	Time consumption for drawing revision	Much
Case 2	The designer provided the unclear drawings of post tension slab. There is lack of information regarding to openings for M&E. The contractor needs to check the design and coordinate with designers from architecture, structure, and M&E. Due to the poor information in design, contractor is unhappy because there are many unclear drawing and it takes much time to recheck. All parties know that it can cause the time extension.	
	Attributes	*Conditions*
	Design complexity	Highly complicated
	Time of change occurrence	Before construction
	Time consumption for designer's response	Before deadline
	Time consumption for drawing revision	Medium

Table 5.2 Cases of significant change leading to time conflict at level 1 (Cont.)

Cases	Description of cases of change due to poor and incomplete design leading to time conflict at level 1	
Case 3	There are drawings related to façade views and sections of building project. But, section views are not clearly made. Contractor has to request for clear information. The waiting time last quite long. Despite of good cooperation among parties, the designers is late to provide the finalized design. After getting the feedback form the design, contractor also informs the owner about the time consumed by designer related to this issue.	
	Attributes	*Conditions*
	Time of change occurrence	Before construction
	Party cooperation	Active
	Time consumption for designer's response	Beyond deadline
Case 4	The architectural and structural drawings of a commercial building are not consistent. It might create the clashes during construction due to the inconsistent locations of structural elements and ceiling. The contractor also makes RFIs to confirm the different location of those elements. Meanwhile, contractor is forced to change work sequence. Construction activities of current works are changed to avoid idle time. The contractor side also express its dissatisfaction and inform the owner that schedule is changed dramatically and it could lead to delay.	
	Attributes	*Conditions*
	Time of change occurrence	During construction
	Party cooperation	Active
	Time consumption for designer's response	Before deadline

Table 5.3 Cases of significant change leading to time conflict at level 2

Cases	Cases of change due to poor and incomplete design leading to time conflict at level 2	
Case 1	The project is divided into two phases. The drawings of both phases are related. However, they provide different information that the contractor cannot build. The both buildings are connected and must have the same levels. It is also related to access road between the buildings. At first, contractor did not check clearly at the beginning of the new work. When he starts the construction tasks, the problems come up. Contractor is able to conduct the work, but needs time to recheck, and designer also needs time to revise. It leads to delay of the project. Therefore, contractor asked for 2-week extension. Owner agrees.	
	Attributes	*Conditions*
	Time of change occurrence	During construction
	Contractor's capability to change	Yes
	Time consumption for designer's response	Before deadline
	Time consumption for drawing revision	Much
Case 2	In the drawing, there is lack of information about materials. Contractor puts the standard price for the materials during bidding (sound insulation material). After winning, owner requires contractor to provide him the high class ones (beyond the standard). Since the material need to be ordered from overseas, it takes around one month to arrive. During discussion, owner disagrees with such time consumption. But since there is no choice, owner has to agree with that because he still wants that product. Therefore, both parties agree to add more three weeks for project time.	
	Attributes	*Conditions*
	Time of change occurrence	During construction
	Time consumption for material order	Much

Table 5.3 Cases of significant change leading to time conflict at level 2 (Cont.)

Cases	Cases of change due to poor and incomplete design leading to time conflict at level 2	
Case 3	Architectural drawings related to mirrors are not clear. Contractor has to rectify the mirror installation at the real construction site. Furthermore, contractor need to make sure that it is good looking, functional, and constructive. It causes low productivity. It is a new work for contractor. Since, the contractor has less experience of mirror installation; it takes longer time for do that job. Although it makes contractor cost more and spend more time, contractor ask for only time extension (4 weeks). Owner is not happy at the first time of hearing delay. The contractor explains the reason and tells owner that only time extension is requested although contractor himself has to pay off for the cost. Owner understands and agrees on time extension.	
	Attributes	*Conditions*
	Time of change occurrence	During construction
	Contractor's capability to change	No
Case 4	The layout drawing of architect and structure of 18^{th} floors are not consistent. Contractor also makes a request for more information. However, designer is so late to inform back (designer is operated in another country). Although contractor makes efforts to change the work consequences in order to finish the project on time, it is still the problem. Since the slab work is a critical activity in contractor schedule, it is hard to avoid the delay. The designer takes around 20 days to reply back. It doe beyond the deadline set by contractor. After that, contractor also spends few days to revise and check drawings to be sure that drawings are correct and constructive. Because the project deadline almost arrives and no free float rests, contractor asks for one month extension. At first, owner does not agree with that. However, after a long discussion from all parties, 25-day extra time is approved.	
	Attributes	*Conditions*
	Time of change occurrence	During construction
	Type of activity	Critical
	Time consumption for designer's response	Beyond deadline
	Time consumption for drawing revision	Less

Table 5.4 Cases of significant change leading to time conflict at level 3

Cases	Cases of change due to poor and incomplete design leading to time conflict at level 3	
Case 1	In the project of huge super market, contractor asks to change the method statement of a big work related to metal frame to use concrete instead. Since the design of metal frame is so poor. For instance, they do not provide the specific materials. Moreover, it needs very high technology to conduct such work. So contractor asks to do it in RC concrete. It takes long time for resign. At that time, it causes the project delay (1 month.). Owner complains on the capability of contractor that cannot build the metal frame. It is a frustrated argument between both parties, since the contractor already informed at the beginning of the project time. The construction was suspended almost one month.	
	Attributes	*Conditions*
	Time of change occurrence	During construction
	Time consumption for material order	Much
Case 2	The internal painting in the 3rd and 4th floors in a nine-floor building is not clearly indicated. However, contractor also requested for clear information. But there is no responded from the designer until 3 weeks. At meantime, contractors cannot wait; he decided to do the painting work like the one in 2nd floor due to the deadline of completion date. When he finished the 3rd floor painting work, the designer replied. Unfortunately, the colors should be different. Since contractor already did the 3rd floor painting, so he had to remove the recent painting. The deadline almost arrived, so contractor requested for 2 weeks extension and additional cost from owner. At first, owner did not agree. They had very big argument over the change. After the several times of negotiation, they come up with the agreement of 2 weeks extension but not for extra cost.	
	Attributes	*Conditions*
	Time of change occurrence	After construction
	Time consumption for designer's response	Beyond deadline
	Party cooperation	Inactive

Table 5.4 Cases of significant change leading to time conflict at level 3 (Cont.)

Cases	Cases of change due to poor and incomplete design leading to time conflict at level 3	
Case 3	Based on architectural drawing, there is a generator room at the 3rd floor. However, designer does not consider about the ways to bring generator into the room. Since the generator cannot be moved into the height of the 3rd floor (3 m). So, contractor requests to change generator room to the 1st floor which the height is 3.8m. It needs more time to prepare the concrete slab with the 30 cm thickness. Contractor needs to more time to accomplish this work because it is almost the project deadline. Owner does not agree because he wants to open his building as schedule. Tension between both parties occurs. In this case, the contractor needs more time and cost. But to maintain relationship between parties, he decides to request only the 4-week extra time. Finally, an agreement arises. Contractor might need to make new drawing for generator slab and repair the slab at 3rd floor.	
	Attributes	*Conditions*
	Time of change occurrence	After construction
	Party cooperation	Not good
	Time consumption for drawing revision	Much
	Relationship	To maintain

Based on all the cases above, attributes and conditions have been found. These elements differentiate the level of conflicts in terms of time.

Table 5.5 Summary of attributes and conditions affecting time conflict

No.	Attributes	Conditions
1	Time of change occurrence	Before construction
		During construction
		After construction
2	Type of activity	Non critical
		Critical
3	Design complexity	Less complicated
		High complicated
4	Party cooperation	Active
		Inactive
5	Time consumption for designer's response	Before deadline
		Beyond deadline
6	Time consumption for drawing revision	Less (Less than one week)
		Much (More than one week)
7	Contractor's capability to change	Yes
		No
8	Time consumption for material order	Less (Within one week)
		Much (More than one week)
9	Relationship	Not mention
		To maintain

All attributes and conditions are used to develop the scenario-based model in the following step. Those important components of morphological box are identified as described in the following sections**.**

- **Time of occurrence**

Time of change occurrence contributes to conflict development. It refers to the stage of construction that a change can occur. Moreover, it is also included when the change is found. This attribute have three types of conditions which are before, during, after construction phases. The three conditions of this attribute may take part in different conflict levels.

- **Type of activity**

Type of activity is added in the main attribute list of change issue scenario, since it would have alternative impact if change occurs for different types of activity. The impact of time caused by change might become severe if the activity is the main task. On the other hand, the negative effect may be not severe if the relevant task is not critical in the schedule set by contractor. The two conditions for the type of activity are “critical” and “Non critical”.

- **Design complexity**

Geometry and complicatedness of designed elements are concluded as an important attribute. It initiates with design complexity in this research work. It might refer to building shapes and/or level of difficulty to complete the work. The context of design complexity in this research is concluded by Cambodian interview participants who were asked to provide their perceptions about design complexity. Based on their opinions, “Less complicated” refers to the designs which have simple geometry and uncomplicated elements. Moreover, “High complicated” designs are the works that consist of many intricate processes due to complex building geometry.

- **Party cooperation**

The collaboration among project participants is crucial to achieve the project success. It also plays a vital role to manage changes in construction. Participations from all parties, including contractors, designers, MEP engineers, owners, and other stakeholders are regarded as one of the main attributes. The conditions of this attribute are active and inactive. The active cooperation focuses on the support and assistance from a party by involving in problem solving. The inactive cooperation refers to poor participations of a party in the projects.

- **Time consumption for redesign**

The time consumption for designer's response is the responding rate that designers spend to finalize the design after the change is noticeably found. It happens after contractor makes request for more information related to design. Two conditions of time consumption are discussed. The first condition is before deadline, while the second one is beyond deadline which is set by contractor.

- **Time consumption for drawing revision**

The duration spent by contractor to revise the drawings is an essential component in this scenario study. In general, time consumption for drawing revision depends on the amount of work to modify. In this research, two types of its conditions are examined according to the opinions of participants. Less time consumption for drawing revision is the duration less than one week for contractor team to revise the drawings, while much consumption is counted when more than one week is spent for the revision.

- **Contractor's capability to change**

Working capacity of contractor is considered significant parameter. It is very important when there is modification related to work process. When there is new proposed work, contractor needs to perform the work. The conditions of this attribute are (1) yes (Contractor is able to conduct the changed work), and (2) no (Contractor is not able to do the new task.). In some cases, contractor has to be flexible to resolve the problem if he is not able to do the new task. Hiring professional or subcontractor is also managerial decision.

- **Time consumption for material order**

Material order influences the project timeline. When it takes long time to order or to ship the materials, the construction activities may need to be delayed as well. Construction material supplies in Cambodia have some limitations due to country resources and economy. Some materials need to be imported from other countries such as China, Thailand, Vietnam, and other European nations. It is obvious that it takes different duration for the delivery of those materials. However, in this research, two conditions are assumed according to general practices in Cambodia. "Within one

week" is the first conditions for the attribute of time consumption for material order, while "More than one week" is the second attribute.

- **Relationship**

Long term relationship among contractor and owner is a large contribution to managerial decision in construction projects. Many important decisions have been made based on the consideration on long term relationship. Normally, contractor tries hard to perform work well in order to get the next projects from the owner. In some cases, contractor forces himself to absorb the consequences of time in order to maintain the good relationship among both parties. Thus, relationship is defined as the vital component in this research model. Many decisions are made to maintain the relationship. In some situations, the terms of long term relationship is not taken into account because the impact is not much serious.

To sum up, the potential parameters of change leading to time conflict consist of nine attributes and nineteen conditions. All this morphological components are defined according to the general perception of construction professionals in Cambodia.

5.2.2.2 Identifying attributes and conditions of cost conflict

Cost is very important in a construction project. Hence, it should be taken into account in every decision. Conflict related to cost is one of the main purposes in this research. Three levels of cost conflicts are carefully considered by target respondents.

Table 5.6 Cases of significant changes leading to cost conflict at level 1

Cases	Case of change due to poor and incomplete design leading to cost conflict at level 1	
Case 1	In the drawing, the color of exterior wall is not stated clearly (code number of color). When they do the mock up, the owner rejects the color and asks to change. There is no different on variation of quantity but it is slightly different on unit price. It costs the contractor, and he is not so happy with that. However, in order to maintain the relationship between parties, he absorbs the cost impact.	
	Attributes	*Conditions*
	Time of change occurrence	During construction
	Unit price variation	Occur
Case 2	Due to incomplete design of lift wall drawing, the contractor put different type of starter bars for the lift wall at the next level. Because the existing starter bars are smaller than the one in new drawing, so contractor have to cut the existing starter bars and drill the new ones. There are costs of drilling bar. Contractor also asks for additional cost but it costs slight amount, so they negotiate to not consider about it.	
	Attributes	*Conditions*
	Time of change occurrence	During construction
	Cost amount of new material	Occur
	Rectification cost	Occur

Table 5.7 Cases of significant changes leading to cost conflict at level 2

Cases	Cases of change due to poor and incomplete design leading to cost conflict at level 2	
Case 1	In a supermarket project, the canopy drawings from the designer are not clear and have a lot of conflicts between drawings. The design is poor and unconstructive. The contractor needs to produce new design and make detailed drawings. The new design is approved. But, there is variation of materials and quantity. The contractor notices that there is quite huge different quantity and it needs skill labor to do that job. So contractor decides to ask for additional costs of material and labor. However, owner thinks that the labor cost should not be paid because it is the responsibility of contractor to perform the work. After a discussion related to method to perform that new work, the owner agrees to pay for that.	
	Attributes	*Conditions*
	Quantity variation	Much different (from the original drawing)
	Specific skill labor need	Yes
Case 2	In the drawing, there is lack of information regarding to materials. Contractor puts the standard price for the materials during bidding (sound insulation material). After winning, owner requires contractor to provide him the high class ones (beyond the standard). The owner feels that the new price proposed by contractor is not competitive. But owner has to accept that price.	
	Attributes	*Conditions*
	Unit price variation	Occur
Case 3	The indication of two types of isolation in the drawing is not clear. It provides the uncertain positions to put different types of isolations. Contractor also asks to clarify the drawing, but the consultant does not cooperate. Contractor cannot wait until consultant replies. When contractor starts constructing; they put wrong location of isolation. The contractor When consultant inspects the contractor's work, the problem comes up. Contractor complains that it is the faults caused by poor drawing from designer. Because the prices between both types of isolations are far different, contractor asks for extra cost and tries to keep the schedule as before.	
	Attributes	*Conditions*
	Unit price variation	Occur
	Material and drawing Approval	Late

Table 5.7 Cases of significant changes leading to cost conflict at level 2 (Cont.)

Cases	Cases of change due to poor and incomplete design leading to cost conflict at level 2	
Case 4	There is no specific information in the drawings of ceiling. However, there is quotation for complex ceiling in the specification. Contractor cannot know where the complex ceiling location. Thus, contractor decides to put the normal ceiling price for all area in order to have an appropriate cost for bidding. Later on, there is a problem after he wins the contract and gets start the project. Based on the construction drawing, the complex ceiling exists. There is much different price between normal and complex ceiling and variation of quantity between both ceilings. Contractor thinks he should get the extra cost because the drawing is not clear at the beginning. Thus, contractor asks for additional cost. After a long discussion and explanation from contractor, owner agrees to pay for the extra cost.	
	Attributes	*Conditions*
	Unit price variation	Occur
	Quantity variation	Much different (from the original drawing)
	Material and drawing Approval	Late
Case 5	The sanitary materials are not well defined in document. Before construction, contractor also request for material approval. Yet, owner side is late to reply back. Since there is no free float for contractor's schedule, contractor cannot wait and decides to order the materials. Moreover, he also needs to deposit for supplier. Later on, owner found that it is not what he wants in his project. He asks to changes from another model which costs more expensive. Contractor does not agree and argues that there is no specification of sanitary materials in the document that is why he takes that one for the project. Contractor is upset because he already paid the deposit for new materials. If he orders the new one proposed by owner, he has to change the supplier too which means that his deposit is taken. The contractor request for extra money on unit price and deposit. However, after negotiation, the owner pays only for unit price variation not for deposit because it is also contractor's fault to order the material without material approval.	
	Attributes	*Conditions*
	Unit price variation	Occur
	Material and drawing approval	Late
	Deposit to supplier	It is taken by supplier.

Table 5.8 Cases of significant changes leading to cost conflict at level 3

<table>
<tr><td>Cases</td><td colspan="2">Cases of change due to poor and incomplete design leading to cost conflict at level 3</td></tr>
<tr><td>Case 1</td><td colspan="2">Designer provides a very poor design to contractor. In actual site construction, the drawing cannot be followed based on the constructability. Contractor needs to redesign some parts of design. New design brings huge variation of quantity. Contractor makes a request for more cost from owner. However, owner does not agree. They come up with many discussion and negotiation. Contractor still stay strict with his request because the amount of impact is considerable.
<table>
<tr><th>Attributes</th><th>Conditions</th></tr>
<tr><td>Quantity variation</td><td>Much different (from the original drawing)</td></tr>
<tr><td>Agreement</td><td>Agreement with frustration and tension</td></tr>
</table></td></tr>
<tr><td>Case 2</td><td colspan="2">Due to incomplete design, contractor cannot follow the schedule. However, he tries to manage the time project by working overtime. At the meantime, his project overhead increase and also the payment of labor cost. Contractor thinks it is due to poor and late design from all designers. The schedule is hard to manage in order complete project on time. All project team needs to work overtime to avoid late project. Contractor requests for overtime cost for labor from owner, since he also shares his project overhead cost. Owner is explained many times about the consequences of poor drawing from designers. Contractor argues that he needs to work OT to be on schedule, so he requests for more cost. Owner is not happy with that, he thinks it is the contractor's obligation to do that. Frustration happens during meeting. After a long and fruitful discussion, contractor's request is accepted.
<table>
<tr><th>Attributes</th><th>Conditions</th></tr>
<tr><td>Quantity variation</td><td>Much different (from the original drawing)</td></tr>
<tr><td>Overtime cost</td><td>Occur</td></tr>
<tr><td>Agreement</td><td>agree with frustration and tension</td></tr>
</table></td></tr>
</table>

In accordance with the collected cases above, relevant parameters are explored. The essential results in this part are the attributes and conditions leading to cost conflicts brought by changes due to poor and incomplete design. Each attribute consists of two or three specific conditions based on general assumptions from experts. Table 5.9 briefly presents the important parameters and their conditions.

Table 5.9 Summary of attributes and conditions affecting cost conflict

No.	Attributes	Conditions
1	Time of change occurrence	Before construction
		During construction
		After construction
2	Unit price variation	Not occur
		Occur
3	Quantity variation	Less (Less than 25 %)
		Much (More than 2 5%)
4	New material cost	Not occur
		Occur
5	Rectification cost	Not occur
		Occur
6	Specific skill labor need	No
		Yes
7	Deposit to supplier	It is taken by supplier./No loss
		It is returned to contractor.
8	Overtime cost	Not occur
		Occur
9	Material and drawing approval	On time
		Late
10	Agreement	Agreement with frustration and tension
		Agreement without frustration and tension

Ten attributes and twenty one conditions were found from the collected cases. To clarify the definitions of those important elements, the explanation on each attribute and each condition are discussed based on the experience and perception of the professionals.

- **Time of change occurrence**

Stage of change occurrence contributes to conflict development in terms of cost. This parameter refers to the stage of construction that a change is detected. On the other hand, this attribute also refers to the period that the change occurs. It consists of three types of conditions which are before, during, after construction. Each condition may assist to differentiate the conflict levels caused by that change.

- **Unit price variation**

The unit price mentioned here refers to the cost of material per units. It can change at any time of construction stage. When change occurs, the unit price variation also affects the project cost. Some participants think that it also leads to cost conflict between owner and contractor when there is huge amount of unit price variation. However, other participants also express their opinions that they will ask for extra cost from another party when the unit price is increased. In this research, occurrence of unit price variation is included. The first condition is its variation does not occur, while the second condition is when unit price variation occurs.

- **Quantity variation**

Most of the participants argue that additional cost will be requested when there is huge amount of quantity. They also say that the amount of quantity for claim may be quoted in the contract document. Anyhow, when the quantity amount exceeds 25% of original quantity, the additional cost will be requested. Thus, in this case, two conditions of quantity variation are proposed. The first one is less quantity variation (less than 25%), and the second one is much quantity variation (equal or greater than 25%).

- **New material cost**

The increase of cost amount for new materials is also important in terms of project cost. It is also considered as an attribute affecting the cost conflicts. Normally, contractor will request for the new material cost. Subsequently, there are two circumstances for this attribute. The first one is “Not occur”; and the second one is “Occur”. These conditions might involve in the conflict level development.

- **Rectification cost**

This parameter refers to the modification of work, such as rework or demolition. Some changes may cause the rectification of work which infers that the cost can be incurred. The interviewed participants raise that they do not satisfy when rework occurs. Due to the loss of productivity and cost, contractor may not be happy with such change. Contractor may request for extra cost from owner. Therefore, "Not occur" and "Occur" are the conditions to be considered.

- **Specific skill labor**

The skilled labor who does a specific work can also have the impact on cost. The needs of skilled labor in construction project are in high demand. In Cambodia, there is limitation of the special work, such as metal work and high technology. If there is any change related to this area, contractor may face some problems due to lack of labor. Therefore, similar to the above attribute, "Not occur" and "Occur" are considered for the scenario study of cost conflict.

- **Overtime cost**

Since some changes require overtime, extra cost of overtime work is also concerned. Sometimes, contractor also asks for supplementary cost for overtime work from the owner according to a specific reason of change, especially when the cost caused by the fault of owner. Two conditions are discussed in this research. They are "Not occur" and "Occur".

- **Material and drawing approval**

This attribute plays an important role in change process. It indicates the cooperation from owner side in construction projects. It might have detrimental consequence to the following activities such as materials, equipment order, and so on. Therefore, "On time" and "Late" conditions are discussed in the model.

- **Deposit to supplier**

For general material order procurement, contractor has to deposit some cash to order the materials in advance. It is practical in Cambodia's construction. According to the previous description of materials and drawing approval, deposit to supplier is

also considered as one of the important attributes for cost conflict. Contractor might take risk to lose the deposit if he fails to follow the material order procurement. In this research, two variables of the attributes are taken in to account. The first condition is that the deposit is retuned back to contractor (No loss). The second case is that the deposit is taken by supplier.

- **Agreement**

Before reaching the agreement between both parties, many meetings are required in order to deal with the problems. Anyhow, during the meeting, there may have some frustration and tension between both parties. It may take some time to settle the issue. Both conditions are agreement with frustration and agreement without frustration.

5.2.3 Morphological Box Formation

This section aims to set up the morphological box for change due to poor and incomplete design. The attributes and conditions influencing the conflict levels caused by changes will be presented in the boxes. The morphological box will be used as a template to determine the scenarios of each conflict level by including all components. Morphologic boxes of attributes and conditions are presented in the following figures. It presents the conflict in terms of time and cost, respectively.

These boxes provide the useful information related to necessary parameters for time and cost conflicts created by change due to poor and incomplete design. The parameters of attributes and conditions are the main components to form the morphological box. In particular, the template shows the relevant factors involving in a scenario of change. Thus, it could be important for project practitioners to be aware of these components.

The output of this formation will be used for scenario development in the next step. All the components are organized from the less impact to high impact in order to facilitate the next step, defining the scenarios.

Time of change occurrence	Before construction	During construction	After construction
Type of activity	Non critical		Critical
Design complexity	Less complicated		Highly complicated
Party cooperation	Active		Inactive
Time consumption for designer's response	Before deadline		Beyond deadline
Time consumption for drawing revision	Less		Much
Contractor's capability to change	No		Yes
Time consumption for material order	Less		Much
Relationship	To maintain		Not mention
Time conflict at level	**1**	**2**	**3**

Figure 5.2 Morphological box of attributes and conditions for time conflict

Attributes	Conditions		
Time of change occurrence	Before construction	During construction	After construction
Unit price variation	Not occur		Occur
Quantity variation	Less		Much
Cost amount of new material	Not occur		Occur
Cost amount of rectification	Not occur		Occur
Specific skilled labour need	No		Yes
Overtime cost	Not cccur		Occur
Material and drawing approval	On time		Late
Deposit to supplier	It is returned back to contractor.		It is taken by supplier.
Agreement	Agreement without frustration		Agreement with frustration
Cost conflict at level	**1**	**2**	**3**

Figure 5.3 Morphological box of attributes and conditions for cost conflict

5.2.4 Scenario Development

A short survey has been conducted to find out the development of scenarios. Eight participants were requested to consider all elements in the process of developing the scenario for each conflict level. The project practitioners experienced different works in construction. The scenario of change leading to the three levels of conflicts is discussed.

5.2.4.1 Scenario Development for Time Conflict

- **Scenarios of Change Leading to Time Conflict at Level 1**

After relevant attributes and conditions were found and the template was created, the participants were asked to go through to all elements in the morphological box and formulate the scenario-based model. The combinations of the variables can create different levels of conflict. As a result, four morphological fields were adopted.

According to the scenario-based model of change leading to time conflict at level 1, different combinations of attributes and conditions create the same conflict level. High impact conditions associated with less impact conditions bring various scenarios. Furthermore, it is noticed that shared conditions are Active (Party cooperation), Yes (Contractor's capability to change), Less (Time consumption for material order), and Not mention (Relationship). It indicates that when change leads to time conflict at level 1 (it can be said as low conflict.). It is noticed that it requires having active cooperation between parties. Moreover, contractor needs to be able to adopt the change, less time for material order, and it may not be related to the relationship consideration since it is slightly impact. To maintain the low conflict, designer has to be on time in providing the feedback of design to contractor. Last but not least, change should be detected at early stage of the construction projects. Thus, it can be managed effectively.

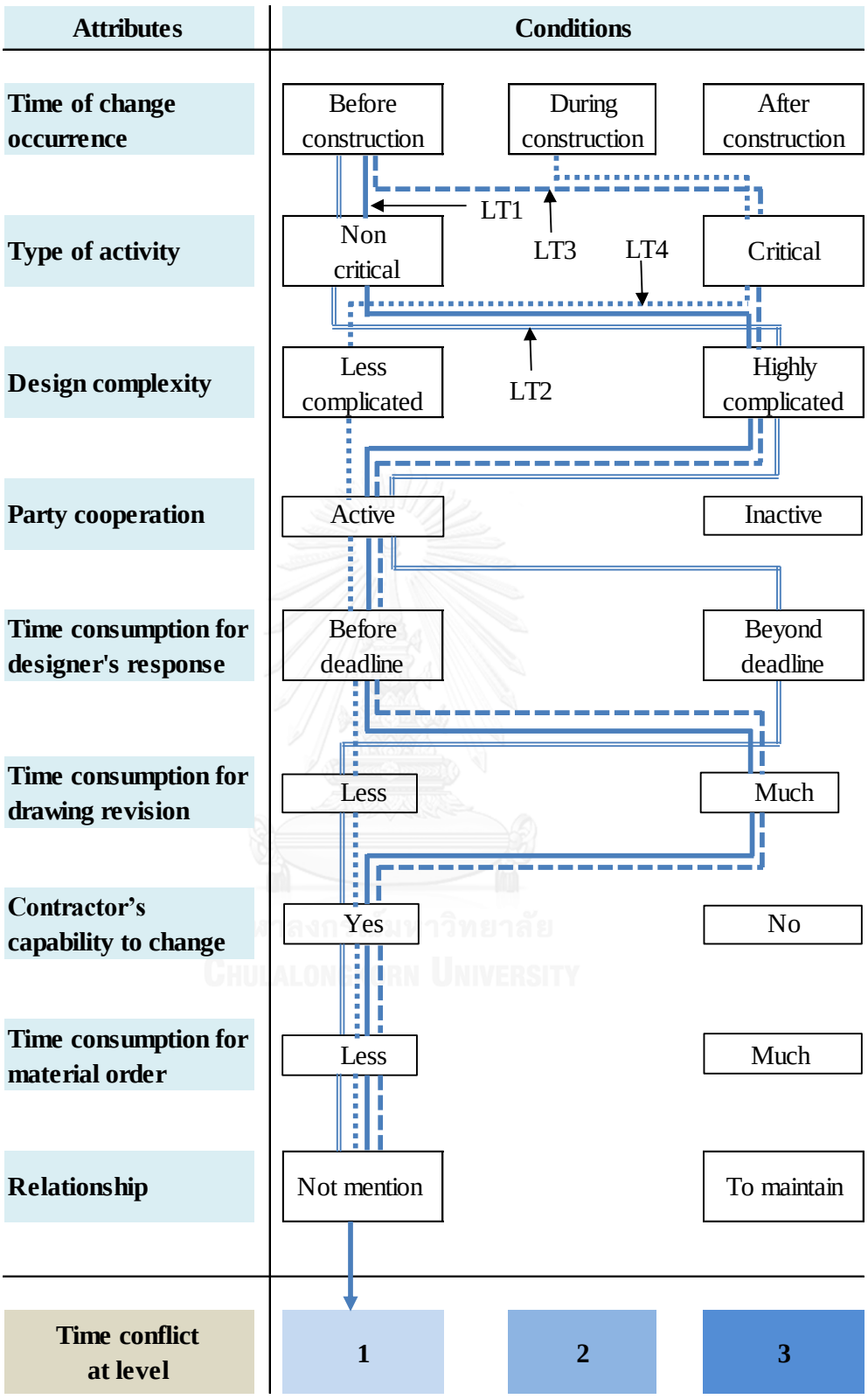

Figure 5.4 Scenario-based model of change leading to time conflict at level 1

Table 5.10 Summary of scenarios of change leading to time conflict at level 1

Time conflict at level 1	Relevant attributes and conditions
Scenario LT1	▪ Time of occurrence – Before construction ▪ Type of activity – Non critical ▪ Design complexity – Less complicated ▪ Party cooperation – Active ▪ Time consumption for redesign – Before deadline ▪ Time consumption for drawing revision – Much ▪ Contractor's capability to change – Yes ▪ Time consumption for material order – Less ▪ Relationship – Not mention
Scenario LT2	▪ Time of occurrence – Before construction ▪ Type of activity – Critical ▪ Design complexity – Less complicated ▪ Party cooperation – Active ▪ Time consumption for redesign – Before deadline ▪ Time consumption for drawing revision – Much ▪ Contractor's capability to change – Yes ▪ Time consumption for material order – Less ▪ Relationship – Not mention
Scenario LT3	▪ Time of occurrence – Before construction ▪ Type of activity – Critical ▪ Design complexity – Less complicated ▪ Party cooperation – Active ▪ Time consumption for redesign – Beyond deadline ▪ Time consumption for drawing revision – Less ▪ Contractor's capability to change – Yes ▪ Time consumption for material order – Less ▪ Relationship – Not mention
Scenario LT4	▪ Time of occurrence – During construction ▪ Type of activity – Critical ▪ Design complexity – Less complicated ▪ Party cooperation – Active ▪ Time consumption for redesign – Before deadline ▪ Time consumption for drawing revision – Less ▪ Contractor's capability to change – Yes ▪ Time consumption for material order – Less ▪ Relationship – Not mention

- **Scenarios of Change Leading to Time Conflict at Level 2**

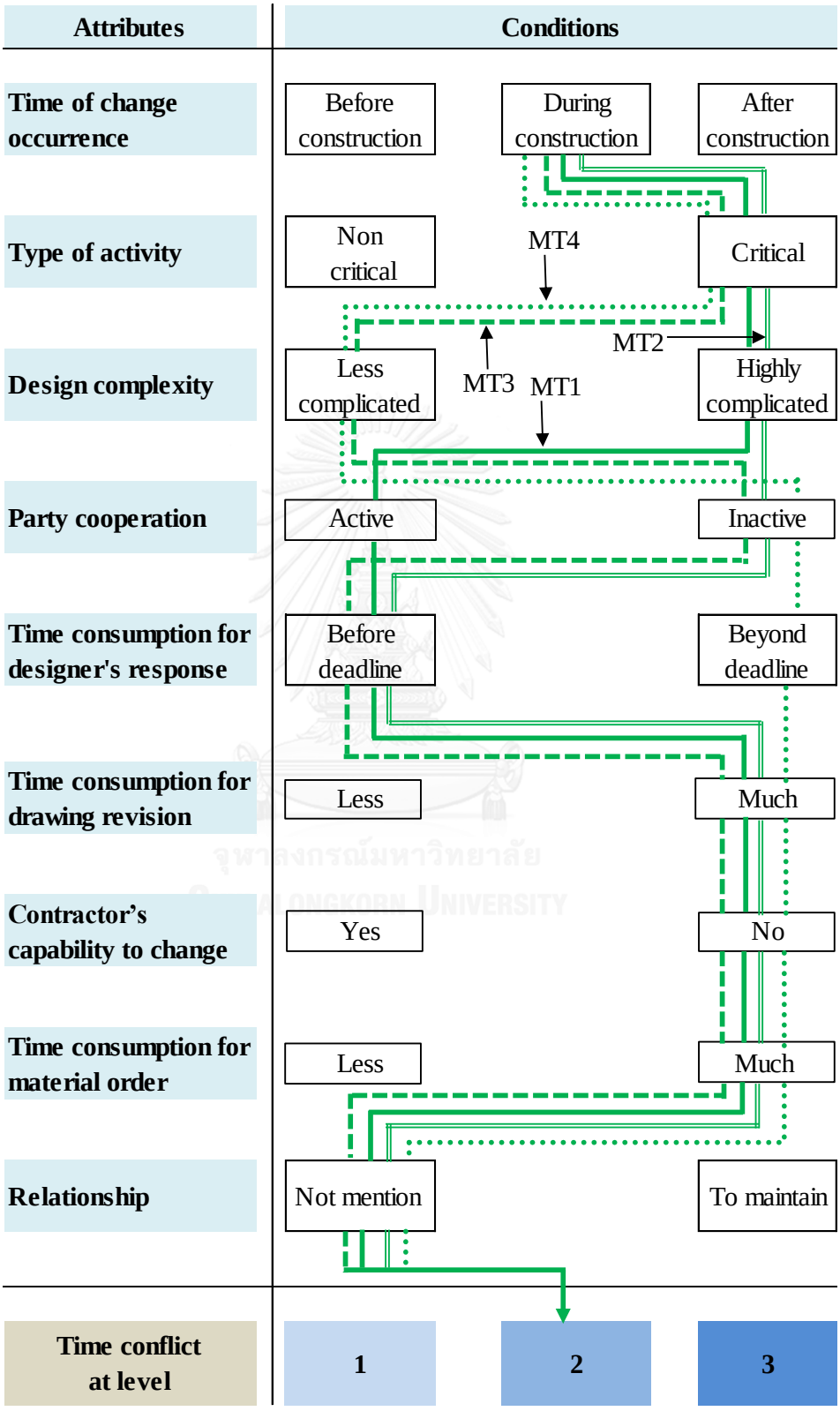

Figure 5.5 Scenario-based model of change leading to time conflict at level 2

Table 5.11 Summary of scenarios of change leading to time conflict at level 2

Time conflict at level 2	Relevant attributes and conditions
Scenario MT1	• Time of occurrence – During construction • Type of activity – Critical • Design complexity – High complicated • Party cooperation – Active • Time consumption for redesign – Before deadline • Time consumption for drawing revision – Much • Contractor's capability to change – Yes • Time consumption for material order – Much • Relationship – Not mention
Scenario MT2	• Time of occurrence – During construction • Type of activity – Critical • Design complexity – High complicated • Party cooperation – Inactive • Time consumption for redesign – Before deadline • Time consumption for drawing revision – Much • Contractor's capability to change – Yes • Time consumption for material order – Much • Relationship – Not mention
Scenario MT3	• Time of occurrence – During construction • Type of activity – Critical • Design complexity – Less complicated • Party cooperation – Inactive • Time consumption for redesign – Before deadline • Time consumption for drawing revision – Much • Contractor's capability to change – Yes • Time consumption for material order – Much • Relationship – Not mention
Scenario MT4	• Time of occurrence – During construction • Type of activity – Critical • Design complexity – Less complicated • Party cooperation – Inactive • Time consumption for redesign – Beyond deadline • Time consumption for drawing revision – Much • Contractor's capability to change – Yes • Time consumption for material order – Much • Relationship – Not mention

Applying the same method as conducted for the previous cases, scenarios of change issues leading to time conflict at level 2 were established. Four morphological fields are developed. The table and box above show all relevant components of the four adopted scenarios.

Owning to the various combinations of components, the four scenarios highlight the important conditions, such as During construction (Time of occurrence), Critical (Type of activity), Much (Time consumption for drawing revision), No (Contractor's capability to change), Much (Time consumption for material order), and Not mention (Relationship). This implies that change occurs during construction stage and it can cause time conflict at level 2. In addition, the contractor's performance on drawing revision and capability to change also results in time conflicts between owner and contractor. Last but not least, attention on relationship is not mentioned in the developed scenarios. It may be because they haven't experienced such conditions before; or this condition is not much relevant to this level.

- **Scenarios of Change Leading to Time Conflict at Level 3**

Three morphological fields are created as shown in the table below. It indicates that the four adopted scenarios formed by different features of the combinations of the attributes and conditions.

As reported by the morphological fields, the critical conditions for high conflict of time are Critical (Type of activity), Highly complicated (Design complexity), Inactive (Party cooperation), Much (Time consumption for drawing revision), No (Contractor's capability to change). It is observed that the conflict can escalate to high level when change is identified after construction. Major impact might occur due to this late detection. Additionally, the critical activity and complicated design are the factors causing this impact. Poor party cooperation also influences this conflict level. On the other hand, the situation becomes even worse when there is poor performance of contractor and much consumption for material order.

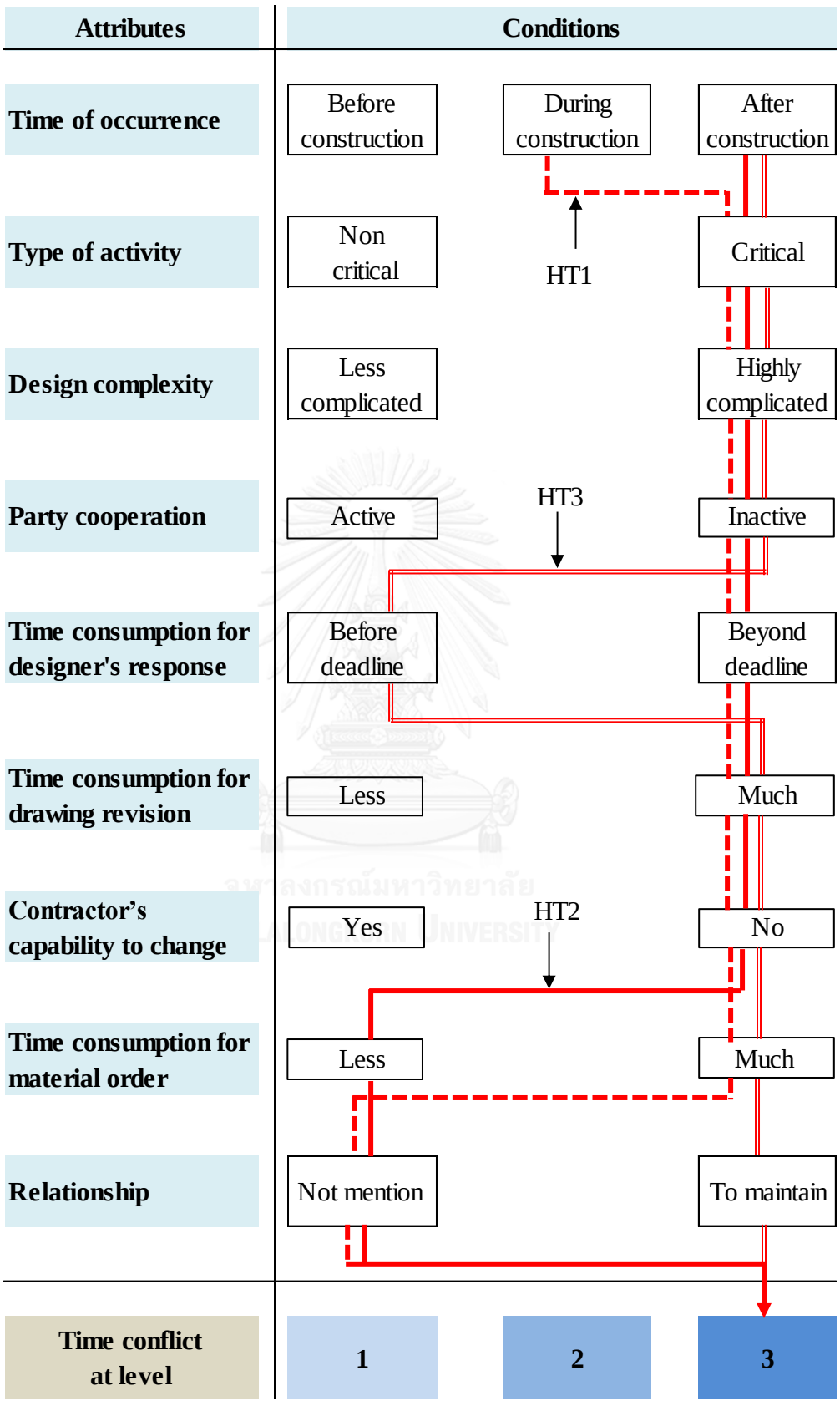

Figure 5.6 Scenario-based model of change leading to time conflict at level 3

Table 5.12 Summary of scenarios of change leading to time conflict at level 3

Time conflict at level 3	Relevant attributes and conditions
Scenario HT1	▪ Time of occurrence – During construction ▪ Type of activity – Critical ▪ Design complexity – High complicated ▪ Party cooperation – Inactive ▪ Time consumption for redesign – Beyond deadline ▪ Time consumption for drawing revision – Much ▪ Contractor's capability to change – No ▪ Time consumption for material order – Much ▪ Relationship – Not mention
Scenario HT2	▪ Time of occurrence – After construction ▪ Type of activity – Critical ▪ Design complexity – High complicated ▪ Party cooperation – Inactive ▪ Time consumption for redesign – Beyond deadline ▪ Time consumption for drawing revision – Less ▪ Contractor's capability to change – No ▪ Time consumption for material order – Less ▪ Relationship – Not mention
Scenario HT3	▪ Time of occurrence – After construction ▪ Type of activity – Critical ▪ Design complexity – High complicated ▪ Party cooperation – Inactive ▪ Time consumption for redesign – Before deadline ▪ Time consumption for drawing revision – Less ▪ Contractor's capability to change – No ▪ Time consumption for material order – Less ▪ Relationship – To maintain

The different tendencies of conflict levels show the operating factors in each level. It can highlight the active attributes and conditions in conflict development. This provides deeper knowledge related to situation of change. Thus, both parties can prepare well for the consequence.

5.2.4.2 Scenario Development for Cost Conflict

- **Scenarios of Change Leading to Cost Conflict at Level 1**

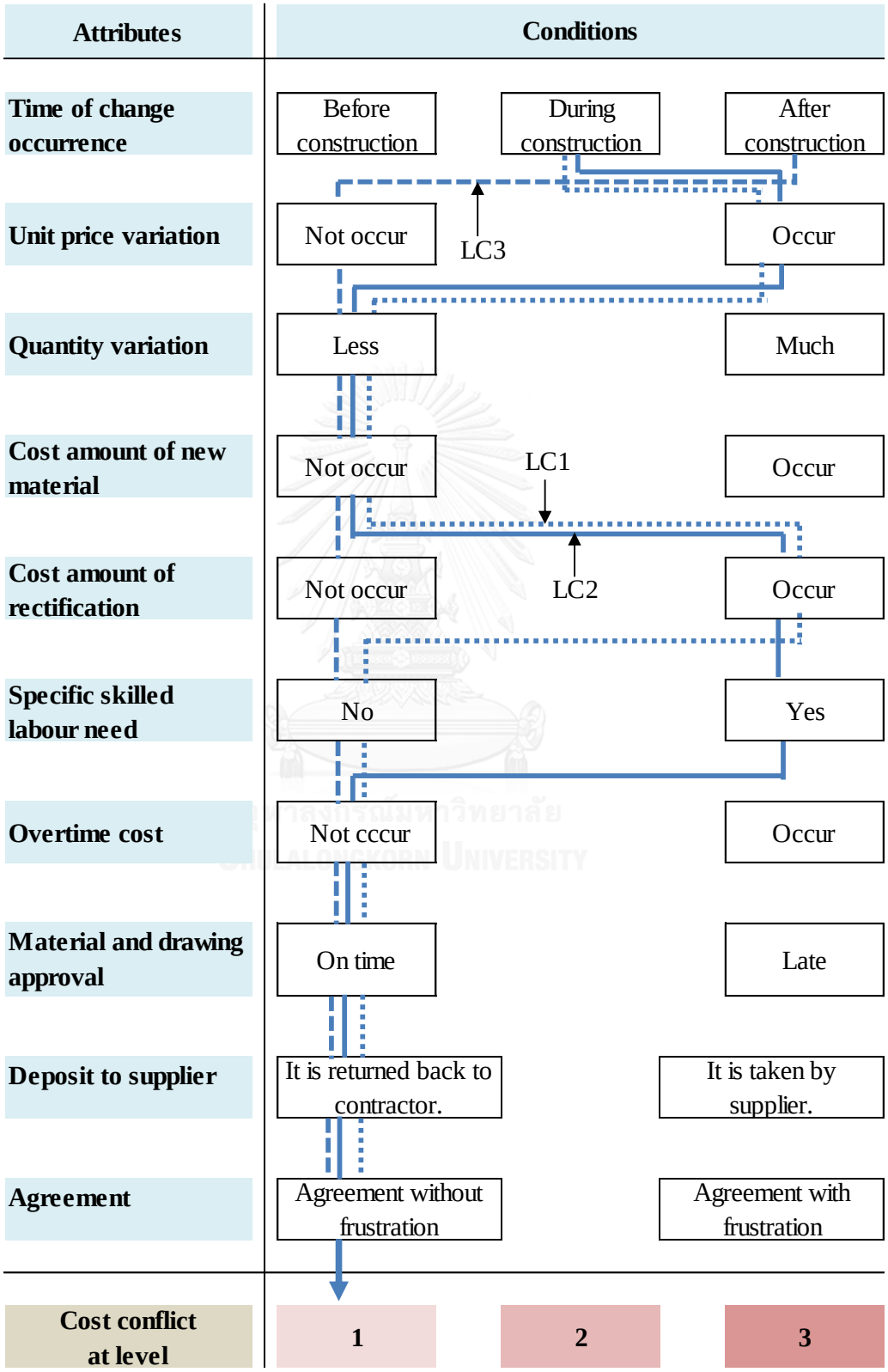

Figure 5.7 Scenario-based model of change leading to cost conflict at level 1

Table 5.13 Summary of scenarios of change leading to cost conflict at level 1

Cost conflict at level 1	Relevant attributes and conditions
Scenario LC1	▪ Time of occurrence – During construction ▪ Unit price variation – Occur ▪ Quantity variation– Less ▪ New material cost – Not occur ▪ Rectification cost – Not occur ▪ Specific skilled labour – No ▪ Overtime cost– No ▪ Material and drawing approval – On time ▪ Deposit to supplier – No loss ▪ Agreement – Agreement without frustration
Scenario LC2	▪ Time of occurrence – After construction ▪ Unit price variation – Not occur ▪ Quantity variation– Less ▪ New material cost – Not occur ▪ Rectification cost –Occur ▪ Specific skilled labour need – Yes ▪ Overtime cost– No ▪ Material and drawing approval – On time ▪ Deposit to supplier – No loss ▪ Agreement – Agreement without frustration
Scenario LC3	▪ Time of occurrence – During construction ▪ Unit price variation – Occur ▪ Quantity variation– Less ▪ New material cost – Not occur ▪ Rectification cost –Occur ▪ Specific skilled labour need – Yes ▪ Overtime cost– No ▪ Material and drawing approval – On time ▪ Deposit to supplier – No loss ▪ Agreement – Agreement without frustration

The three scenarios figure the active attributes and conditions for the cost conflict at level 1. It is noticed that most scenarios are formed by conditions of Not occur (Overtime cost), On time (Material and drawing approval), No loss for deposit (Deposit to supplier), and Agreement without frustration (Agreement). These situations might provoke slightly impact on the project cost. On the other hand, there

is no new material cost. This indicates that contractor may not request for additional cost when there is no new materials, although sometimes it needs skilled labour to do the task. However, contractor team might not be content with this unfavourable consequence.

- **Scenarios of Change Leading to Cost Conflict at Level 2**

Four types of scenarios were developed by using the morphological box. It provides the tendency of change situation which may bring to cost conflict at level 2. The diagram presents the flow of combinations between different conditions of all attributes. The table below shows the different combinations of attributes and conditions for each scenario. The display of each combination reveals that most of the elements are less impact conditions.

As shown in both figure and table below, the significant parameters are Occur (Unit price variation), Much (Quantity variation). It indicates that when there is much quantity variation, occurrence of unit price variation, one party may raise the claim. Moreover, it also requires conditions of On time (Material and drawing approval), No loss (Deposit to supplier), and Agreement without frustration (Agreement). These scenarios reflect actual situations that the contractors have met in their projects. Most of the additional cost claims are related to the variation of unit price and quantity.

Table 5.14 Summary of scenarios of change leading to cost conflict at level 2

Cost conflict Cost at level 2	Relevant attributes and conditions
Scenario MC1	▪ Time of occurrence – During construction ▪ Unit price variation – Not occur ▪ Quantity variation– Much ▪ New material cost – Not occur ▪ Rectification cost – Not occur ▪ Specific skilled labour need – Yes ▪ Overtime cost– No ▪ Material and drawing approval – On time ▪ Deposit to supplier – No loss ▪ Agreement – Agreement without frustration
Scenario MC2	▪ Time of occurrence – After construction ▪ Unit price variation – Occur ▪ Quantity variation– Less ▪ New material cost – Occur ▪ Rectification cost –Occur ▪ Specific skilled labour need – Yes ▪ Overtime cost– No ▪ Material and drawing approval – Late ▪ Deposit to supplier – No loss ▪ Agreement – Agreement without frustration
Scenario MC3	▪ Time of occurrence – Before construction ▪ Unit price variation – Occur ▪ Quantity variation– Much ▪ New material cost – Not occur ▪ Rectification cost – Not occur ▪ Specific skilled labour need – No ▪ Overtime cost– No ▪ Material and drawing approval – On time ▪ Deposit to supplier – No loss ▪ Agreement – Agreement without frustration
Scenario MC4	▪ Time of occurrence – During construction ▪ Unit price variation – Occur ▪ Quantity variation– Less ▪ New material cost – Not occur ▪ Rectification cost – Not occur ▪ Specific skilled labour need – No ▪ Overtime cost– No ▪ Material and drawing approval – On time ▪ Deposit to supplier – It is taken by supplier. ▪ Agreement – Agreement without frustration

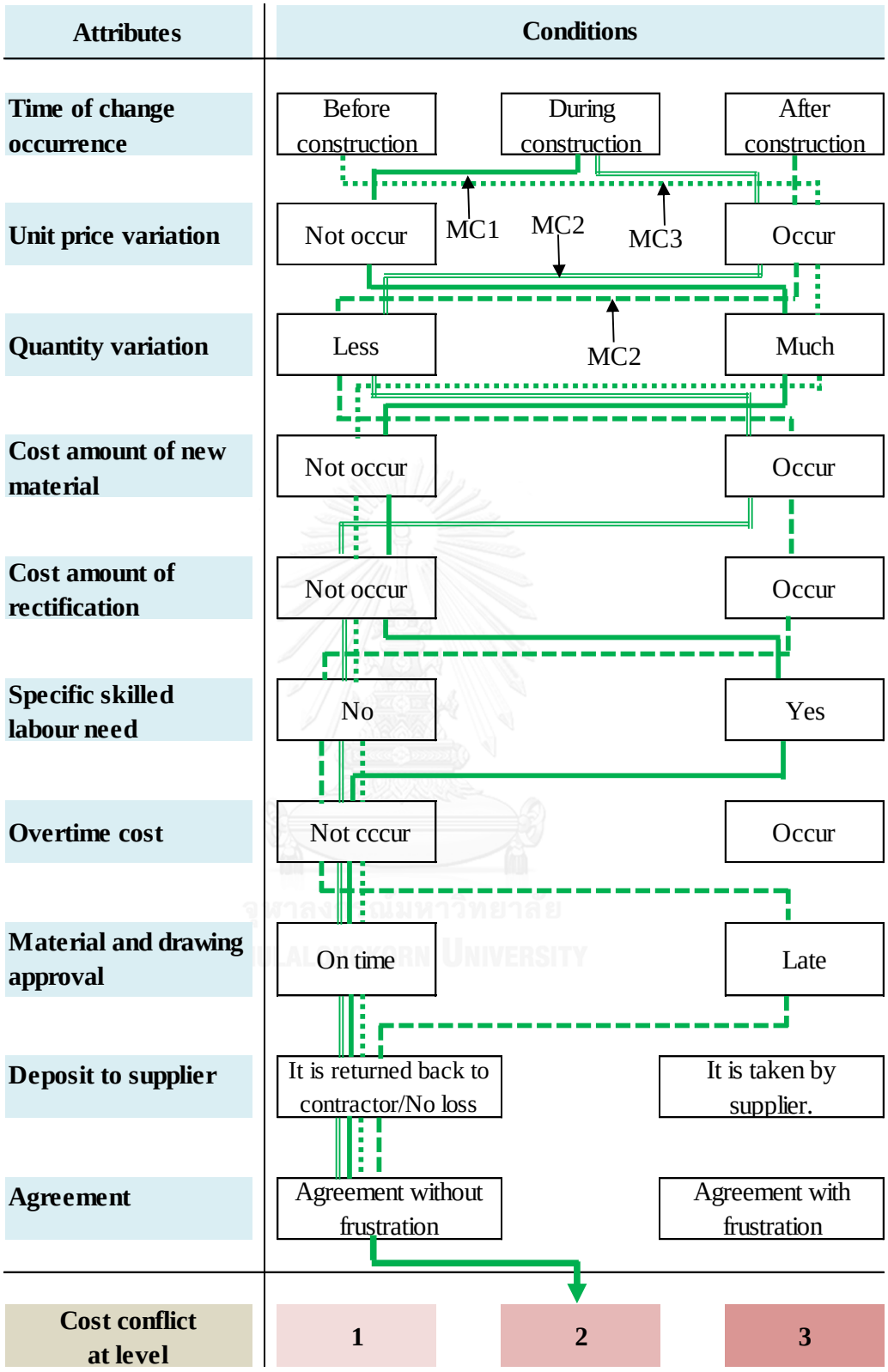

Figure 5.8 Scenario-based model of change leading to cost conflict at level 2

- **Scenarios of Change Leading to Cost Conflict at Level 3**

Table 5.15 Summary of scenarios of change leading to cost conflict at level 3

Cost conflict Cost at level 3	Relevant attributes and conditions
Scenario HC1	▪ Time of occurrence – After construction ▪ Unit price variation – Occur ▪ Quantity variation– Much ▪ New material cost – Occur ▪ Rectification cost – Occur ▪ Specific skilled labour need – No ▪ Overtime cost– Not occur ▪ Material and drawing approval – Late ▪ Deposit to supplier – It is taken by supplier. ▪ Agreement – Agreement with frustration
Scenario HC2	▪ Time of occurrence – During construction ▪ Unit price variation – Not occur ▪ Quantity variation– Much ▪ New material cost – Not occur ▪ Rectification cost – Not occur ▪ Specific skilled labour need – No ▪ Overtime cost– Occur ▪ Material and drawing approval – Late ▪ Deposit to supplier – It is taken by supplier. ▪ Agreement – Agreement with frustration
Scenario HC3	▪ Time of occurrence – During construction ▪ Unit price variation – Occur ▪ Quantity variation– Less ▪ New material cost – Occur ▪ Rectification cost – Not Occur ▪ Specific skilled labour need – Yes ▪ Overtime cost– Occur ▪ Material and drawing approval – Late ▪ Deposit to supplier – It is taken by supplier. ▪ Agreement – Agreement with frustration

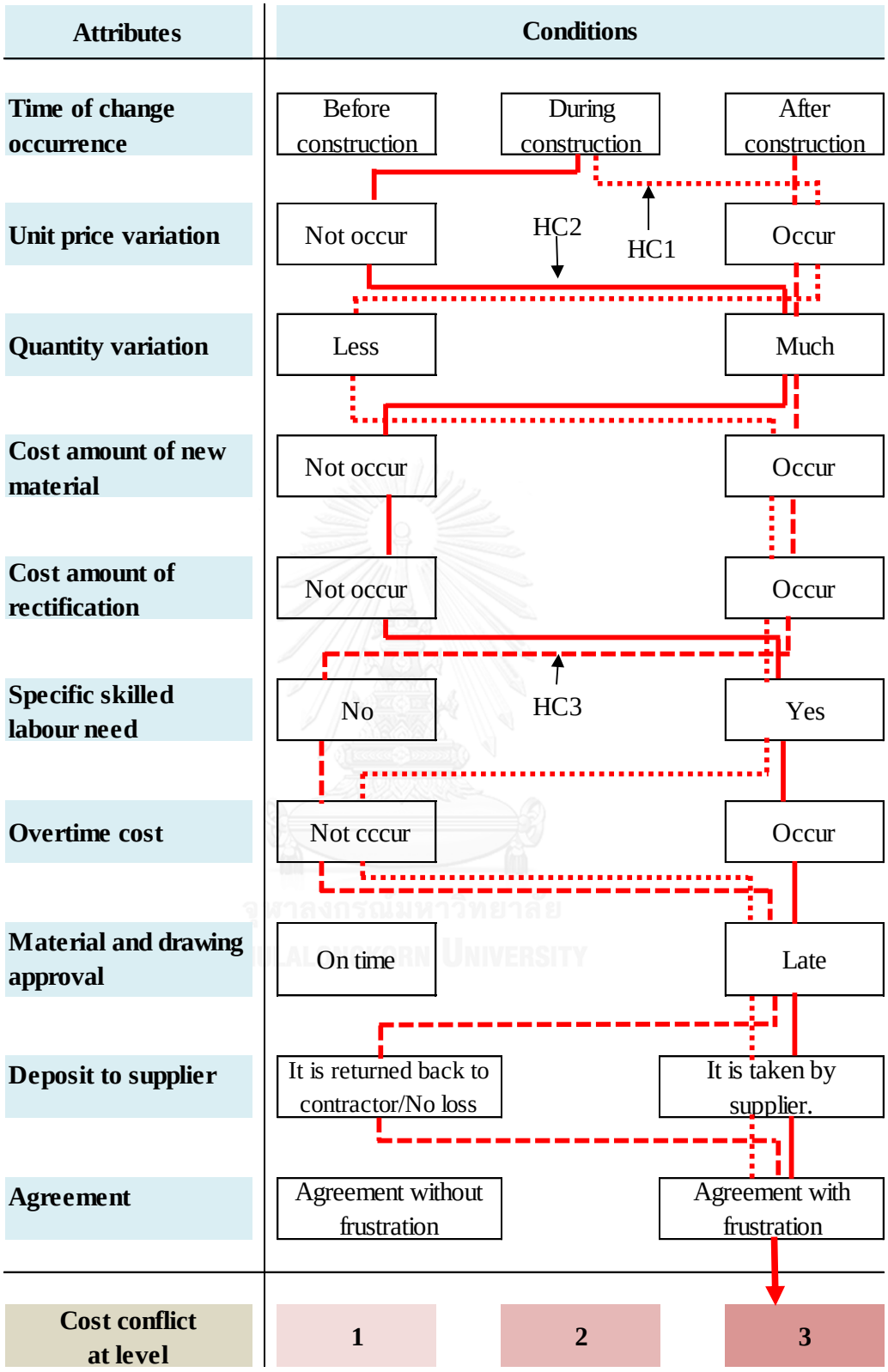

Figure 5.9 Scenario-based model of change leading to cost conflict at level 3

The tendency of conflict for this level mostly tends to the negative side conditions. Much quantity variation, skilled labor involvement, late material and drawing approval, loss of deposit, and agreement with frustration are the key conditions in cost conflict at level 3. It is remarked that all scenarios create high impact on cost; and there is hard situation between both parties. It is quite hard process to reach the agreement among stakeholders. These situations reflect the ideas of conflict prevention. To prevent high conflict level, all parties should participate in all phases and do their own tasks effectively without any late process. Furthermore, contractor's resource is also significant point to reduce the conflict.

Again, various scenarios create different conflict levels. Based on the above results, the crucial information related to scenarios of changes that lead to different conflict levels is presented. In addition, the lines representing conflict levels also show the trend of element combinations. The conflict becomes more serious when the most combined elements are detrimental. This structured model helps to discover new relationships between components which might have been overlooked by others.

CHAPTER VI
RESEARCH CONCLUSIONS

6.1 Research Findings

Change is very critical issue in construction sector and occurs at any stages of project. Changes and its caused conflicts should not be underestimated due to the negative impact on construction project success. This research study attempts to improve the change management in construction by focusing on situation of a critical change issue that leads to conflict. The outputs of this research were derived from the perspective of the contractors and owner.

The first finding of this research study come up with three lists of important change issues that could lead to conflicts of time, cost and quality respectively. As a result, in time conflict, the top five change issues ranked by their means are schedule change due to poor planning or scheduling from contractor side (C2, Mean = 4.47), schedule change from owner/client (O3, Mean =4.09), change due to poor and incomplete design (D3, Mean =4.9), Scope change by owner (O1, Mean =3.98), contractor's change due to construction errors (C3, Mean =3.94). For the aspect of cost, the top five important are schedule change by owner (O3, Mean = 4.04), scope change by owner (O1, Mean =4.02), change due to poor and incomplete design (D3, Mean =3.96), design function change due to client's requirement (O2, Mean =3.85), change in material specifications (O4, Mean =3.79). Last but not least, the top five ranking change issues of quality conflict are contractor's change due to construction errors (C3, Mean= 4.40), schedule change by owner (O3, Mean= 3.53), contractor's change due to unavailable resources (C4, Mean=3.42), change in specifications by designer (D2, Mean=3.38), change due to design errors (D1, Mean=3.34). According to these outputs, project practitioners might see what are the critical change issue concerning time, cost, and quality.

The second finding focuses on the development of scenario-based model of change due to poor and incomplete design from designers. The model serves as a template which indicates the relevant variables affecting time and cost conflicts. Nine Attributes and twenty conditions influencing time conflicts are Time of change

occurrence (Before construction, During construction, After construction), Type of activity (Critical, Non critical), Design complexity (Less complicated, Highly complicated), Party cooperation (Active, Inactive), Time consumption for designer response (Before deadline, Beyond deadline), Time consumption for drawing revision (Less (Less than one week), Much (More than one week), Contractor's capability to change (Yes, No), Time consumption for material order (Less (Within one week), Much (More than one week)), Relationship (Not mention, To maintain). In addition, eleven scenarios are also presented for the three levels of time conflicts.

In terms of cost, ten attributes and twenty one conditions are illustrated. They are Time of change occurrence (Before construction, During construction, After construction), Unit price variation (Not occur, Occur), Quantity variation (Less (Less than 25 %), Much (More than 25 %), New material cost (Not occur, Occur), Rectification cost (Not occur, Occur), Specific skill labor need (No, Yes), Deposit to supplier (It is taken by supplier., It is returned to contractor.), Overtime cost (Not occur, Occur), Material and drawing approval (On time, Late), Agreement (Agreement without frustration and tension, Agreement with frustration and tension). Ten different scenarios are developed to express three different levels of cost conflict.

According to the scenario study the most critical change issue, the attributes and conditions are determined. They are very important to differentiate the conflict levels for each aspect. The model importantly illustrates the combinations between conditions of attributes which create different scenarios. As a result, eleven scenarios of change issue leading to time conflict between owner and contractor are determined. Ten scenarios related to cost conflict between both parties are also presented as well. Each scenario is formed by different attributes and conditions and leads to different level of conflict. It can be concluded that the more conflict becomes serious, the more high impact conditions are combined.

6.2 Research Contributions

Deeper understanding of specific change issues is provided in terms of relationship aspect. Project stakeholders can pay more attention on important change issues for each category of conflict (time, cost and quality). Therefore, they can be aware and take pro-action to avoid serious negative consequences caused by changes.

This model's concept presents a new way to improve change management by concentrating on situations of change issue. This model is a beneficial tool for project practitioners who want to make modifications or change unintentionally. Based on the model, the presences of attributes and conditions in the templates may help project practitioners to be aware of important factors affecting time and cost conflicts. Additionally, project stakeholders can see which situations of change could lead to a particular conflict level. Project practitioners can see the possible scenario which may be overlooked. They may get and understand useful information related to different scenarios of change. It may help to reduce the conflicts during the change process.

In conclusion, this study also provides the perceptions of Cambodian project stakeholders about change issues and demonstrates their overviews of changes affecting to the relationship aspect. The detailed model components which refer to attributes and conditions are beneficial for designer to improve the change management by understanding the situations of change due to poor and incomplete design.

6.3 Research Limitations

This research study was developed under certain limitations. The research study was carried out in Cambodia. The current practices in Cambodia are different from ones in other countries. This research focuses on specific study of change issues over the aspects of time, cost and quality.

The change issues are extracted from literature review and perceptions of project practitioners during pilot survey. However, there may be some specific points which are not thought about due to the limitation of time. For instance, changes related to financial problems of project parties are not mentioned in the change issue list.

Regarding to scenario-based model, the numbers of collected cases are not sufficient. More cases would provide complete and clear information. Participants would be requested to participate to share new cases. Therefore, many cases and participants with experience are needed. Additionally, the important parameters (attributes and conditions) are defined according to the Cambodian experts who have

provided their perceptions and experience at the data collection periods. Besides, this model focuses on situations of building construction in Cambodia, a developing country, because data are from experience and perception from Cambodian project practitioners. If the model is developed in another country, the important attributes and conditions are different and either the scenarios. However, this work gives the concept of developing model by using morphological analysis for scenario study. It might discover new relationship between components which might be overlooked.

6.4 Further Studies

Future studies are recommended to focus on:

(1) The studies of specific change issues in different formations still need to be conducted.

(2) The update of the knowledge related to change due to poor and incomplete design might be crucial to improve the developed model.

(3) Scenario-based model of other change issues might be target for the studies in the future.

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APPENDICES

APPENDIX A

Survey Questionnaire Part 1and 2

No:……..

Date:……

SURVEY QUESTIONNAIRE-PART I

Thesis Topic: SCENARIO-BASED MODEL OF CHANGE ISSUES LEADING TO CONFLICTS IN BUILDING CONSTRUCTION

The research aims to provide deeper insight of change issues leading to conflicts between owner and contractor related to time, cost, and quality. Firstly, I would like to appreciate your willingness to be a participant of this research study as it is believed that you are the competent person to fill in the questionnaire regarding to your personal information, knowledge and experience. The success of the study depends upon your warm support to response to the questionnaires.

Please do not hesitate to answer all questions from your personal point of view and your precious experience without any bias, as all information will be treated strictly confidential and anonymous. In addition, all information will be used only for the purpose of data analysis in this research.

I. General Information

1.1 Name:……

1.2 Current Position:……

1.3 Company Name:……...

1.4 Work experience in mid-rise/high rise projects:……..years

1.5 Tel:……

1.6 Email:……..…..

1.7 Website:……...…..

II. Questionnaire regarding to change issues leading to conflicts between owner and contractor related to time, cost, and quality

Please kindly indicate by ticking (✓) in the number that represents your response for agreement of each change issues according to the following scale:

Scale	Description
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

***The respondents can add more change issues, if they think it is important.

Identify and explore change issues leading to conflicts between owner and contractor related to time, cost, and quality																
Coding	List of change issues	Time					Cost					Quality				
Coding O	Changes caused by Owner/Client	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
O1	Do you agree that ***scope change*** could lead to conflicts between owner and contractor related to...? (Scope change: additional work, deletion work, etc.)															
O2	Do you agree that ***design function change due to client's requirement*** could lead to conflicts between owner and contractor related to…? (It refers to design change initiated by the occupier and/or client representative.)															

Identify and explore change issues leading to conflicts between owner and contractor related to time, cost, and quality																
Coding	List of change issues	Time					Cost					Quality				
Coding O	Changes caused by Owner/Client	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
O3	Do you agree that *schedule change by owner* could lead to conflicts between owner and contractor related to…? (Ex: Owner intends to change the date of opening)															
O4	Do you agree that *Change in material specifications by owner* could lead to conflicts between owner and contractor related to…? (Ex: Material changes)															
Coding D	Changes caused by Designer	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
D1	Do you agree that *change due to design errors* could lead to conflicts between owner and contractor related to…? (Design errors include design omission, design conflicts and so on.)															
D2	Do you agree that *change in specifications* could lead to conflicts between owner and contractor related to.?															
D3	Do you agree that *change due to poor and incomplete design of drawings which do not provide enough information to contractor* could lead to conflicts between owner and contractor related to…?															

Identify and explore change issues leading to conflicts between owner and contractor related to time, cost, and quality																
Coding	List of change issues	Time					Cost					Quality				
Coding D	Changes caused by Owner/Client	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
D4	Do you agree that *design change due to the inconsistent site conditions* could lead to conflicts between owner and contractor related to…? (Ex: Foundation change due to soil condition)															
Coding C	Changes caused by Contractor	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
C1	Do you agree that *change in construction method in order to improve constructability, including site* could lead to conflicts between owner and contractor related to…?															
C2	Do you agree that *schedule change due to poor planning or scheduling from contractor side* could lead to conflicts between owner and contractor related to…?															
C3	Do you agree that *contractor's change due to construction errors* could lead to conflicts between owner and contractor related to…?															

Identify and explore change issues leading to conflicts between owner and contractor related to time, cost, and quality																
Coding	List of change issues	Time					Cost					Quality				
Coding C	Changes caused by Contractor	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
C4	Do you agree that *contractor's change in unavailable resources* could lead to conflicts between owner and contractor related to…? (Resources are raw materials such as steel, gravel, sand, etc.)															
C5	Do you agree that *contractor's change in unavailable material specifications* could lead to conflicts between owner and contractor related to? (Ex: Tiles, finishing materials, etc.)															
Coding S	Changes caused by Other parties (Supplier, Local authority, etc.)	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
S1	Do you agree that *change in design initiated by a supplier/manufacturer* could lead to conflicts between owner and contractor related to…?															
S2	Do you agree that *regulation change* could lead to conflicts between owner and contractor related to…? (Ex: Change in government codes.)															
S3	Do you agree that *change in material cost by a supplier/manufacturer* could lead to conflicts between owner and contractor related to?															

No:……..……..……..

Date:..…….

SURVEY QUESTIONNAIRE-PART 2

Thesis Topic: Scenario-based model of change issues leading to conflicts in building construction

This survey questionnaire attempts to clarify the conflicts in building construction projects caused by a specific change issue. Moreover, it also aims to develop scenario-based model of schedule change by owner side, which can cause conflicts between owner and contractor in terms of time. To achieve research objective, we use morphological method of scenario analysis in which cases of change issues will be collected from respondents.

I would like to appreciate your willingness to be a participant of this research study as it is believed that you are the competent person to fill in the questionnaire regarding to your personal information, knowledge and experience. The success of the study depends upon your warm support to response to the questionnaires.

I. General Information

1.1 Name:……..……

1.2 Current Position:……

1.3 Company Name:……..……

1.4 Work experience in mid-rise/high rise projects:……. years

1.5 Tel:……...….

1.6 Email:……

II. Clarification of change issues leading to conflicts between owner and contractor

Please answer the following questions:

What are the conflicts between owner and contractor related to

1. Scope change from owner side (O01)?

Description: additional or deletion works made by owner/client

……

……

……

2. Design function change due to client's requirement (O02)?

Description: Function of room or building is changed according to client's request.

Ex: In hotel project, the owner asks to change from lobby to conference room.

……

……

……

3. Schedule change from owner side (O03)?

Description: Modification of schedule due to owner's request.

Ex: Owner intends to change the date of opening; Owner wants the project start earlier than the schedule.

……

……

……

4. Change due to design errors (D1)?

Description: It causes by designer. Design errors include design omission, design conflicts and so on.

……

……

……

5. Change due to poor and incomplete design (D3)?

Description: Designer provides the unclear and incomplete plans and drawings.

……

……

……

6. Design change due to inconsistent site condition (D4)?

Description: Foundation change due to soil condition

……

……

……

7. Schedule change due to poor planning or scheduling from contractor side (C2)?

Description: Contractor modifies the schedule because he may fail in planning or scheduling his work.

……

……

……

8. Contractor's change due to construction errors (C3)?

Description: When contractor makes errors during construction. He may ask revise the drawing to respond to the actual situations.

……

……

……

9. Contractor's change due to unavailable resource (C4)?

Description: Resources are raw materials such as steel, gravel, sand, etc.

……

……

……

III. Case collection to develop scenario-based model

In this part research study, precise explanations of conflict degree are provided.

Change due to poor and incomplete design from designers:

Due to lack of information, unclear drawing or specification, and incomplete designer, changes might occur. Modification can be counted in work sequence, deviation, work process, etc.

- **Time aspect**

  - Time conflict at level 1:

This conflict degree is presented by the different opinion and/or disagreement between owner and contractor over the issues of time. It may slightly effect to the project timeline. Sometimes, one party decides to absorb the consequence without any complaint. Anyhow, both parties may know that such modification may tend to deviation of work. They acknowledge that it can cause change of work consequences; and one party may express the dissatisfaction. In some cases, contractor may release letter to inform the owner about the time effect. It may also leads to project delay later on.

  - Time conflict at level 2:

As change due to poor and incomplete design caused by designers occurs, one party might ask for time extension. In a construction party's opinions, mostly contractor, he should get extra time compensation because of the occurring change. Contractor needs to prepare the detail document and evidence for claim approval. They may have tension at the early negotiation. However, several meetings are hold to discuss and negotiate about the claim amount. Finally, the claim is settled.

  - Time conflict at level 3:

There is argument over the request for time extension caused by change due to poor and incomplete design. One party, mostly owner, does not agree with the request while another party. Owner may be able to provide only the specific amount of the requested claim. However, contractor party may not satisfy and tries to fight or propose the time extension for many times. Unfortunately, the situation creates the tension and frustration between parties. The hard situation can bring to contract

termination or change of contractor. Seriously, it can lead to lawsuits due to unsatisfied claims.

- **Cost aspect**

  - Cost conflict at level 1:

In terms of cost, low conflict refers to situations in which the change can create the slightly deviation of project cost. Both sides may have different ideas about the cost occurrence. However, one party does not ask for additional cost. He just shows his dissatisfaction to another party.

- Cost conflict at level 2:

As change due to poor and incomplete design caused by designer occurs, one party might ask for additional cost. One party, mostly referring to contractor, thinks that he should get extra cost because of the work variation. The issues are about raising extra cost. In this conflict degree, contest among parties arises. Before reaching the agreement, both parties might have some frustration or hard situation between each other. After the negotiation, both parties agree with a specific amount of request. Therefore, the request is approved.

- Cost conflict at level 3:

There is controversy of additional cost due to changes caused by poor and incomplete design by designer. However, there is no agreement on this request. The requested extra cost is rejected several times. The fight for claim from one party becomes serious. The altercation with tension and frustration would happen. It can lead to contract termination. Moreover, this situation can bring to the court.

Please describe the cases of **Change due to poor and incomplete design by designers** that you have met in your current projects. Please fill in attributes and conditions influencing to the levels of conflicts in each case.

Change due to poor and incomplete design by designer leading to **conflict at level 1**

Case 1 ……....

……

……

No.	Attribute	Condition

Case 2 ……....

……

……

No.	Attribute	Condition

Change due to poor and incomplete design by designer leading to **conflict at level 2**

Case 1 ……....

……

……

No.	Attribute	Condition

Case 2 ……....

……

……

No.	Attribute	Condition

Change due to poor and incomplete design by designer leading to **conflict at level 3**

Case 1 ……....

……

……

No.	Attribute	Condition

Case 2 ……....

……

……

No.	Attribute	Condition

APPENDIX B

Independent T-Test of aspects of Time, cost and quality

INDEPENDENT T-TEST OF TIME ASPECT

Objective: To determine the perception between owner and contractor on change issues leading to time conflict

Question:

- Is there a significant difference of agreement between owner and contractor sides on change issues leading to time conflicts?

Hypothesis on the aspect of time:

- Null hypothesis: H_0: $\mu owner = \mu contractor$, the population means for contractor and owner are equal. Both parties have the same perception on change issues.
- Alternative hypothesis*:* $H_1 = \mu owner \neq \mu contractor$, the population means for contractor and owner are not equal. Both parties have the different perception on change issues.

Result

Assessing differences between the groups

- When Sig. (2-tailed) value is less than or equal to 0.05, then there is a significant difference in the mean score on dependent variables (change issues) for each of the two groups.
- When Sing (2-tailed) value is more than 0.05, there is no significant different between the two groups.

According to the analysis, we can conclude that there is no significant different perception between owner and contractor on all change issues because all Sig (2-tailed) are more than 005.

Independent t-Test result of time aspect

Change issues		Levene's Test		t-test for Equality of Means						
									95% Confidence	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Differenc	Std. Error	Lower	Upper
Scope change	Equal variances assumed	0.966	0.330	-0.129	51.000	0.898	-0.030	0.235	-0.501	0.441
	Equal variances not assumed			-0.124	34.899	0.902	-0.030	0.245	-0.528	0.467
Design function change due to client's requirement	Equal variances assumed	11.417	0.001	-1.662	51.000	0.103	-0.464	0.279	-1.024	0.096
	Equal variances not assumed			-1.842	50.738	0.071	-0.464	0.252	-0.969	0.042
Schedule change	Equal variances assumed	2.844	0.098	1.144	51.000	0.258	0.312	0.273	-0.236	0.860
	Equal variances not assumed			1.071	32.475	0.292	0.312	0.291	-0.281	0.905
Change in material specifications	Equal variances assumed	0.387	0.537	-1.046	51.000	0.301	-0.236	0.226	-0.690	0.217
	Equal variances not assumed			-1.034	38.755	0.308	-0.236	0.229	-0.699	0.226
Change due to design errors	Equal variances assumed	0.919	0.342	-0.357	51.000	0.723	-0.092	0.259	-0.612	0.428
	Equal variances not assumed			-0.373	45.707	0.711	-0.092	0.248	-0.592	0.407
Change in specifications	Equal variances assumed	0.244	0.624	-0.476	51.000	0.636	-0.118	0.248	-0.616	0.380
	Equal variances not assumed			-0.508	47.922	0.614	-0.118	0.233	-0.586	0.350
Change due to poor and incomplete design	Equal variances assumed	3.189	0.080	0.263	51.000	0.793	0.071	0.270	-0.472	0.614
	Equal variances not assumed			0.285	49.332	0.777	0.071	0.250	-0.431	0.573
Design change due to inconsistent site conditions	Equal variances assumed	2.248	0.140	-0.940	51.000	0.352	-0.305	0.324	-0.955	0.346
	Equal variances not assumed			-0.974	44.771	0.335	-0.305	0.313	-0.935	0.325
Change in construction method in order to improve constructability	Equal variances assumed	0.064	0.801	-0.527	51.000	0.601	-0.148	0.282	-0.714	0.417
	Equal variances not assumed			-0.530	41.043	0.599	-0.148	0.280	-0.714	0.417
Schedule change due to poor planning or scheduling from contractor side	Equal variances assumed	0.019	0.892	-0.483	51.000	0.631	-0.126	0.260	-0.648	0.397
	Equal variances not assumed			-0.456	33.289	0.651	-0.126	0.276	-0.687	0.435

Independent t-Test result of time aspect (cont.)

Change issues		Levene's Test		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Differenc	Std. Error	95% Confidence Lower	95% Confidence Upper
Change due to construction errors	Equal variances assumed	0.193	0.662	0.237	51.000	0.813	0.070	0.294	-0.520	0.659
	Equal variances not assumed			0.239	40.994	0.812	0.070	0.292	-0.520	0.659
Change due to unavailable resources	Equal variances assumed	0.762	0.387	-0.415	51.000	0.680	-0.136	0.329	-0.796	0.524
	Equal variances not assumed			-0.430	44.911	0.669	-0.136	0.317	-0.775	0.502
Change in unavailable material specification	Equal variances assumed	0.005	0.942	-0.019	51.000	0.985	-0.006	0.314	-0.637	0.625
	Equal variances not assumed			-0.019	40.838	0.985	-0.006	0.313	-0.638	0.625
Change in design initirated by a supplier	Equal variances assumed	6.313	0.015	-1.582	51.000	0.120	-0.447	0.283	-1.014	0.120
	Equal variances not assumed			-1.761	50.858	0.084	-0.447	0.254	-0.957	0.063
Regulation change	Equal variances assumed	0.011	0.916	-1.507	51.000	0.138	-0.527	0.350	-1.230	0.175
	Equal variances not assumed			-1.505	40.028	0.140	-0.527	0.350	-1.236	0.181
Change in material costs by a supplier	Equal variances assumed	1.485	0.229	-1.366	51.000	0.178	-0.503	0.368	-1.243	0.236
	Equal variances not assumed			-1.428	45.850	0.160	-0.503	0.352	-1.212	0.206

INDEPENDENT T-TEST OF COST ASPECT

Objective: To determine the perception between owner and contractor on change issues leading to cost conflict

Question:

- Is there a significant difference of agreement between owner and contractor sides on change issues leading to cost conflicts?

Hypothesis on the aspect of time:

- Null hypothesis: H_0: $\mu owner = \mu contractor$, the population means for contractor and owner are equal. Both parties have the same perception on change issues.
- Alternative hypothesis*:* $H_1 = \mu owner \neq \mu contractor$, the population means for contractor and owner are not equal. Both parties have the different perception on change issues.

Result

Assessing differences between the groups

- When Sig. (2-tailed) value is less than or equal to 0.05, then there is a significant difference in the mean score on dependent variables (change issues) for each of the two groups.
- When Sig. (2-tailed) value is more than 0.05, there is no significant different between the two groups.

According to the analysis, we can conclude that there is no significant different perception between owner and contractor on all change issues because all Sig (2-tailed) are more than 005.

Independent t-Test result of cost aspect

Change issues		Levene's Test		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Differe	Std. Error	95% Lower	95% Upper
Scope change	Equal variances assumed	0.263	0.610	0.129	51.000	0.898	0.030	0.235	-0.441	0.501
	Equal variances not assumed			0.127	38.381	0.899	0.030	0.238	-0.452	0.512
Design function change due to client's requirement	Equal variances assumed	0.221	0.640	1.004	51.000	0.320	0.239	0.238	-0.239	0.718
	Equal variances not assumed			1.023	42.633	0.312	0.239	0.234	-0.232	0.711
Schedule change	Equal variances assumed	3.696	0.060	0.828	51.000	0.411	0.221	0.267	-0.315	0.757
	Equal variances not assumed			0.768	31.399	0.448	0.221	0.288	-0.366	0.809
Change in material specifications	Equal variances assumed	0.371	0.545	-1.172	51.000	0.246	-0.333	0.284	-0.904	0.237
	Equal variances not assumed			-1.213	44.508	0.232	-0.333	0.275	-0.887	0.220
Change due to design errors	Equal variances assumed	0.306	0.583	-0.013	51.000	0.989	-0.003	0.229	-0.462	0.456
	Equal variances not assumed			-0.014	44.802	0.989	-0.003	0.220	-0.447	0.441
Change in specifications	Equal variances assumed	0.939	0.337	-0.017	51.000	0.986	-0.005	0.261	-0.528	0.519
	Equal variances not assumed			-0.019	48.338	0.985	-0.005	0.243	-0.494	0.485
Change due to poor and incomplete design	Equal variances assumed	2.068	0.157	0.919	51.000	0.362	0.261	0.284	-0.309	0.830
	Equal variances not assumed			0.958	45.496	0.343	0.261	0.272	-0.287	0.808
Design change due to inconsistent site conditions	Equal variances assumed	2.964	0.091	-0.073	51.000	0.942	-0.023	0.313	-0.651	0.606
	Equal variances not assumed			-0.078	48.399	0.938	-0.023	0.292	-0.611	0.565

Independent t-Test result of cost aspect (cont.)

Change issues		Levene's Test		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Differe	Std. Error	95% Lower	95% Upper
Change in construction method in order to improve constructability	Equal variances assumed	0.704	0.405	-0.905	51.000	0.370	-0.279	0.308	-0.897	0.340
	Equal variances not assumed			-0.954	46.790	0.345	-0.279	0.292	-0.867	0.309
Schedule change due to poor planning or scheduling from contractor side	Equal variances assumed	0.382	0.539	0.120	51.000	0.905	0.038	0.316	-0.596	0.672
	Equal variances not assumed			0.122	42.234	0.904	0.038	0.311	-0.589	0.665
Change due to construction errors	Equal variances assumed	0.993	0.324	0.600	51.000	0.551	0.177	0.296	-0.416	0.771
	Equal variances not assumed			0.566	33.366	0.575	0.177	0.313	-0.459	0.814
Change due to unavailable resources	Equal variances assumed	0.678	0.414	-0.329	51.000	0.743	-0.103	0.313	-0.731	0.525
	Equal variances not assumed			-0.335	42.431	0.739	-0.103	0.308	-0.724	0.517
Change in unavailable material specification	Equal variances assumed	0.602	0.442	-0.791	51.000	0.433	-0.244	0.308	-0.863	0.375
	Equal variances not assumed			-0.791	40.192	0.434	-0.244	0.309	-0.867	0.380
Change in design initirated by a supplier	Equal variances assumed	2.045	0.159	0.010	51.000	0.992	0.003	0.305	-0.610	0.616
	Equal variances not assumed			0.010	47.101	0.992	0.003	0.289	-0.578	0.584
Regulation change	Equal variances assumed	1.558	0.218	-1.056	51.000	0.296	-0.377	0.357	-1.095	0.340
	Equal variances not assumed			-1.114	46.821	0.271	-0.377	0.339	-1.059	0.304
Change in material costs by a supplier	Equal variances assumed	3.823	0.056	-2.465	51.000	0.017	-0.867	0.352	-1.573	-0.161
	Equal variances not assumed			-2.653	48.870	0.011	-0.867	0.327	-1.523	-0.210

INDEPENDENT T-TEST OF QUALITY ASPECT

Objective: To determine the perception between owner and contractor on change issues leading to quality conflict

Question:

- Is there a significant difference of agreement between owner and contractor sides on change issues leading to quality conflicts?

Hypothesis on the aspect of time:

- Null hypothesis: H_0: $\mu owner = \mu contractor$, the population means for contractor and owner are equal. Both parties have the same perception on change issues.
- Alternative hypothesis*:* $H_1 = \mu owner \neq \mu contractor$, the population means for contractor and owner are not equal. Both parties have the different perception on change issues.

Result

Assessing differences between the groups

- When Sig. (2-tailed) value is less than or equal to 0.05, then there is a significant difference in the mean score on dependent variables (change issues) for each of the two groups.
- When Sig. (2-tailed) value is more than 0.05, there is no significant different between the two groups.

According to the analysis, we can conclude that there is no significant different perception between owner and contractor on all change issues because all Sig (2-tailed) are more than 005.

Independent t-Test result of quality aspect

Change issues		Levene's Test		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Lower	95% Upper
Scope change	Equal variances assumed	0.264	0.610	-1.233	51.000	0.223	-0.411	0.333	-1.079	0.258
	Equal variances not assumed			-1.269	43.907	0.211	-0.411	0.324	-1.063	0.241
Design function change due to client's requirement	Equal variances assumed	1.454	0.233	-1.495	51.000	0.141	-0.500	0.334	-1.171	0.171
	Equal variances not assumed			-1.587	47.499	0.119	-0.500	0.315	-1.134	0.134
Schedule change	Equal variances assumed	2.540	0.117	0.930	51.000	0.357	0.286	0.308	-0.332	0.904
	Equal variances not assumed			1.003	49.018	0.321	0.286	0.285	-0.287	0.860
Change in material specifications	Equal variances assumed	0.664	0.419	-0.105	50.000	0.917	-0.031	0.299	-0.632	0.569
	Equal variances not assumed			-0.107	43.974	0.915	-0.031	0.291	-0.618	0.555
Change due to design errors	Equal variances assumed	0.003	0.954	-1.077	51.000	0.286	-0.338	0.314	-0.967	0.292
	Equal variances not assumed			-1.080	40.587	0.286	-0.338	0.313	-0.970	0.294
Change in specifications	Equal variances assumed	0.360	0.551	-0.399	51.000	0.692	-0.117	0.292	-0.704	0.470
	Equal variances not assumed			-0.413	44.468	0.682	-0.117	0.283	-0.686	0.453
Change due to poor and incomplete design	Equal variances assumed	3.868	0.055	-1.931	51.000	0.059	-1.589	0.823	-3.242	0.063
	Equal variances not assumed			-2.051	47.592	0.046	-1.589	0.775	-3.148	-0.031
Design change due to inconsistent site conditions	Equal variances assumed	0.052	0.821	-0.652	51.000	0.517	-0.198	0.304	-0.809	0.412
	Equal variances not assumed			-0.661	41.830	0.513	-0.198	0.300	-0.805	0.408
Change in construction method in order to improve	Equal variances assumed	0.411	0.524	0.005	51.000	0.996	0.002	0.309	-0.620	0.623
	Equal variances not assumed			0.005	42.641	0.996	0.002	0.304	-0.611	0.614
Schedule change due to poor planning or scheduling from	Equal variances assumed	0.339	0.563	-1.482	51.000	0.145	-0.479	0.323	-1.128	0.170
	Equal variances not assumed			-1.531	44.369	0.133	-0.479	0.313	-1.109	0.151

Independent t-Test result of quality aspect (cont.)

Change issues		Levene's Test		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Lower	95% Upper
Change due to construction errors	Equal variances assumed	0.953	0.334	1.046	51.000	0.301	0.302	0.288	-0.277	0.880
	Equal variances not assumed			1.058	41.701	0.296	0.302	0.285	-0.274	0.877
Change due to unavailable resources	Equal variances assumed	0.044	0.835	-1.761	51.000	0.084	-0.538	0.305	-1.151	0.075
	Equal variances not assumed			-1.799	42.980	0.079	-0.538	0.299	-1.141	0.065
Change in unavailable material specification	Equal variances assumed	1.199	0.279	-0.904	51.000	0.370	-0.268	0.297	-0.864	0.327
	Equal variances not assumed			-0.960	47.497	0.342	-0.268	0.279	-0.830	0.294
Change in design initirated by a supplier	Equal variances assumed	1.519	0.223	-0.499	51.000	0.620	-0.159	0.319	-0.799	0.481
	Equal variances not assumed			-0.527	47.003	0.600	-0.159	0.302	-0.766	0.448
Regulation change	Equal variances assumed	6.581	0.013	-0.634	51.000	0.529	-0.221	0.349	-0.922	0.479
	Equal variances not assumed			-0.700	50.582	0.487	-0.221	0.316	-0.856	0.413
Change in material costs by a supplier	Equal variances assumed	0.280	0.599	-2.596	51.000	0.012	-0.862	0.332	-1.529	-0.195
	Equal variances not assumed			-2.669	43.789	0.011	-0.862	0.323	-1.513	-0.211

VITA

Lakhena Cheang was born in 1988 in Kampong Chhnang province, Cambodia. She finished high school in 2006 at Preah Bat Soramrithi high school. In the same year, she moved to Phnom Penh, the capital of Cambodia, to pursue her study in the Institute of Technology of Cambodia (ITC). After graduating from ITC, she had worked for an French-Cambodian construction company, called LBL international. After one year of working as an engineer, she got a chance to pursue Master program in Chulalongkorn University, Thailand, under the support of CU-ASEAN Scholarship.