

# IMPROVEMENTS OF SMALL BUILDING CONSTRUCTION PROJECTS

Mr. Winyu Taechateerawat



บทคัดย่อและแฟ้มข้อมูลฉบับเต็มของวิทยานิพนธ์ตั้งแต่ปีการศึกษา 2554 ที่ให้บริการในคลังปัญญาจุฬาฯ (CUIR)  
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วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต  
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Accepted by the Faculty of Engineering, Chulalongkorn University in Partial  
Fulfillment of the Requirements for the Master's Degree

.....Dean of the Faculty of Engineering  
(Professor Bundhit Eua-arporn, Ph.D.)

THESIS COMMITTEE

.....Chairman  
(Assistant Professor Manop Reodecha, Ph.D.)

.....Thesis Advisor  
(Associate Professor Parames Chutima, Ph.D.)

.....Examiner  
(Associate Professor Jeirapat Ngaoprasertwong)

.....External Examiner  
(Assistant Professor Boonwa Thampitakkul, Ph.D.)

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วิทยานิพนธ์ฉบับนี้ได้ทำการศึกษาวิจัยที่ก่อสร้างแห่งหนึ่งที่เกี่ยวข้องกับปัญหาด้านการจัดการโครงการก่อสร้างอาคาร ซึ่งครอบคลุมอาคารก่อสร้างที่มีขนาดอาคารก่อสร้างไม่เกิน 4 ชั้น และมีมูลค่าโครงการไม่เกิน 100 ล้านบาท หากพิจารณาการก่อสร้างในแต่ละโครงการนั้น จะประกอบไปด้วยงานหรือกิจกรรมหลายส่วนซึ่งแต่ละส่วนล้วนมีความเกี่ยวเนื่องซึ่งกันและกัน ทั้งนี้การดำเนินการของแต่ละกิจกรรมนั้นจะขึ้นอยู่กับคุณภาพ ต้นทุน และ ระยะเวลาการดำเนินงาน ด้วยเหตุปัจจัยดังกล่าว วิทยานิพนธ์ฉบับนี้จึงมีวัตถุประสงค์ที่จะทำการพัฒนาวิธีการจัดการโครงการเพื่อที่ว่าแต่ละโครงการนั้นจะสามารถดำเนินงานไปได้ด้วยความราบรื่นภายใต้เวลาที่จำกัดและ ต้นทุนที่เหมาะสม อีกทั้งได้โครงการที่มีคุณภาพที่น่าพึงพอใจ

ในการศึกษารุ่นนี้ โครงการก่อสร้างอาคารขนาดเล็กจำนวน 10 โครงการที่ได้ดำเนินงานมาในช่วงปี 2006 ถึง 2012 ได้ถูกนำมาพิจารณา จากการศึกษาข้อมูลในอดีตพบว่า หลายๆโครงการประสบกับปัญหาหลายอย่างด้วยกัน ไม่ว่าจะเป็น คุณภาพงานที่ไม่ได้มาตรฐาน โครงการมีต้นทุนที่สูง และการส่งมอบงานล่าช้า อย่างไรก็ตามจากข้อมูลพบว่า ปัญหาการส่งมอบงานล่าช้าเป็นปัญหาหลักที่เกิดขึ้นกับโครงการในอดีตเกือบทุกโครงการ และส่งผลต่อต้นทุนที่สูงขึ้นอันเนื่องมาจากโดนค่าปรับสำหรับการส่งมอบงานล่าช้า รวมทั้งค่าใช้จ่ายด้านแรงงานที่สูงขึ้นเช่นกัน เพื่อแก้ปัญหาดังกล่าว จึงได้ทำการศึกษาถึงสาเหตุที่ส่งผลต่อการล่าช้าของโครงการโดยละเอียด โดยใช้ แผนภูมิแกงปลา แผนภูมิพาเรโตและ แผนภูมิต้นไม้ ทำให้ทราบว่าปัญหาส่วนใหญ่เกิดจากการที่ผู้รับเหมาไม่มีประสิทธิภาพ พนักงานของบริษัทขาดประสบการณ์และผู้จัดหาววัสดุไม่มีประสิทธิภาพ ตามลำดับ แต่เนื่องด้วยข้อจำกัดด้านระยะเวลางานวิจัย จึงได้พิจารณาหาแนวทางแก้ไขเฉพาะในส่วนของผู้รับเหมาและการจัดหาววัสดุซึ่งปัญหาทั้งสองคิดเป็นร้อยละ 55 ของสาเหตุของปัญหาที่ทำให้โครงการเกิดความล่าช้า

จากการศึกษาและวิเคราะห์ ทำให้ได้แนวทางในการแก้ปัญหาและพัฒนาวิธีการบริหารจัดการโครงการจำนวน 3 แนวทางได้แก่ (1) คู่มือในการวางแผนและจัดการโครงการ (2) วิธีการเพื่อช่วยในการตัดสินใจจ้างทำ (3) วิธีการคัดเลือกผู้รับเหมาและผู้จัดหา ทั้งนี้ ได้นำวิธีการเพื่อช่วยในการตัดสินใจจ้างทำและการคัดเลือกผู้รับเหมาไปทดลองใช้กับโครงการในอดีตจำนวน 6 โครงการซึ่งมีทั้งหมด 184 กิจกรรม พบว่ามีว่าการตัดสินใจที่แตกต่างจากเดิมคิดเป็นร้อยละ 16 และพบว่าจะต้องมีการพิจารณาการคัดเลือกผู้รับเหมาหรือผู้จัดหาใหม่ คิดเป็นร้อยละ 15 ซึ่งจากการตรวจสอบพบว่าทั้งหมดล้วนแต่เป็นกระบวนการที่มีปัญหาในอดีตทั้งสิ้น นอกจากนี้ยังได้นำคู่มือการวางแผนและจัดการไปใช้กับโครงการใหม่ ซึ่งผลที่ได้คือ สามารถส่งมอบงานได้ทันเวลา ขณะเดียวกันสามารถลดต้นทุนได้อีกร้อยละ 3.57 เนื่องมาจากต้นทุนค่าวัสดุที่น้อยกว่าแผน และค่าแรงงานที่ลดลงเพราะงานเสร็จเร็วกว่าที่วางแผนไว้

ภาควิชา ศูนย์ระดับภูมิภาคทางวิศวกรรมระบบการผลิต ลายมือชื่อนิสิต .....

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KEYWORDS: SMALL BUILDING CONSTRUCTION / PROJECT MANAGEMENT / OUTSOURCE / IN-HOUSE /  
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WINYU TAECHATEERAWAT: IMPROVEMENTS OF SMALL BUILDING CONSTRUCTION  
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This thesis based on a company, which faced the problem in management of small building construction projects, which involve buildings with no more than four floors and construction budgets lower than 100 million baht. The entire project consists of several work areas and inter-independent activities. The performance of each activity depends on quality, budget and timing. This thesis aim to improve project management approach so that the project can proceed smoothly with time constraint, suitable budget and satisfactory quality.

In this research, 10 projects taking place during 2006 to 2012 were studied. According to the historical data, it is noticed that many projects encountered several obstacles, such as poor project quality, high budget, and delay deliverables. However, it is obvious that the most common problem is delay deliverables which lead to over budget problem regarding to penalty and extra wage. To tackle the problem, Fishbone diagram, Pareto chart, and fault tree diagram were adopted in order to investigate the root causes of delay. Consequently, it found that the root causes of problem consist of inefficiency subcontractor, non-experience workers and inefficiency suppliers respectively. With the limitation of time, only inefficiency subcontractors and inefficiency supplier problem were examined in this study because over 55% of delay deliverable problem are caused by those problems.

In order to tackle the problems and improve project management, three solutions are proposed; (1) Project management procedure and project management template (2) Decision Making criteria and/or decision-making process and (3) Outsources selection. From the simulation, a company applied the last two solutions in 6 previous projects with 184 activities; it obviously represents 16% of the different decision making of in-source or outsources, while 15% of activities are needed to review the new outsource or suppliers. Moreover, the first solution, project management procedure and template, was implemented in a new project. As a result, this project can be delivered on time under the satisfied quality. Furthermore, it gained more profit by 3.57%, due to lower material cost, and lower daily wage regarding to shorter working time of some in-house activities.

Department:   Regional Centre for Manufacturing   Student's Signature .....

                  Systems Engineering                     Advisor's Signature .....

Field of Study:   Engineering Management

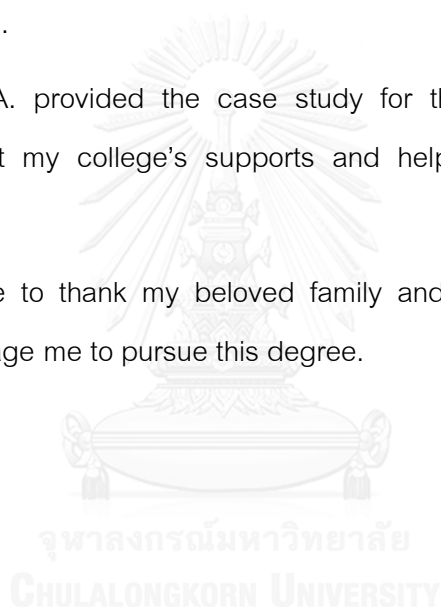
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## CHAPTER 1

### INTRODUCTION

#### 1.1 Introduction

Company A is a medium size construction company located in Chiang Rai province, the northernmost last province in Thailand. Chiang Rai is famous as the economic strategic city, which is bordered with Lao and Burma and 200 km far from the Yunnan of China. In 2015, when AEC organisation started, Chiang Rai hoped to be the gate of trading as it is foreseen that thousands of investors from mainly China and Asians will enter Thailand mainly through Chaing Rai. The city itself will be rapidly growth of real estate and tourism those will encourage high spending throughout city. Also, the state budget for Chiang Rai has raised significantly in the past few years which mainly emphasised in improving State agency building, school building, tourist service building.

Company A established since 1996. It is the family business; which all of projects came from state budget bidding especially from Road construction and Water management in Chiang Rai for over 20 years. The beginning of small-sized building construction (lower than 100 million bath) was from year 2006 when company won the building project of Sport complex and School building. From that point forward, company has emphasised on building construction as can be seen in the company performance between 2010 to currently below.



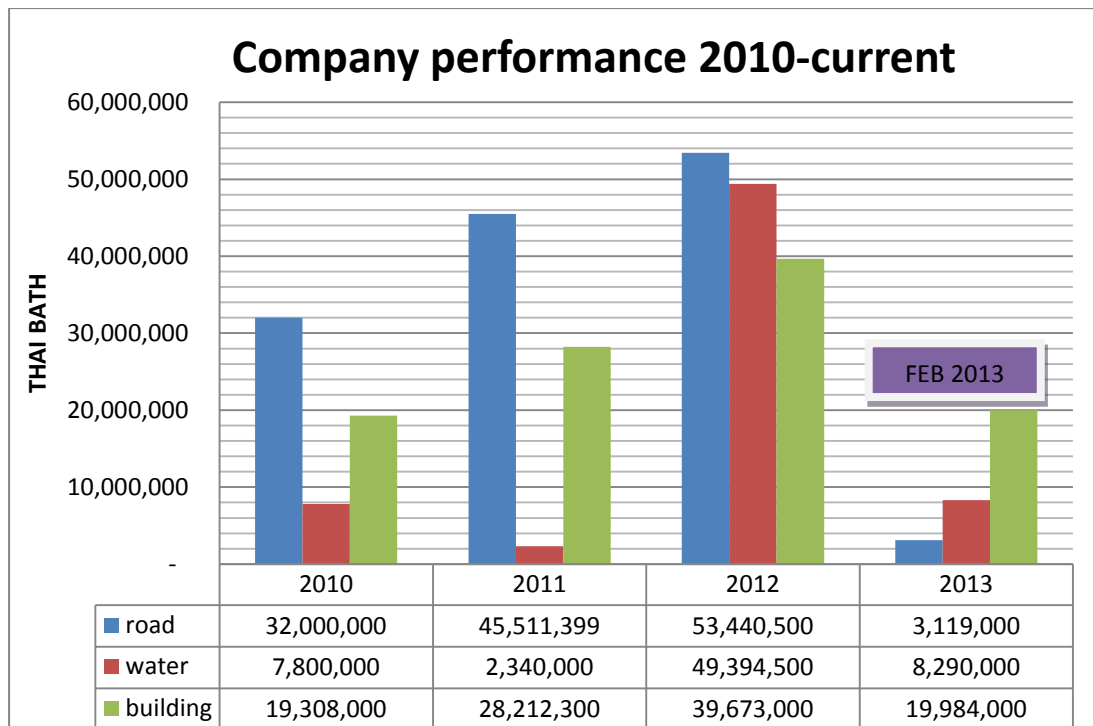


Figure 1-1 Company Performance

The result of company performance 2010-2013 showed that although mainly income has still come from Road and Water construction. But in last 3 consecutive years; demonstrated the rising of small-sized building construction income which means company has turn to emphasise more on this category.

Although the nature of building construction itself is more complex, time-consuming, highly need of attention than other construction categories, letting only few players can maintain their growth in this business. However, the margin of building construction is widely known as relatively high, Company A has experienced this advantage since the beginning and try to improve their methods and expand resources to fit with construction activities. The activities which always included in small-sized conventional building are simply divided into 3 main categories as following

(1) Structure

- Foundation
- Structural works
- Truss and Roof

(2) Architect works

- Masonry
- Painting
- Surfacing
- Ceiling
- Framing

(3) System works

- Sanitary
- Pipeline
- Electricity
- Instrument system

According to construction department of COMPANY A, the construction methods that company has adopted are to divide the overall project into specific tasks and hire sub-contractor which familiar with company to perform in those sections or some will be performed by in-house team, the details are as following bellow

**1.1.1 Own making**

This type, company will perform a specific task by own monthly labours, the process will be monitored by in-house supervisor. Buyer department is responsible for supplying materials, which are stocked in construction-site controlled by company warehouse supervisors.

**Advantage:**

- Company is able to intensively control the quality of materials and labours.
- Cost consuming for this type is from actual used which known as lower cost than other types
- It is known as very powerful method to deliver the finish task within a limit of time

**Disadvantage:**

- Company need to have a strong material storage system in construction site in order to prevent the leakage and damage issues.
- Company need to have a high skill foreman to check real use of labours, arrange the sequence of the tasks and assign the task to labours
- Company must have exact number of high skilled labours to fit with assigned activity, more or less is undesirable

**1.1.2 Labours sub-contractors:**

Sub-contractors in this type are to provide only labours to perform a specific job at the predetermined price; company has to provide the material and ensure that the site area is ready for sub-contractors.

**Advantage:**

- Company can control the quality of material to ensure that the finished works will meet required standard, however the buyers also need be highly effective in order to provide the material running with sub-contractors.

**Disadvantage:**

- Company need to have a strong material storage system in construction site in order to prevent the leakage and damage issues.
- The short of labours and also poor skills, are always happen for this type because the sub-contractors need to save their cost by hiring low wage labours and also providing less than appropriate amount

### 1.1.3 Completely sub-contractors:

Sub-contractor in this type is responsible for both materials and labours to perform a specific job at the predetermined price: company has to ensure that the site area is ready for sub-contractors.

#### Advantage:

- The material storage system and buyers are unnecessary in this type
- Cost of this hired part can be clearly recognised, allowing other parts to be easily managed

#### Disadvantage:

- Company need to have expertise supervisors in specific part in order to perform an inspection process.
- The quality of material is hard to control to meet the required standard because subcontractors always find the way to save their cost by using low quality material.
- The leaving work issue can happen if the subcontractors do not have enough potential budgets to perform the job.

The key advantage for COMPANY A is that company has had an experience in small-sized building construction for over 6 years, and the highest project reference from state budget is 29.9 million baht, which is necessary to present in state qualification process. This reference allows company to have a qualification for bidding the state building budget in the range of 60 – 100 million baht, which has only few players in this level. However 7 projects could not be submitted within contact deadline, and the consequence of them is not only rising of cost but it is also the penalty fee that company must response for those delays .Moreover, quality of finish works have been very low as can be determined by defected works and repeat works. The result of construction performance for last 10 projects can be seen in table below.

Table 1-1 3previous company projects and their results

Year	Name of project	Budget	Contact length	Operation length	Delay	%Profit	Defected
		(Bath)	(Days)	(Days)	(Days)	(Bath)	
2006	Sport complex centre	18,670,000	720	704	0	19.56	34
2007	School of municipal building Tessaban 1	8,292,000	420	404	0	17.40	16
		26,962,000				-	
2010	Phuttamonthon celabating 750 years	6,959,000	240	333	93	12.12	31
2010	School of municipal building Tessaban 8	12,349,000	240	311	71	9.41	21
		19,308,000					
2011	Phuttamonthon celabating 750 years phase 2	7,982,300	197	205	8	16.98	22
2011	School of Vocational building	15,350,000	420	440	20	17.43	35
2011	Overpass	4,880,000	150	190	40	11.61	19
		28,212,300					
2012	Tourist centre	29,760,000	420	450	30	9.61	53
2012	Child care centre	5,704,000	180	198	18	13.44	17
2012	Health care centre	3,990,000	120	110	0	20.07	11
		39,454,000					

From the interviews with building construction managers of COMPANY A and the studies for last 6 project conclusion books, enabling to clarify that the concerned QCD (Quality, Cost, Delivery) from different types, either in-source or outsource. The statistically analysis is adopted in this part to identify which types having huge impact on the project as well as their frequencies. The quantitative method is combined to prioritise and score each item in order to get accurate result as can be shown in table below.

Table 1-2 Example of Pareto analysis of Tourism project evaluation

Tourism centre project	29.97 million bath	Delay = 30 days			Penalty = 892,800 baths	
Items	Type	Scheduling (Days)	Actual (Days)	%Cost	Impact	Defected
Foundation	Completely subcontractor	20	15	-7.20%	0.9	1
Structural works	Completely subcontractor	60	95	-1.50%	0.8	5
Masonry	Labour subcontractors	120	85	15.6%	0.75	3
Roof work	Completely subcontractor	85	85	4.45%	0.6	2
Colour work	In-house	60	70	14.40%	0.5	11
Instrument	Completely subcontractor	25	20	5.24%	0.5	0
Surface work	Completely subcontractor	50	66	-5.64%	0.65	7
Landscape	Completely subcontractor	30	45	5.45%	0.4	0
Sanitary	Labour subcontractors	14	30	-6.50%	0.5	6
Electricity and system	Labour subcontractors	20	28	-34.40%	0.6	7
Ceiling	Completely subcontractor	10	20	6.65%	0.5	12

In a table below is the result of analysis that grouping similar types into specific category. The average budget per activity, defected work and delay are also demonstrated in this area to be an effectiveness indicator of concerned issues.

Table 1-3 Result of statically analysis of last 6 projects

Categories	Total Budget (Million baths)	Activities (Times)	Average (Million baths/activity)	Defected (Times)	Average (Million baths/Defected)	Delays (Times)	%Delay (Delay/activity)
In-house	16.50	18	0.92	35	0.47	5	27.70%
Labour	20.70	22	0.94	52	0.39	10	45.45%
Completely	35.50	32	1.11	42	0.84	20	62.50%

## 1.2 Problem statement

From the analysis above, it is able to clarify that main problems of building construction of COMPANY A is as following

1. Decision making (In-source or Outsource) that company has adopted for each activity is unclear and inappropriate
2. Company has an ambiguous aims to identify that company should emphasise on quality ,cost ,or delivery for each activity

## 1.3 Objective

The objective of this research is to improve a small building construction project management.

## 1.4 Scope

This research is going to focus on a small building, which has not over 4 storey and project cost is not more than 100 million baht conducted by company A.

## 1.5 Methodology

1. Literature review on concerned theories
  - Risk management
  - Fish bone
  - QCD analysis
  - Sub-contractors management
  - Project planning management and control
2. Study on section 1 and 2 and gathering information
3. Study on how to identify the aim to prevent delay defected and high cost
4. Implement the solution in section 3
5. Conduct the result to improve solution and implement in section 4
6. Conclusion
7. Project complete

### 1.5.1 *Expect benefit*

1. The comparison of in-source or outsourcing to suit which specific activity for small building constrictions and its aim are able to figure out
2. The aims and critical issues for each activity will be list to guide company in selecting appropriate construction type
3. Enhancing making decision process for in-source or outsource
4. Risk reduction during project execution
5. Decentralisation in term of decision-making
6. Cost optimisation





## CHAPTER 2

### THEORETICAL CONSIDERATION AND LITERATURE REVIEW

Regarding to the characteristic of construction, it is a kind of project which has a clear objective and the exact duration. Thus, understanding in project management is necessary that it can lead to manage construction project effectively. With those reasons, this chapter is going to review the relevant theory and literature about project management and construction, respectively.

#### 2.1 Project Management

According to Project Management Institute (2009), Project Management is defined as “the application of knowledge, skills, tools, and techniques to project activities to meet the project requirement”. In the process of project management, it can be divided into 5 process groups, which are;

- 1) Initiating
- 2) Planning
- 3) Executing
- 4) Monitoring and Controlling
- 5) Closing

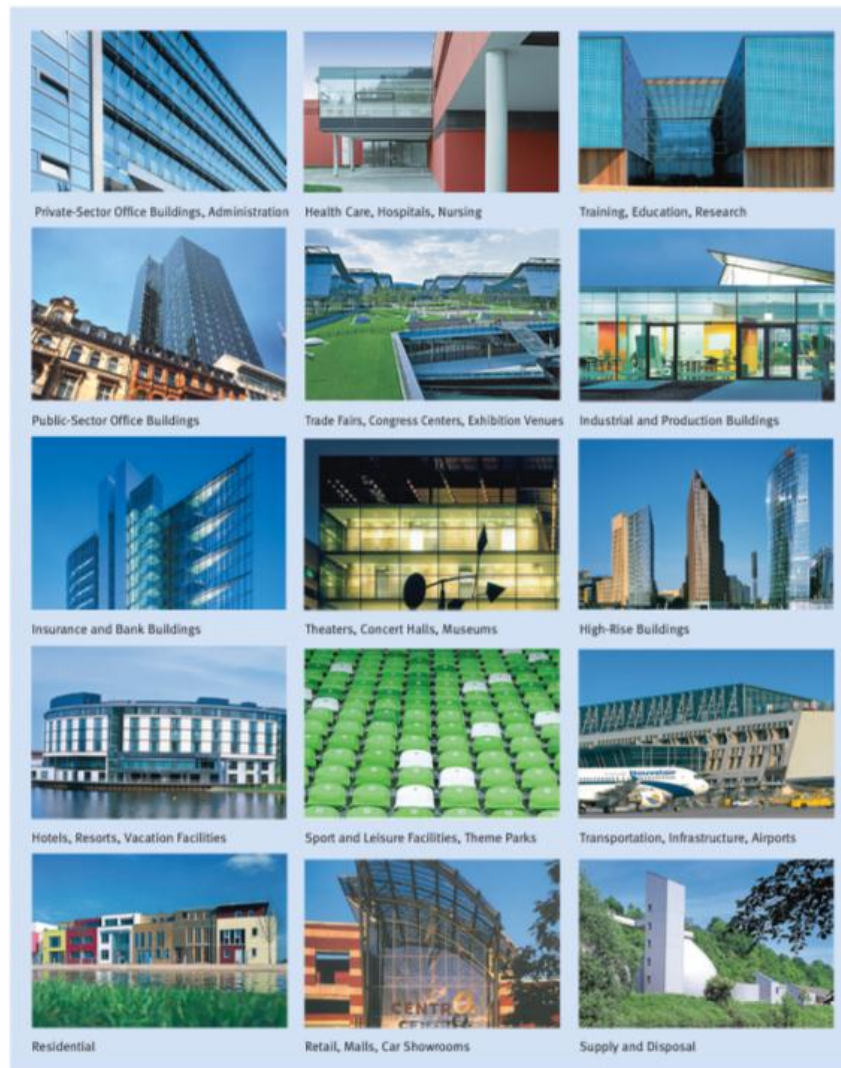
With the unique of each project, it causes the way of application of the project management techniques using in the individual project is different, depending on the characteristic of each project (Wei, 2010).

The techniques for a construction project, Wei Wei mentioned that it can be managed and controlled in terms of organization structure and project plan and control in order to accomplish the project on time schedule, within the budget, high quality, and client's satisfaction.

## 2.2 Project Management for construction

In the construction industry, it can be divided into various construction sectors, such as infrastructure (road, railway, port, etc.) and building. However, each sector is also separated into several types. As well as building construction, it can be categorized based on project type as follows (Hans, 2010);

1. Private-Section Office Building, Administration
2. Health Care, Hospital, Nursing
3. Training, Education, Research
4. Public-Section Office Building
5. Trade Fairs, Congress Centres, Exhibition Venues
6. Industrial and Production Buildings
7. Insurance and Bank Building
8. Theatres, Concert Halls, Museums
9. High-Rise Building
10. Hotels, Resorts, Vocation Facilities
11. Sport and Leisure Facilities, Theme Parks
12. Transportation, Infrastructure, Airports
13. Residential
14. Retail, Malls, Car Showrooms
15. Supply and Disposal



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Figure 2-1 Project types in building construction

With the difference of building construction type, it has individual difficulty. Managing the project for construction is not easy due to its complexity, and it also consists of several processes and decisions which have to be finished within the limit of time and cost. As this reason, careful and organized planning is as important as timely coordination of a variety of measures to be executed. If do so, the losses resulting of unsuccessful project can be reduced, while costs and time are also saved (Hans, 2010). On the other hand, it is necessary for project managers to manage change which can take place throughout the construction project. Because of that, project manager is a key person that has to undertake detailed planning in order to integrate the work activities of consultants, subcontractors and suppliers (Love, et.al, 2002)

In order to have more understanding in project management in construction, the outstanding point of construction project can be illustrated as following;

### ***2.2.1 The change of project management in construction***

Love, P.E.D. and his team (2002) explains the characteristic of construction project that it is a dynamic project derived from two basic sources which are planned activities and unexpected activities.

### ***2.2.2 Planned Activities or Attended dynamics***

The major planned activities of a project management system consist of:

1. Decision Making
2. Techniques and Technology
3. Behavioral responses
4. Project structure

### ***2.2.3 Unexpected activities or Unattended dynamics***

It is unexpected circumstance causing change to a project. The major sources of this type of activities can be divided into 2 terms which are internal uncertainties and external uncertainties.

#### ***1. Internal Uncertainties***

Internal uncertainties include;

- Project-related uncertainties
- Organisation-related uncertainties
- Finance-related uncertainties
- Interest-related conflicts
- Human-related uncertainties

## 2. *External Uncertainties*

External uncertainties are treats that they are difficult to expect in advance. At the same time, it cannot avoid from those circumstances. The following areas represent the example of external uncertainties that can affect the project.

- Government-related uncertainties
- Economy-related uncertainties
- Social uncertainties
- Legal uncertainties
- Technological uncertainties
- Institutional influences
- Physical conditions
- Acts of god/force majeure

In order to cope with those changes, Love, P.E.D. and his colleagues emphasises the importance of developing the ability of properly identifying project dynamics. On the other hand, it is necessary to improve the ability to respond promptly to change within the project.

### 2.3 Construction Management

#### 2.3.1 *Critical success factor (CSFs) of construction project*

Completing the construction project is not easy because its difficulty and complexity. It is due to various factors influencing the project, such as uncertainties in technology, budgets, and development process (Chan, A.P.C., Chan, A.P.L., and Scott, 2004). From this point of view, it is essential to know how to conduct project, in order to complete the project within the budget, limit of time and satisfied quality. There are several literatures mentioning CSFs of construction project which can be divided into 5 genres.

1. *Human-related factors*

2. *Project-related factors*

Project scope is identified as a useful predictor for construction time (Walker, 1995). It is because it can indicate either complexity of project or number of tasks in the project. For instance, in building project, scope of project will help a project manager to know number of floors, and type of project.

3. *Project procedure*

Project procedure can be separated into two terms; Procurement and Tendering method. Procurement method is defined as selection of the organisation for the design and construction of the project, while tendering approach is mentioned as procedure used for selection of the project team and the main contractor.

4. *Project management factors*

Hubbard (1990) mentions that project management action plays an importance for project success. While adopting the management tools can assist a project manager to plan and execute construction project to success (Jaselskis, and Ashley, 1991). Furthermore, Chan, A.P.C. and colleagues (2004) also summarises the attribution affecting the project, which are communication system, control mechanism, feedback ability, planning effort, organisational structure, safety and quality assurance, subcontractor control, and overall managerial actions.

5. *External environment*

External environment is included social, political, and technical aspects. Those factors affect the achievement of project, at the same time, they also influence on the construction process, consisting social, political, and technical aspects.

## 2.4 Quality-Cost-Delivery (QCD)

The Quality, Cost, and Delivery (QCD) now play an important role in supply chain performance management. They are nothing new but they are usually applied in many businesses in order to measure company performance. Several researches or articles mention the application of seven key measures under the concept of Quality, Cost and Delivery (QCD). The seven key measures influencing on QCD are (SMMT Industrial Forum, 2004);

1. Not right first time – this measure an ability matching a specification, including the expression of a number of defect parts per million
2. Delivery schedule achievement – measure how well a vendor or supplier serve the planned delivery requirement
3. People productivity – measure the output that people can produce goods or service comparing time
4. Stock turns – measure how frequently the stock are turned over
5. Overall equipment effectiveness – measure the availability, performance and quality of the process
6. Value added per person – measure financial term relating people who are involved in the process that can add a value in the product
7. Floor space utilisation – measure the sale revenue which can be generated per square meter of factory floor space

## 2.5 Outsource (In-source or Outsource)

Considering outsourcing is not easy because it is needed to know how obtaining the most benefit from outsourcing comparing in-house sourcing. Thus, it is essential to consider pros and cons of outsourcing in order to gain the advantage and repose the expected objectives. Based on Ketler, K. and Walstrom, J. (1993) , the advantages and disadvantages are represented which are divided into 6 issues including; (1) Personnel, (2) Economic, (3) Risk Versus Control, (4) Characteristics of Outsourced Data/Segment,

(5) Organisational Characteristics, and (6) Vendor and Contract Issues. However, each issue contains both advantages and drawback which shown in table below.

Table 2-1 Advantages and disadvantage of outsourcing

Issues of outsourcing	Advantages	Disadvantages
Personal issue	1.Increased knowledge and expertise 2.Alternative to staff increases for short term projects	1. Loss of in-house expertise 2. Severance costs for termination/transfer of existing IS staff
Financial issue	1.Cost saving 2.Increased return on equity	1. Higher than expected outsourcing bills due to low vendor estimates or contract misunderstanding 2. Increased tax liability 3. Decreased profit margin 4. Hidden costs (such as severance packages)
Control issue	1.Share the risk 2.Elimination/reduction of the weaknesses of the MIS department	1. Loss of control over <ul style="list-style-type: none"> <li>● Quality of IS services</li> <li>● (B) Disaster recovery</li> <li>● (C) Confidentiality</li> </ul>
Data/segment issue	1.Outsource the non-strategic 2.Focus attention on the strategic	1. Determination of strategic/non-strategic 2. Confidentiality/security
Organisational issue	1. Outsource the weaknesses of the MIS department 2. Applicable to the procedurally	1. Loss of control in vertically integrated organisations 2. Outsourcing requirements in



Issues of outsourcing	Advantages	Disadvantages
	oriented organisations	dynamic organisations may be difficult to contract  3. The extent of end-user computing and the ability
Vendor and Contract issue	<ol style="list-style-type: none"> <li>1. Experience <ul style="list-style-type: none"> <li>● Prior success in outsourcing</li> <li>● Knowledge of client's industry</li> </ul> </li> <li>2. Planning <ul style="list-style-type: none"> <li>● Evidence of long range planning</li> <li>● International perspective</li> </ul> </li> <li>3. Technology/personnel <ul style="list-style-type: none"> <li>● State of the art technology</li> <li>● Trained personnel in appropriate areas</li> <li>● Plans for technology improvements</li> </ul> </li> <li>4. Contract issues <ul style="list-style-type: none"> <li>● Flexibility in entering/existing contract</li> <li>● Willingness to negotiate <ol style="list-style-type: none"> <li>(a) Price</li> <li>(b) Service</li> <li>(c) Ownership</li> </ol> </li> </ul> </li> <li>5. Communication <ul style="list-style-type: none"> <li>● Working relationship between vendor and client</li> <li>● Importance of client's input/communication</li> </ul> </li> <li>6. Transfer of personnel</li> <li>7. Financial stability</li> </ol>	

## 2.6 Outsource selection

Mohamed M. Marzouk, Ahmed A. El Kherbawy, and Mostafa Khalifa (2013) proposed factors influencing sub-contractors selection in construction projects by using survey and determining the mean score for each factors. Forty six factors are collected from the previous study and considered by 29 experts in the construction industry through a questionnaire, respectively.

Table 2-2 Frequencies of importance level for the different factors (Marzouk, et.al., 2013)

ID	Factor	Less	...	...	...	Most	Mean score
		1	2	3	4	5	
CC1	Cost overruns	3	2	4	7	13	3.86
CC2	Flexibility in payment terms and conditions	0	2	8	10	9	3.90
CC3	Tender price	1	1	3	11	13	4.17
CC4	Sub-contractor's difficulty in reimbursement	1	1	6	9	12	4.03
CC5	Failure to complete contract	3	0	1	7	18	4.28
CC6	Financial stability	2	1	6	11	9	3.83
CC7	Financial references	4	5	10	5	5	3.07
QC1	Quality	0	1	2	13	13	4.31
QC2	Sub-contractor's poor management ability	2	2	6	9	10	3.79
QC3	QA/QC programs	2	3	10	6	8	3.52
SC1	Energy saving materials and installations	7	3	11	8	0	2.69
SC2	Poor competency of laborers	0	2	9	11	7	3.79
SC3	Experience of technical personnel	0	2	3	18	6	3.97
SC4	Decorum, conduct and non-disruptiveness of the staff	1	1	17	7	3	3.34
SC5	Prevention of vandalism	2	0	7	12	8	3.83
SC6	Cooperation with the other subcontractors on the project	1	2	10	12	4	3.55
SC7	Creativity and innovation	0	4	12	9	4	3.45
SC8	Labor force retention	3	2	11	8	5	3.34
SF1	Jobsite cleanliness during projects and upon leaving jobsites	3	4	8	10	4	3.28
SF2	Prosecution due to unlawful disposal of construction waste	3	5	5	13	3	3.28
SF3	Safety consciousness on the job site	0	3	6	8	12	4.00
IR1	Onsite plant maintenance and repair programs	0	2	12	11	4	3.59
IR2	Responsiveness to warranty issues	3	5	8	9	4	3.21
IR3	Not buying insurance for major equipment and employees	3	3	10	10	3	3.24
DR1	Suppliers incompetency to deliver materials on time	1	2	2	7	17	4.28
DR2	Disputes and arbitration	1	2	2	7	17	3.97
DR3	Failure to comply with the quality specifications	1	2	2	6	18	4.31
DR4	Lack of readily available utilities on site	1	7	8	7	6	3.34
DR5	Risk avoidance	2	2	5	11	9	3.79
TC1	Flexibility and cooperation when resolving delays	0	0	4	10	15	4.38
TC2	Delay	1	0	2	11	15	4.34
TC3	Length of time in industry	0	2	7	13	7	3.86
TC4	Flexibility in critical activities	0	1	7	11	10	4.03
TC5	Flexibility in the noncritical activities	4	5	8	6	6	3.17
EC1	Reputation	0	0	4	10	15	4.38
EC2	Being familiar with the area or being domestic	0	2	7	13	7	3.86
EC3	Knowledge of construction regulations	0	3	5	12	9	3.93
EC4	Volume of work committed	1	2	7	16	3	3.62
EC5	Experience in local area	0	1	9	15	4	3.76
EC6	Scale of projects completed	1	2	5	14	7	3.83
TD1	Tender quality	2	3	10	6	8	3.52
TD2	Willingness to tender	3	1	7	10	8	3.66
OC1	Site proximity	6	4	11	6	2	2.79
OC2	Ongoing work commitments	1	4	10	8	6	3.48
OC3	Physical resources	0	0	4	15	10	4.21
OC4	Relationships with the client	1	1	9	8	10	3.86

Then, statistical analysis by using SPSS is adopted to asset the mean score of each factor. As a result, there are twelve factors having a mean score more than 4.00 which are:

1. Flexibility and cooperation when resolving delays
2. Reputation
3. Delay
4. Failure to comply with the quality specifications
5. Quality
6. Suppliers incompetency to deliver materials on time
7. Failure to complete contract
8. Physical resources
9. Tender price
10. Contractor's difficulty in reimbursement
11. Flexibility in critical activities
12. Safety consciousness on the job site

However, it is not only having a good outsources selection system, but contracting process is also important. Zhijian Cui and Sameer Hasija (2011) compare the effectiveness of vendor selection and contracting mechanisms. It is found, although good vendor is selected, it may be not effective if a vender is not match client's capabilities. This is because a vendor's customer-specific capability cannot be recognised simply by examining the general aspects of historical record, but it have to evaluate vendor's capabilities in order to match with specific need. Thus, it is a challenge for customers to select an appropriate vendor which suit capabilities. Moreover, it is needed to design an outsourcing contract by considering the client's knowledge of vendor capabilities and risks in contract renegotiation (Diromualdo, A., V. Gurbaxani. 1998).

Moreover, selecting appropriate suppliers and effective supplier relationship management play an important role in enhancing company's competitiveness. Thus, it is essential to evaluate the supplier's performance after the supplier is selected (Choy, et.al., 2003; Ghodsypour, and O'Brien, 2001).

In several researches, many methods for outsourcing selection and evaluation have been proposed, such as the categorical method, the weighted point method, the cost ratio method, and the weighted point method adopting a performance matrix and AHP. Though, many techniques and approaches have been used for selective and evaluating suppliers, each method has limitations under different situations (Li, et. al., 1997).

K.L. Choy, W.B. Lee, and Victor Lo (2002) mention that choosing suppliers based on accumulated experience is not effective and reasonable. This is because the judgment may lack of systematic analysis. Thus, it is needed to continuously track and benchmark supplier's performance and building the suitable supplier selection mechanism. Because of that, they proposed "an intelligent supplier management tools (ISMT) using the case-based reasoning (CBR) and neural network (NN) techniques to select and benchmark suppliers". To verify the competency of the potential suppliers, the total weighted score of each factor is compared with the ideal score which is assigned by the user group.

Furthermore, there is the combination of the Analytic Network Process (ANP) and the Balanced Scorecard (BSC) which is built for determining outsourcing strategy (Tjader, et.al., 2014). Besides, a logistic regression model is adopted to identify criteria for net sourcing decision (Loebbecke, and Huyskens, 2009). While, Osei-Bryson and Ngwenyama (2006) represent a mathematical model to demonstrate firms the value of outsourcing, identify outsourcing risks, and construct mutually satisfactory vendor incentive projects.

According to the research conducted by Mcivor, R. and his colleagues (2009), the issue of performance in the outsourcing decision is considered and an outsourcing framework is developed, respectively. The framework consists of four main stages as follows;

**Stage 1: Process importance analysis**

In this process, the important processes, which are critical for success, have been determined. However, it is important to classify between critical and non-critical process. One of useful technique is the critical success factor (CFC) methodology which point out a linkage between outsourcing and the factors influencing firm success (McIvor, 2005).

**Stage 2: Assessing process capability**

This process involves examining company capability comparing outsourcing. Considering outsourcing, a firm is essential to evaluate its capability internally, suppliers and competitors, especially in terms of cost analysis and benchmarking.

**Stage 3: Selecting the sourcing strategy**

In this stage, the most appropriate sourcing is selected after the first two stages have been determined. Thus, making decision for outsourcing should fully reflect competitive position and capability of organisation.

**Stage 4: Implementing and managing the outsourcing arrangement**

This process is about the management of outsourcing relationship which covers three steps as follows;

1. Negotiating and signing the outsourcing contract – this comprises contractual issues, service agreement, transferring staff and asset, and price and payment terms.
2. Managing the outsourcing relationship
3. Evaluation the relationship

## 2.7 Risk management

Joint risk management (JRM) is a method focusing on the importance of collaboration between the project actors in managing risks which cannot be identified at the beginning of the project. Ekaterina Osipova and Per Erik Eriksson (2013) proposed the lessons learned from two construction project with balancing control and flexibility in this approach. They investigated how mechanistic (control-oriented) and organic (flexibility-oriented) management system affecting the implementation of JRM in the projects. A mechanistic system is identified by a level of control, specialised differentiation, hierarchical structures, and the importance of individual knowledge and skills, which this approach is suitable for stable environment. In contrast, an organic system is more flexible and appropriate for the changing conditions because it is characterised by a network of structure, extension of commitment and informative communication (Burns, and Stalker, 1961). The difference of those two systems is demonstrated in the table below. As a result of the study conducted by Osipova and Eriksson, they mentioned that JRM requires a combination of the formal and collaborative processes, in order to balance between control tools using for identifying risks and flexibility coping with unexpected events.

Table 2-3 Characteristics of mechanistic and organic organisation (Burns and Stalker, 1961)

Mechanistic	Organic
The specialized differentiation of functional tasks	The contributive nature of special knowledge and experience
The abstract nature of each individual task (distinct from the whole organization)	The “realistic” nature of the individual task (task is seen as set by the whole environment)
The precise definition of rights and obligations attached to each functional role	The shedding of responsibility (problems may not be defined as being someone else’s responsibility)
Hierarchical and vertical structure of control, authority and communication	A network and lateral structure of control, authority and communication
Location of knowledge at the top of the hierarchy	Knowledge can be located anywhere in the network
Working behavior is governed by instruction and decisions made by superiors	Superior function of information and advise rather than instructions and decisions
Importance and prestige of individual knowledge	Importance and prestige of common knowledge

In construction project, there are several risks affecting the process of construction project. In order to avoid or reduce the impact from those risks, it is needed to evaluate risk and find out the action plan to prevent or correct when they take place. Li-ying, X. and Xin-zheng, Wang. (2010) propose the assessment index system for project risk which covers 5 risk categories; political risk, natural risk, economic risk, technical risk, and management risk, respectively. Each risk category contains the specific indexed shown below.

Table 2-4 The assessment index system of project risk

Risk categories	Specific indexes	Indicators describe
political risk	administrative intervention risk	administrative departments' excessive intervention and improper command to the project
	policies and regulations risk	project construction system's and policy's change
natural risk	weather conditions risk	bad weather conditions' effect on the construction and the difficulty to the construction
	catastrophe risk	earthquakes, floods, etc. some overpowering disasters
economic risk	interest rate risk	country micro-scope interest rate adjustment
	prices rising risk	engineering materials' prices rising, such as cement
technical risk	feasibility research risk	the wrong decision caused by the imperfect work during the feasibility research stage, etc.
	design risk	defective designs, error or omission, unreasonable selection of the safety coefficient, etc.
	construction risk	lagging construction technology; unreasonable construction technologies and solutions, etc.
management risk	project target control risk	poor control measures such as schedule, cost, safety, etc. poor control measures
	business activities risk	poor management, reachless expected earnings

## 2.8 Internal assessment

Internal Factor Evaluation (IFE) matrix is a strategic management tool for auditing or evaluating major strengths and weaknesses in functional areas of a business and it can be developed in five steps (Fred R., 2007).

1. Listing key internal factors including both strengths and weaknesses
2. Assigning a weight which range from 0.0 (not important) to 1.0 (all-important) to each factor
3. Assigning a number of 1 to 4 rating to each factor in order to indicate whether factor represent a major weakness (1), a minor weakness (2), a minor strength(3), or a major strength (4).
4. Multiplying each factor's weight
5. Summarising the weighted scores for each variable in order to determine the total weighted score for the firm

According to IFE Matrix, the total weighted score can range from a low (1.0) to a high (4.0), 2.5 of weighted score is an average. If total weighted scores are below 2.5, it means that organisations will be weak internally. While, if the scores are higher than 2.5, this indicates a strong internal position of organisations.

This approach has been adopted in various industries. For instance, using IFE to evaluate an organisation's internal strengths and weakness of Hamadan Glass Company (There are six factors that are considered; (1) management and its structure, (2) sales and marketing, (3) finance and accounting, (4) research and development, (5) competitive forces, and (6) manpower. Each factor is obtained from summarising the questionnaires and weighted during the discussion in the meeting. Based on IFE matrix as seen in, it represents the most important strengths which are R&D and modern and advanced machinery, while pool liquidity and lack of production experts are the weakness.

Table 2-5 IFE matrix for Hamadan GlassCo.

Internal Factors	Weight	Rating	Score
<b>Strengths:</b>			
Research and development unit	0.2	4	0.8
Experienced managers	0.05	4	0.2
Modern, up-to-date and advanced machinery in the plant's Unit 1	0.15	4	0.6
The plant's large area of land (40 acres)	0.05	2	0.1
Enjoyment from the silica mine in the city of Abhar	0.05	3	0.15
<b>Weaknesses:</b>			
Problem of liquidity (lack of sufficient working capital)	0.15	3	0.45
Lack of production experts who are at the level of experts in the European and advanced countries	0.15	2	0.3
Old and surplus manpower	0.1	2	0.2
Old support equipment and facilities	0.05	1	0.05
Impossibility for the full settlement of maturity debt of the received facilities from the banking system	0.05	2	0.1
<b>Total</b>	<b>1</b>	<b>-</b>	<b>2.95</b>

## 2.9 Cost Management for Construction Project

Earned Value Method (EVM) is a well-known approach used to conduct project cost management. This is because it is not only managing project cost, but it also help a construction company to guarantee profit of the project (XU, 2009).



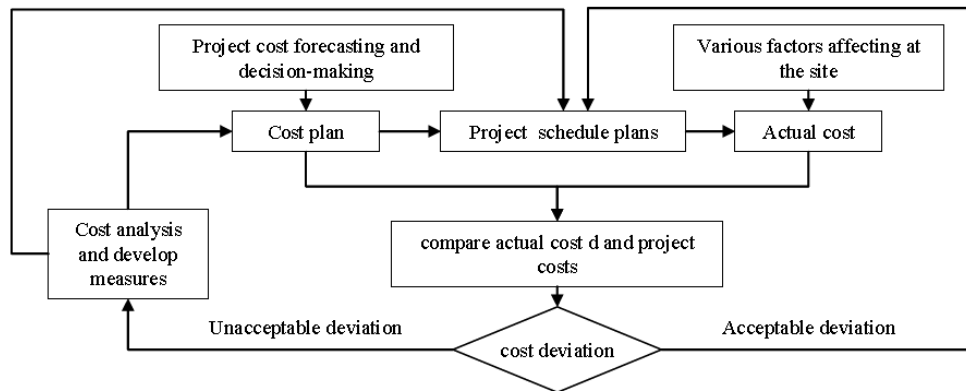


Figure 2-2 The process of construction project cost management (Bing,2009)



## CHAPTER 3

### COMPANY BACKGROUND AND PROBLEM ANALYSIS

#### 3.1 Company Background

Company A is one of the leading construction industries who operate majority in the north of Thailand. Company is small size organisation which consists of employees as following. Company A is run the business into 3 majority areas which consist of road, water and building. Currently, company A has various equipment and machines using for construction project shown in

Table 3-1 Employee in organisation

No.	Position	Quantity
1	Administration	12
2	Consultance	3
3	Accountance	2
4	Purchasing	2
5	General staff	3
6	Architect	2
7	Lawyer	1
8	Project secretary	3
9	Foreman	15
10	Project engineer	4
11	Carpenter	20
12	Bricklayer and Plasterer	15
13	Smith	15
14	Plumber	2
15	Electrician	3
16	Messenger	4
17	Labour	150

Table 3-2 Current equipment and machines

No.	Equipment and Machines	Brand	Quantity
1	Large excavators	Komatsu PC200	5
2	Medium excavators	Kobeko	2
3	Small excavators	Caterpillar	3
4	Large truck	HINO	2
5	Medium truck	ISUZU	2
6	Small truck	FORD	1
7	Small truck	TOYOTA	2
8	Fuel truck	-	1
9	Scaffolding	-	500
10	Sheet pile	-	125 m <sup>2</sup>
11	Concrete mixer	-	4
12	Concrete vibrating machine	-	2
13	Electrical Welding	-	3
14	Pumps and pipes	-	3
15	Level-measuring instrument	NIKON	2
16	Branche	-	200
17	U-head	-	130
18	Joint	-	150

No.	Equipment and Machines	Brand	Quantity
19	Base leveling	-	520
20	Pipe clamping	-	500
21	Ladder	-	10
22	Square lashing	-	150
23	Plastic plan construct	-	120
24	Metal plan construct	-	100
25	Reinforced Concrete Pavement	-	200
26	Tempolary office	-	7
27	Tempolary toilet	-	7
28	Pickup truck	-	8

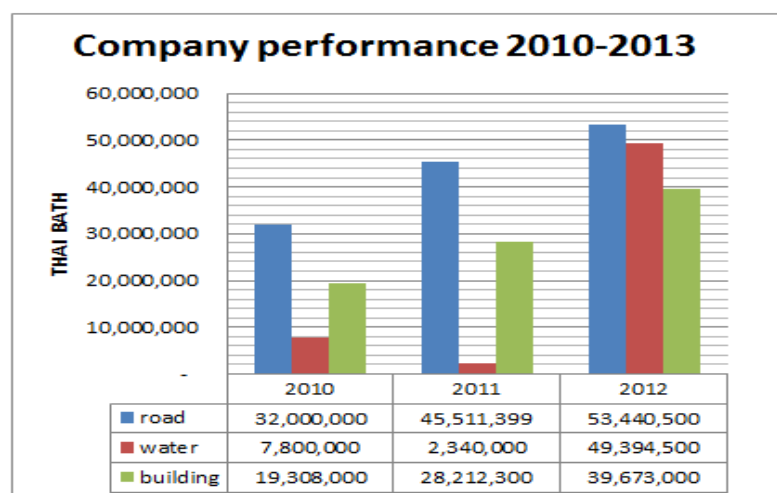


Figure 3-1 Company A performance during 2010-2012

From bar chart above has showed company A service during 2010 to 2012. As mention there are 3 areas of company A services which are road, water and building. The result of company performance shows the majority income of the company gain from road and water. By the end of 2012, company A realised about the growth in building business in last 3 consecutive years. Moreover this performance represent that the income of majority business which mean road and water were fluctuated. Thus, company A realised to emphasised into building business which gain more margin to the company.

Table 3-3 List of Company A building project during 2010-2012

Year	Name of project	Budget (Bath)	Contact length (Days)	Operation length (Days)	Delay (Days)	Cost of penalty (Bath)	Penalty/Budget (%)
2006	Sport complex center	18,670,000	720	704	0	0	0
		<b>18,670,000</b>				0	0
2007	School of municipal building Tessaban 1	8,292,000	420	404	0	0	0
		<b>8,292,000</b>				0	0
2010	Phuttamonthon celabating 750 years	6,959,000	240	333	93	647,187	9.30%
2010	Phuttamonthon celabating 750 years phase 2	7,982,300	197	205	8	63,858	0.80%
2010	School of municipal building Tessaban 8	12,349,000	240	311	71	876,779	7.10%
		<b>27,290,300</b>				<b>1,587,824</b>	<b>5.82%</b>
2011	School of Vocational building	15,350,000	420	440	20	307,000	2.00%
2011	Overpass	4,880,000	150	190	40	195,200	4.00%
		<b>67,851,600</b>				<b>3,030,662</b>	<b>4.47%</b>
2012	Tourist center	29,760,000	420	450	30	892,800	3.00%
2012	Child care center	5,704,000	180	198	18	102,672	1.80%
2012	Health care center	3,990,000	120	140	20	256,765	6.44%
		<b>39,454,000</b>				<b>1,252,237</b>	<b>3.17%</b>
	<b>Total Budget (Y2006-Y2012)</b>	<b>161,557,900</b>				<b>5,870,723</b>	<b>3.63%</b>

From Table above Company A start to review performance of building project since company A entering into building business respectively,

Year 2006	Sport complex centre no delay
Year 2007	School of municipal building Tessaban 1 no delay
Year 2010	Phuttamonthon celebrating 750 years delay 93 days Phuttamonthon celebrating 750 years phase 2 delay 8 days School of municipal building Tessaban 8 delay 71 days
Year 2011	School of Vocational building delay 20 days Overpass delay 40 days
Year 2012	Tourist centre delay 30 days Child care centre delay 18 days Health care centre delay 20 days

Since review company performance about building in last 2 years (year 2010-2012), the majority problems that company A faced was delay problem. A delay problem effect directly to penalty cost which significant influence to decreasing profit margin.

As a result of investigation of company A performance in building business still got important problem were pressure to find appropriate solution with proper time in order to expand business in this area.

### 3.2 Problem Analysis

In order to analyse root cause of serious problem, the systematic and required. Also, tools that represent cause and effect of problem are significant tool. In this situation, the proper tools that help to clarify root cause of the problem are Fishbone Diagrams, Pareto Chart, Fault tree diagram, , Histogram and FMEA. To solve this problem company A formulates a team by selecting team member base on variety of skills and background knowledge. As a result of team brain storming, the problems are lists and investigated respectively.

### 3.2.1 Fishbone diagram

For systematically analysis Fish bone diagram is applied to investigate root cause of problem as shown in figure below

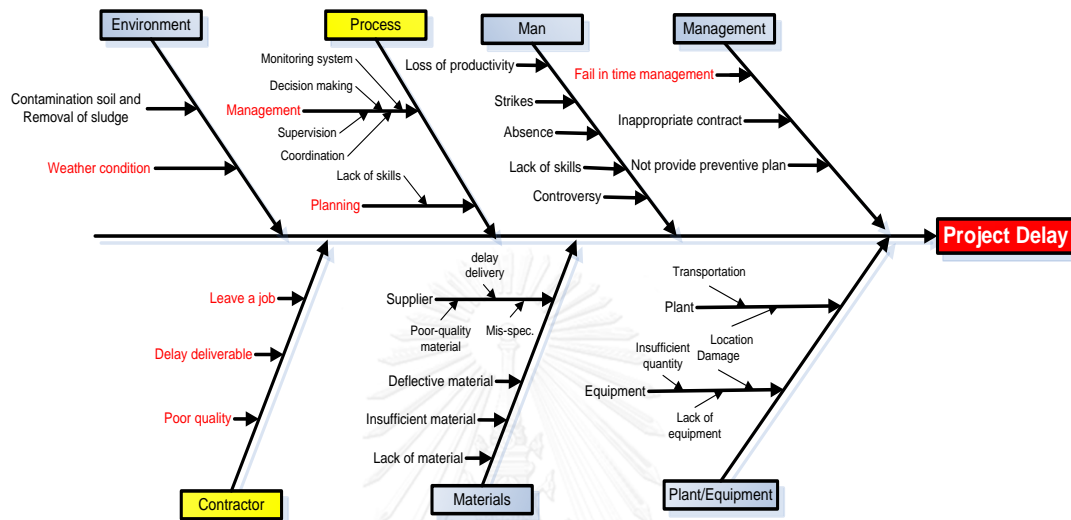


Figure 3-2 Fish bond diagram

According to Fish bond diagram, its can conclude the regular problem occurring into 6 categories consists of environment, process, people, contractor, materials and plant/equipment.

#### 1. Environment

Due to the fluctuation of weather in couple year in the North of Thailand especially unpredictable raining effect directly to civil work such as earthwork, foundation, structure, concrete etc. Also, slightly affect to the transportation which impact to delay of the project.

#### 2. Process

There are many errors occurring in process; due to non-experience in this area of business thus company A cannot provide perfect management and also failure in planning process.

### 3. Man

Due to company A not familiar with building business, there are a lot of requirements skill of human resource; it make company A lack of productivity, loss of bargaining power, and controversy.

### 4. Sub-Contractor

Due to company A lack of skills in building business, the sub-contractor is the best solution for the project. As result of disadvantage of hiring sub-contractor, company A lose control power. Existing problem which company A has affected such as sub-contractor leaves a job, delay deliverable and poor quality etc.

### 5. Materials

Delay problem is also cause from materials, which consists of supplier, defective materials, insufficient materials and/or lack of materials.

### 6. Plant/Equipment

The last factor that relevant to delay problem is plant/equipment. Plant/equipment effects to delay problem in term of plant location and/or transportation and insufficient/damage/lack of equipment.

### 7. Management

Owing to limitation for lead-time in initial phase, poor time management is occurred. As time limitation and improper plan, the project completion not following schedule also not achieves standards. In addition, does not include the uncontrolled variables.

From fish bone diagram indicated relevant possible cause of delay problem. In order to know the majority cause of delay problem, Pareto chart is considerable tools applied to identify the most cause of delay.



### 3.2.1 Pareto chart

Due to review of company A performance, company A start to analysed building project indicated cause of delay as information in table below is studied for plotting pareto chart.

Table 3-4 Company A delay information

Phuttamonthon celabating 750 years						
Cause of delay	Categories	Scheduling	Time-consuming	%delay	Impact	Priority mark
Schedule planning	Company's employee lack of skill	10	30	200%	0.25	0.50
Sculptor sub-contractor	inefficient sub-contractors	60	115	92%	0.30	0.28
Unique material transportation	inefficient suppliers	14	30	114%	0.15	0.17
Tiler sub-contractor	inefficient sub-contractors	60	78	30%	0.05	0.02
Defected works	Company's employee lack of skill	7	15	114%	0.15	0.17
Electrical sub-contractor	inefficient sub-contractors	45	66	47%	0.05	0.02
Others					0.05	0.05

School of municipal building Tessaban 8						
Cause of delay	Categories	Scheduling	Time-consuming	%delay	Impact	Priority mark
Schedule planning	Company's employee lack of skill	10	15	50%	0.25	0.13
Purchase of school equipment	Company's employee lack of skill	20	45	125%	0.25	0.31
Mansory sub-contractor	inefficient sub-contractors	60	77	28%	0.15	0.04
Tiler sub-contractor	inefficient sub-contractors	60	70	17%	0.15	0.03
Defected works	Company's employee lack of skill	7	12	71%	0.05	0.04
Soil level adjustment sub contractor	inefficient sub-contractors	15	24	60%	0.05	0.03
Roof subcontractor	inefficient sub-contractors	60	65	8%	0.05	0.004
Others					0.05	0.05

Phuttamonthon celabating 750 years phas						
Cause of delay	Categories	Scheduling	Time-consuming	%delay	Impact	Priority mark
Schedule planning	Company's employee lack of skill	10	12	20%	0.15	0.03
Sculptor sub-contractor	inefficient sub-contractors	20	65	225%	0.25	0.56
Mansory sub-contractor	inefficient sub-contractors	60	80	33%	0.15	0.05
Material transportation	inefficient suppliers	60	70	17%	0.20	0.03
Defected works	Company's employee lack of skill	7	12	71%	0.05	0.04
Landscape sub-contractor	inefficient sub-contractors	15	24	60%	0.10	0.06
Roof subcontractor	inefficient sub-contractors	60	65	8%	0.05	0.004
Others					0.05	0.05

Tourist center						
Cause of delay	Categories	Scheduling	Time-consuming	%delay	Impact	Priority mark
Schedule planning	Company's employee lack of skill	10	20	100%	0.10	0.10
Roof production	inefficient suppliers	20	70	250%	0.20	0.50
Electrical sub-contractor	inefficient sub-contractors	30	45	50%	0.15	0.08
Material transportation	inefficient suppliers	20	25	25%	0.05	0.01
Air-conditioning sub-contractor	inefficient sub-contractors	20	35	75%	0.10	0.08
Landscape sub-contractor	inefficient sub-contractors	30	45	50%	0.10	0.05
Sanitary transportation	inefficient suppliers	14	30	114%	0.15	0.171
Equipment ordering	Company's employee lack of skill	20	28	40%	0.05	0.02
Defected works	Company's employee lack of skill	10	20	100%	0.05	0.05
Others					0.05	0.05

Child care center						
Cause of delay	Categories	Scheduling	Time-consuming	%delay	Impact	Priority mark
Schedule planning	Company's employee lack of skill	10	15	50%	0.10	0.05
Soil level adjustment sub contractor	inefficient sub-contractors	30	40	33%	0.15	0.05
Mansory sub-contractor	inefficient sub-contractors	45	55	22%	0.20	0.04
Sanitary sub-contractor	inefficient sub-contractors	30	60	100%	0.30	0.30
Defected works	Company's employee lack of skill	7	20	186%	0.10	0.19
Coloring sub-contractor	inefficient sub-contractors	20	37	85%	0.05	0.04
Door and window installation	Company's employee lack of skill	15	25	67%	0.05	0.033
Others					0.05	0.05

After investigating information of Company A delay problem, Pareto Chart is to be used to make a decision for causes of problem to be corrected and prevented.

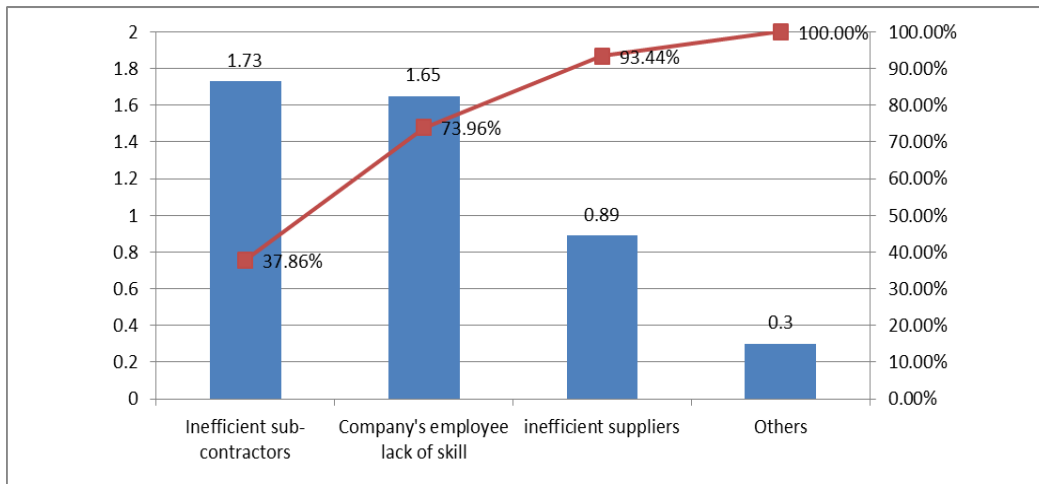


Figure 3-3 Pareto Chart

Due to the Pareto Chart is used to represent the prioritising possible causes of the problem. The graph shows the percentage of delay versus cause of problem. The majority causes of delay occur from inefficient sub-contractor, company's employee lack of skills, inefficient suppliers and others. As a result, inefficient sub-contractors be the most important issue that need to be solve.

### 3.2.2 Fault tree diagram

To get more correctly information, fault tree diagram is used to analyse the cause and effects relationship of the delay problem as shown below.

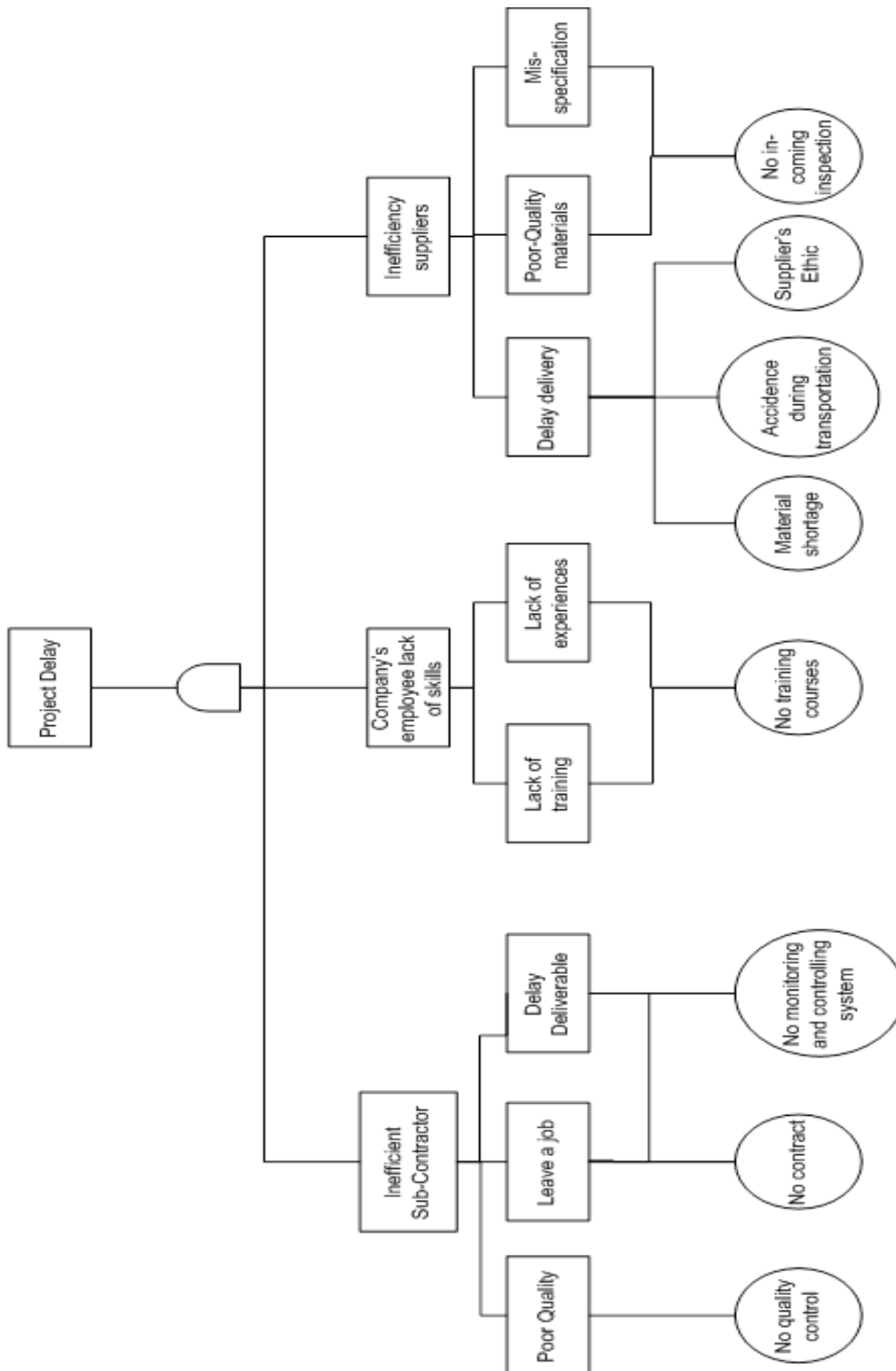


Figure 3-4 Fault tree diagram

Due to Project delay; fault tree diagram represent the 3 sub-problem of the delay problem consists of (i) inefficiency sub-contractor, (ii) company's employee lack of skills and (iii) inefficiency suppliers. Root causes of each sub-problem can be described as below;

1. Inefficiency sub-contractors can occur from 3 factor

- 1.1 Poor quality

Due to company A hire sub-contractor to take care of their project, company A cannot control lead time and quality of project. For example, cement cracking, cement tile, cement basement cracked etc.

- 1.2 Leave a job

During the progress of the project, company A faced problem of contractor leave their job. The causes of this problem are company A not watch contractor closely. Also, we not get any proper contract between company A and contractor.

- 1.3 Delay delivery

Company A is new comer to this business. Also, lack of good planning. During project, we face problem of delay delivery not only material but also leak time of process such as masonry, ceiling, painting etc. Company A not expects delay of all process delivery.

2. Company's employee's lack of skills can occur from 2 factors

- 2.1 Lack of training

- 2.2 Lack of experiences

Both of 2 factors occurs from company's A lack of training courses, company A not consider about training courses because training courses

3. Inefficiency supplier can occur from 3 factors

- 3.1 Delay delivery

There are many factors that influence productivity in the construction industry. Some factors that create variations in production rates for certain activities are extremely difficult to control. There are other factors, however, that can be fairly easily identified and modified and can lead to significant improvements in production rates for activities. The significant factor is delay delivery of materials such as concrete, machinery etc. Delay delivery effect directly to delay of project. Especially, critical activities will effect directly proportional to project delay. Delay delivery can occur from materials shortage, accident that happen during the transportation and suppliers ethic.

### 3.2 Poor quality materials

Poor quality materials such as poor quality stones, low quality iron rods, cement and sand are used in construction of substandard buildings. Furthermore, there is no proper quality assurance mechanism for checking materials. The use of outdated engineering materials and lack of certification standards on materials led to the construction of substandard buildings.

### 3.3 Misspecification

Due to inexperience of construction, company A lack of standard of specification. Standard of specification consider method estimating parameters which allow for effect delay of the project. To achieve the standard, the specification is needed.

As a result of problem analysis, to achieve high effectiveness and efficiency solution, the thoroughly study nature of work is required.

### 3.3 Nature of work

#### 3.3.1 *Civil Work*

#### 3.3.2 *Finishing work*

##### 1. *Roof*

There are wide variety of roof work such as metal sheet, roman tile, hip ridge Roman tile, asbestos cement roofing sheet, asbestos shingle, cement tile, C-pack etc.

- Metal sheet; this task can outsourcing by concerning about price and quality.
- Roman tile, hip ridge Roman tile, asbestos cement, C-pack; these tasks can do in sourcing because simply installation and not need skilled workers.

## 2. *Ceiling*

This task is not complicated. The majority part is material, effect directly to price. Almost 100% of this task, concern in materials price. The rest of materials are useless. Contractors decided to lump sum this entire task. Also, this task concern price and quality, respectively.

## 3. *Partition*

- Aluminum  
This task requires specific skill. And quality of aluminum task control by manpower's skill.
- Plastering and Masonry wall  
This task is difficult and complicated. Due to, plastering and masonry wall related to other tasks and plenty of processes, the quality of this task effect directly to other tasks, so the quality control is needed.

## 4. *Floor*

This task requites time and manpower's skills. Normally, timing varies to numbers of workers. No need to add more manpower's to finish task.

## 5. *Piping*

This task starts since the initial phase till last phase of every project. This task performs while another activity performs. This task divided in many

sequence. Each sequence can perform when the earlier task complete and cannot complete entire task in one time.

6. *Painting*

This task is similarly to plaster task, generally, in sourcing. This task is not precise and focusing on time and quality of this task base on materials. In term of specific area that require specific skill manpower.

7. *Electrical work*

This task requires expertise skill. This task can be implemented to achieve requirement. It's also need to deliver on time and within budget.

8. *Air condition work*

Generally, air conditioner have average price in the market. In rarely case, supplier can purpose lower market price.

9. *Sanitary work*

Quality of materials is key point of this task.

10. *Miscellaneous work*

Miscellaneous work may be different in each project.

## CHAPTER 4

### BUILDING CONSTRUCTION PROCEDURE AND IMPLEMENTATION

In order to enhance the efficiency of building construction, the actual project is studied and adopted as a case study. Based on the previous chapter, the root causes of problem were identified; in this chapter the action plan is going to be developed as a standard procedure for using in building construction project of company A, and will be implemented with the actual building construction project, respectively.

#### **Building Construction Procedure**

In order to compute procedure will consider project after company A bided project, the first process is apply the project to procedure flow. Procedure flow consists of 4 phases which are initial phase, preparation, implementation, and deliverable period, respectively. Also, each phase consist of sub-processes which describe later.

In tem of outsource decision included in preparation phase. Outsource decision consists of 2 main points which are,

1. Outsourcing Decision (In-Source or Out-Source)
2. Vendor Selection

Description of entire elements in the procedure which use to be guideline for construction project as below;

The construction procedure is going to be divided into 4 periods, which are:

#### **4.1 Initial period**

##### **1. *Drafting***

The worker who takes care of this sub-process, this sub-process is required expertise skills and experiences. Normally, project engineer should have a lot experience in this field. Project engineer have to



declare all materials, size, type and the material selection criteria that fit to budget. As a result, company A get entire lists of require materials.

## 2. *Materials price comparison*

As a result from drafting process, price checking is the following step. Generally, company will check price and compare material's price. Company will check highest price to lowest price respectively. Also, check materials' price from several suppliers.

## 3. *Team Building*

To achieve the most effectiveness and efficiency results, the effective resource management is required. Thus, team building is an effort in which a team studies its own process of working together and acts to create a climate that encourages and values the contributions of team members. Company will classify proper manpower to each project which consists of

- Project Manager
- Project Engineer
- Purchasing
- Foreman
- Checker
- Worker

## 4.2 Preparation period

### 1. *Work Breakdown Structure*

Work Breakdown Structure is a hierarchical and incremental decomposition of the project into phases, deliverable and work packages. Also, step of works are representing which cover in detail of activity, priority and relationship between the activities.

2. Risk Analysis

During project operation process, some activity may effect to the successfulness of project. So, risk analysis is necessary to process in each project. This may effect to the successfulness of the project. Thus, risk analysis must include. Also, risk management is necessary too. Company A selected Failure Mode and Effect Analysis Method which consider from

- 1) Failure
- 2) Failure Mode
- 3) Effect
- 4) Causes of Failure
- 5) Current Process Control

All analysis data are recorded in the FMEA then score as shown in tables below

Table 4-1 FMEA format

Processes or Activities	Potential Failure Mode	Potential Effects of Failure	SEV	Potential Causes of Failure	OCC	Current Process Control		DET	RPN
						Preventive Action	Detection		

Table 4-2 FMEA score

Ranking	SEVERITY	OCCURRENCE	DETECTION	
	Severity of Effect	Likelihood of Occurrence	Ability to Detect	Remark
10	Impact on life (Hazardous without warning)	Very High; Failure is almost inevitable	Can not detect	-
9	Impact on life (Hazardous with warning)	Very High; Repeated failures	Very remote	-
8	Very High	High;Frequent Failure	Remote	Final Check
7	High		Very Low	
6	Moderate	Moderate;Occasional Failure	Low	Next process
5	Low		Moderate	
4	Very low		Moderately High	
3	Minor	Low;Relatively Few Failure	High	In process
2	Very minor		Very High	
1	None	Remote;Failure is unlikely	Almost certain	By Design

In process of risk assessment, the project expertise is needed, which cover in management and operation team such as Project manager, Project Engineer, Foreman, and Procurement officers. Team will set meeting for analysis risk which may cause effect to the project. After risk analysis, teams will priorities risks and find best solution.

### **3. Activity Sequencing**

In term of activity sequences represent the relationship between each activity and also time consume of them. The results of risk analysis are considered. If the activity has high risk and effect to project delay, the proper time for that activity is very important. Also, another tools that consider is Gantt Chart

### **4. Out and In Sourcing**

In order to make the decision for making or buying in a small building construction project, it is considered into two terms which are;

- Outsourcing and In-Sourcing decision
- Outsource selection or Vendor selection

#### **1) Criteria for Outsourcing and In-Sourcing decision**

The majority factors of Outsourcing and In-Sourcing decision as below;

- Characteristic of work

This factor will separate characteristic of work by using Quality, Cost and Delivery as criteria. For an example below;

Case 1; This activity use delivery as critical activity which is significant of process because the result will have relation to other activities and also effect to other activity as well.

➤ Competency of employee

Employee competencies are those traits, skills or attributes that employees need to perform their jobs most effectively. Clearly, these competencies will vary by job and position, but there are some commonalities that apply to just about any job in just about any organisation. Companies can hire employees with basic foundational competencies and then teach more specific competencies directly related to the employees' job descriptions. In this factor, company A will consider the employee's skills and the availability of employees.

➤ Required material and Equipment

It is concerned with planning, organising and controlling the flow of materials from their initial purchase through internal operations to the service point through distribution. Material management is a scientific technique, concerned with Planning, Organising and Control of flow of materials, from their initial purchase to destination. An objective of material management is to get;

- 1) The Right quality
- 2) Right quantity of supplies
- 3) At the Right time
- 4) At the Right place
- 5) For the Right cost

➤ Cost

Cost management is the process of planning and controlling the budget of a business. Cost management is a form of management accounting that allows a business to predict impending expenditures to help reduce the chance of going over budget. If company A achieve result of insource is more hire out source. Thus, company A will make decision to outsource.

### ➤ Risks in different terms

Non-systematic risk, in contrast to systematic risk, affects a much smaller number of companies or investments and is associated with investing in a particular product, company, or industry sector. In-source Outsource factors

### ➤ Work Area Weighting

Based on the literature review, weighting score has been widely adopted, but it has the limitation under different situation. As mention in Chapter 3, characteristic and nature of activities that occurring in small building construction project. Partially of each activities are the same, while partially of each activities are different. If consider by using QCD theory, company A found that there are wide variety of work area specification. For an example, the critical path of civil work is delivery. Due to the nature of work and this area are considering as critical activity. If civil works not finish in time, it will effect directly to entirely project. For more understanding, if compare between civil work and piping; civil work is critical activity (schedule is fix and effect to almost every activities) but piping is not critical activity (work schedule more flexible and not effect to other activity). In contrast, piping work must focus in term of quality. Because if piping work is not achieve quality. During construction, problem from piping may effect to other activities such as water ooze out and effect to tiling.

From the differentiation of entire activities, company A brainstorm related employees such as MD, project manager, consultant, project engineer and foreman by review previous projects and apply QCD to be criteria.

Based on the concept of QCD and characteristic of work area of small building construction project, it can be converted the qualitative data into the quantitative one as in table below;

Table 4-3 An example of work area weighting

Work area	Quality	Cost	Delivery
Civil Work	25	25	50
Roof			
- Metal sheet	40	40	20
- C-Pack, Cement	20	20	60
Ceiling	30	10	60
Partition			
- Aluminum	20	20	60
- Plastering and Masonry wall	40	20	40
Floor	40	20	40
Piping	60	20	20
Painting			
- Internal	40	20	40
- External	20	20	60
Electrical work	60	20	20
Air condition work	10	80	10
Sanitary work	10	80	10
Miscellaneous work	Depend		

An example of the weighed characteristic of each work area demonstrated in table above, it can be summarised that, first of all, delivery factor is more important for civil work, Roof (C-Pack and Cement), Partition (Aluminum), and Painting (External). Actually, delivery factor has more impact on critical activities, because critical activity is a task that must start and finish in time in order to ensure that it will be not affect to the next task and the project will be completed on schedule. Secondary, air condition and sanitary work is given more attention on cost. This is because those works are a part of finishing work that is independent and most of cost is material expenses. Thus, providing the lowest material cost will lead more advantage for the company. On the

other hand, quality is the most important in piping and electrical work. This is because if both works are conducted without quality, it is able to bring severe impact on other works and lead to the higher cost for repair or correction and late delivery, respectively. However, it is noticed that, quality and cost of most work areas are given in a same weight since quality and cost are normally a coherent factor; cost of work which has high quality is usually more expensive. In addition, An example of work area weighting illustrate only the major works and activities which tend to take place in a small building construction project, however, there might be different in individual project as well as miscellaneous works which is needed to consider in case by case depending on the characteristic of that task.

#### The process of obtaining the score of work area weighting

In order to establish the effective score of each work area in term of quality, cost, and delivery, it is needed to do as following process at the beginning of the project. The step of this work includes;

- 1) **Setting kick off meeting with project owner** – It aims to get the requirement from the owner
- 2) **Setting internal meeting with concern members** (consists of project managers, project consultant, project engineer, and foreman) – After work breakdown was completed, it is needed to set the internal meeting. This is to distribute project requirement to concern member, so that all members are able to identify an appropriated score of each activity together

#### 2) *Making decision for outsource or in-source*

Deciding when to insource and when to outsource requires a comprehensive knowledge of the supplier market and an understanding of the advantages and disadvantages of each approach. Outsource process flow is applied for making decision which is shown figure 4-1 .

- In-Sourcing

Majority are construction because company A got plenty of employees and the availability

- Out-Sourcing

Tasks this quadrant are important for successful operational performance, but are not strategically important. These tasks could safely be outsourced. They're simply not worth spending in-house time managing. For example, the auto manufacturer in the example above could outsource its delivery logistics to a specialist company. How you deliver cars to dealers is generally not a source of competitive advantage, as it doesn't touch the customer's experience, but how well it's done has a huge impact on operational performance. If transporters are late, stock builds up at the manufacturing plant, and dealers don't have the vehicles they need in their show rooms for customers to test drive.

- Full Outsourcing

Outsourcing is an effective cost-saving strategy when used properly. It is sometimes more affordable to purchase a good from companies with comparative advantages than it is to produce the good internally. An example of a manufacturing company outsourcing would be Dell buying some of its computer components from another manufacturer in order to save on production costs. Alternatively, businesses may decide to outsource book-keeping duties to independent accounting firms, as it may be cheaper than retaining an in-house accountant. Selective-Outsourcing

- Selective Outsourcing

Selective outsourcing involves outsourcing only part of an activity and performing the rest of the activity in-house. Selective outsourcing is generally more successful than total outsourcing for two main reasons.



First, companies that outsource an entire activity tend to be constrained in their ability to control the supplier. This means that companies that outsource an entire activity no longer have a sufficient level of expertise in-house to control or manage their supplier.

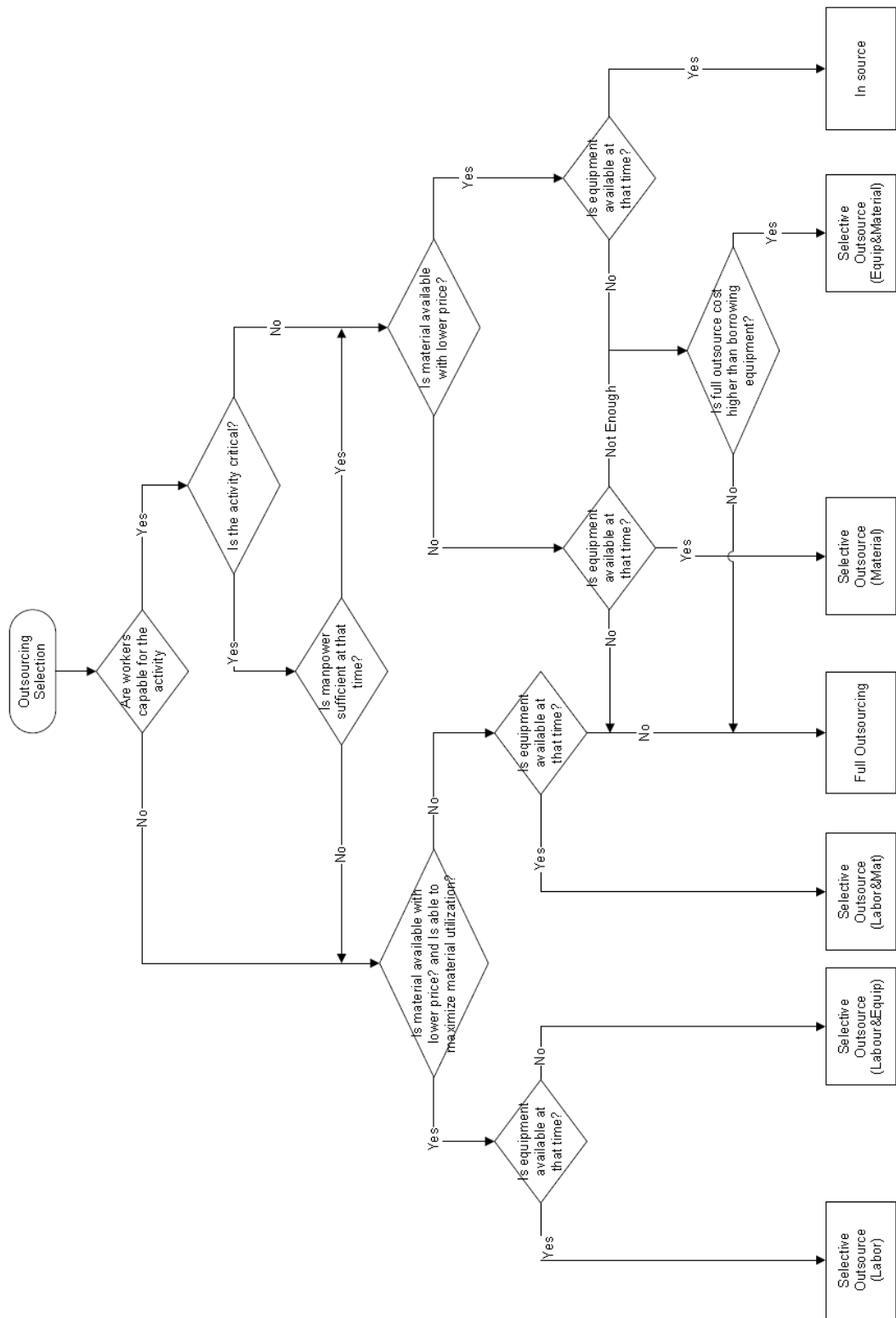
Second, when companies perform a part of the activity in-house, they have access to the operational knowledge and information required to design effective reporting systems. Hence, it is far more difficult for the supplier to behave opportunistically.

According to Process flow will lead to solution as below;

- 1) In-Source
- 2) Full Outsource
- 3) Labour outsource
- 4) Labour and Equipment outsource
- 5) Labour and Material outsource
- 6) Material outsource
- 7) Material and Equipment outsource



Figure 4-1 Outsource process flow



### 3) *Making decision for outsource selection*

After passed process flow which using for in-source or full-outsource or selective outsource. If company A decided to in-source that means entire workers, equipment and machines are asset of company A. In the other hand, materials will purchase from existing supplier that company A already got contract. In case of full-outsource and/or selective outsource, after company A selected to full-outsource and/or selective outsource then company A will consider outsources (vendors lists).

Before outsource (vendor) selections, company A have to prepare data to do comparison between each vendors. Partially data is existing data that company A sort-out. The rest data will prepare by outsources (vendors). There are 2 types of data as below;

#### *Bidding*

In this process outsources (vendors) achieve project description and agreements. Outsources (vendors) will purpose proposal which consists of

- price
- time
- instalment payment

Since company A got all outsource data, employees that take care that project will evaluate and select the proper outsource (vendors). Then company A and outsource (vendors) sign contract.

- Project Warranty: company A set vendor to warranty 5% of total project cost. Then company A will return warranty after project finished.
- Penalty: if company A got problem and/or vendors cannot submit activity on time. Company A will charge with penalty rate 0.1% from total project cost or following project owner rate.

### ***Setting the Standard price***

In case of company A set standard price and purpose to contractors, this method use for existing contractor or contractor who take care this project.

After all contractors submit proposal, company A will review and selected contractor. Company A will select contractor by using weight techniques. The weighting criteria consist of quality, cost and delivery. Each activity will concern in different weight of QCD which describe in previous topic ... Next step is representing weighting QCD to every activities. Each activity will concern in different area, for example if activity focus on quality of workers. Company A will use skill of workers, certification for proving workmanship, and the historical data as selection criteria etc. For this reason, QCD factor must use to be selection criteria. For an example, civil work weight in term of delivery 50%. In delivery factor consists of criteria and summation equal to 50%. After weighting each criteria, the comparison between each contractors. Company A set score for each contractors in 3 level which are 3=Good, 2=Fair, and 1=Poor. Then calculate by multiply rating with weighting criteria. The summation of result will represent the best contractor of the project.

There are 3 session of outsource selections

#### ***4) Full outsource and Labour outsource***

QCD Criteria as below;

- Quality
  - a. Skill labours; based on collective data or historical data
  - b. Minimum requirement (with certification); at least, outsource must meet the minimum requirement. Certification can guarantee vendor' s expertise
  - c. A number of defects (%); based on historical data
- Cost
  - a. Proposing minimum price

- b. Minimum requirements
- c. Flexibility in payment terms and conditions
- Delivery
  - a. Installation payment
  - b. Minimum requirements
  - c. A number of job leaving

Table 4-4 An example of outsource selection table (Full outsource and Labour outsource)

Activity >>>		Outsource selection (Labor&Full)												
QCD	QCD Weight	Criteria for selection	Weight	Rating					Weighted Score					
				Familiar vendor		Unfamiliar vendor			Familiar vendor		Unfamiliar vendor			
				Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	
Q		Skill labors												
		Minimum requirements (with certification)						0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A number of defects						0.00	0.00	0.00	0.00	0.00	0.00	0.00
C		Proposing minimum price (Quotation)						0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Minimum requirements (with certification)						0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Flexibility in payment terms and conditions						0.00	0.00	0.00	0.00	0.00	0.00	0.00
D		Installation payment						0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Minimum requirements (with certification)						0.00	0.00	0.00	0.00	0.00	0.00	0.00
		A number of job leaving						0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>			<b>0.00</b>							<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
Rating: 3 = Good, 2 = Fair, 1 = Poor,										<b>The best vendor is</b>				

##### 5) Material outsource

Criteria of QCD is defined as;

- Quality
  - a. Achieve specification
  - b. A number of defects (%); based on historical data
  - c. Maximum capacity
- Cost
  - a. Minimum total price (Inc. freight)
  - b. Terms of Payment
- Delivery
  - a. Availability
  - b. On time delivery
  - c. Delivery duration

Table 4-5 An example of outsource selection table (Material outsource)

Activity >>>>		Outsource selection (Material)												
QCD	QCD Weight	Criteria for selection	Weight	Rating					Weighted Score					
				Familiar vendor		Unfamiliar vendor			Familiar vendor		Unfamiliar vendor			
				Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	
Q		Achieve specification						0.00	0.00	0.00	0.00	0.00	0.00	
		A number of defect (%)						0.00	0.00	0.00	0.00	0.00	0.00	
		Maximum capacity						0.00	0.00	0.00	0.00	0.00	0.00	
C		Minimum total price (Inc. freight)						0.00	0.00	0.00	0.00	0.00	0.00	
		Terms of Payment						0.00	0.00	0.00	0.00	0.00	0.00	
D		Availability						0.00	0.00	0.00	0.00	0.00	0.00	
		On time delivery						0.00	0.00	0.00	0.00	0.00	0.00	
		Delivery duration						0.00	0.00	0.00	0.00	0.00	0.00	
<b>Total</b>			<b>0.00</b>					<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	
Rating: 3 = Good, 2 = Fair, 1 = Poor,								<b>The best vendor is</b>		Vendor1				

### 6) Equipment and Machine

Criteria of QCD is defined as; Quality

- d. Efficiency and Effectiveness
- e. Readiness
- Cost
  - a. Rental price (Inc. freight)
- Delivery
  - a. Availability
  - b. On time delivery

Table 4-6 An example of outsource selection table (Equipment and Machine sourcing)

Activity >>>>		Outsource selection (Equipment and Machine)												
QCD	QCD Weight	Criteria for selection	Weight	Rating					Weighted Score					
				Familiar vendor		Unfamiliar vendor			Familiar vendor		Unfamiliar vendor			
				Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	
Q		Efficiency and Effectiveness						0.00	0.00	0.00	0.00	0.00	0.00	
		Readiness						0.00	0.00	0.00	0.00	0.00	0.00	
C		Rental price (Inc. freight)						0.00	0.00	0.00	0.00	0.00	0.00	
D		Availability						0.00	0.00	0.00	0.00	0.00	0.00	
		On time service						0.00	0.00	0.00	0.00	0.00	0.00	
<b>Total</b>			<b>0.00</b>					<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	
Rating: 3 = Good, 2 = Fair, 1 = Poor,								<b>The best vendor is</b>		Vendor1				

### 5. Activity Duration Estimation

Project engineer is calculating project timing also include period for each activity as well, which calculate by using detail in activity sequencing.

## 6. Cost Estimation

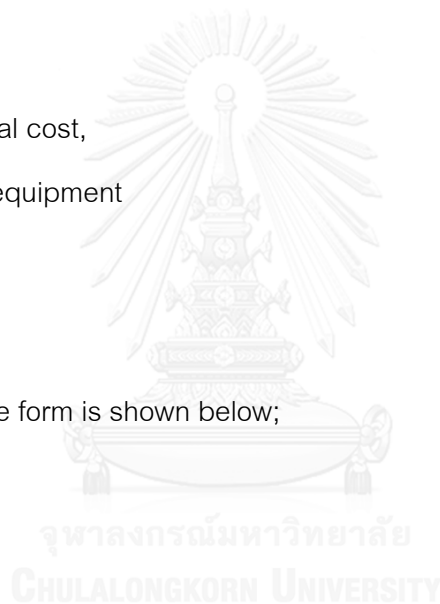
In process of cost estimation in each activity, calculate base on the factors that effect to the project. In addition, using risk management, this included risk assessment, decision-making, buffer etc. The calculation is representing the best solution which is the minimise budget with highest effectiveness and efficiency. The calculation consists of process as below.

### 6.1 Budget Estimation

This process is the process of consideration of activities cost. The process consider list as below;

- material cost,
- plant equipment
- facility
- labour

All cost recorded in the form is shown below;







### 6.2 Cost baseline (S-Curve)

Data from Gantt Chart and the budget calculation in each activity will use as a reference for S-Curve which represent cost VS duration.

### 7. Schedule Development

Schedule development is a process which revise and develop the plan to be more efficiency. The objective is to reduce the project timeline and risk regarding to the duplicate of work.

### 4.3 Implementation period

#### 1. Project Execution

This is a implementation phase following project planning. However, during project has been executing, it is possible that some work may change and affect the schedule of the next process and the whole project as well. Thus, it is necessary to make the schedule up to date in order to be able to rearrange the following job.

#### 2. Schedule Control (Monitor and Control)

Monitor and control is an indispensable process. Nevertheless, having inefficient monitoring and controlling process may affect project progress, cost, and quality. Although, project is effectively planned, there are not suitable project tracking, this could result the failure of project.

In order to improve monitoring and controlling process, PDCA (Plan-Do-Check-Action) concept is adopted which there are 3 factors concerned;

- Project timeline
- Cost
- Quality

In the previous projects, there is no process for monitoring and controlling project. This has an effect to the project, in terms of time, cost, and quality. Based on historical data,

it found that the project defect tend to be found after that activity has been finished. Hence, in order to prevent the problem and reduce the impact of problem, the method for monitoring and controlling project is proposed as following;

- 1) Assigning a checker, who is responsible for monitor and inspection
- 2) Defining a check list (see in **APPENDIX F**)
- 3) Defining the milestone for project tracking which it consists of the progress of tasks completed, the cost, and an important check point representing to quality of work
- 4) Regular reviewing the project plan (in terms of cost and time)

#### The process of monitoring and control

- 1) **Initial period:** project planner distributes the master plan and milestone for checking to an assigned checker
- 2) **Implementation:**
  - An assigned checker is responsible to monitor and follow up the progress of each activity based on milestone defined by project planner
  - An assigned checker regularly report the project manager at least one time a week. In case, it find the problems that cause the project is not follow with milestone, a checker must immediately report to project manager.

#### *3. Project Assessment*

This is a process which used for assess the project before deliver to the customer. It is needed to intensive check.

Moreover, when the project completed, it will be benefit for the project in the future if there are an assessment the result of the current project. It aims to consider the mistake in order to improve an operation of new coming projects.

Finally, the new process can be demonstrated in a form of process flow that shows in figure below;

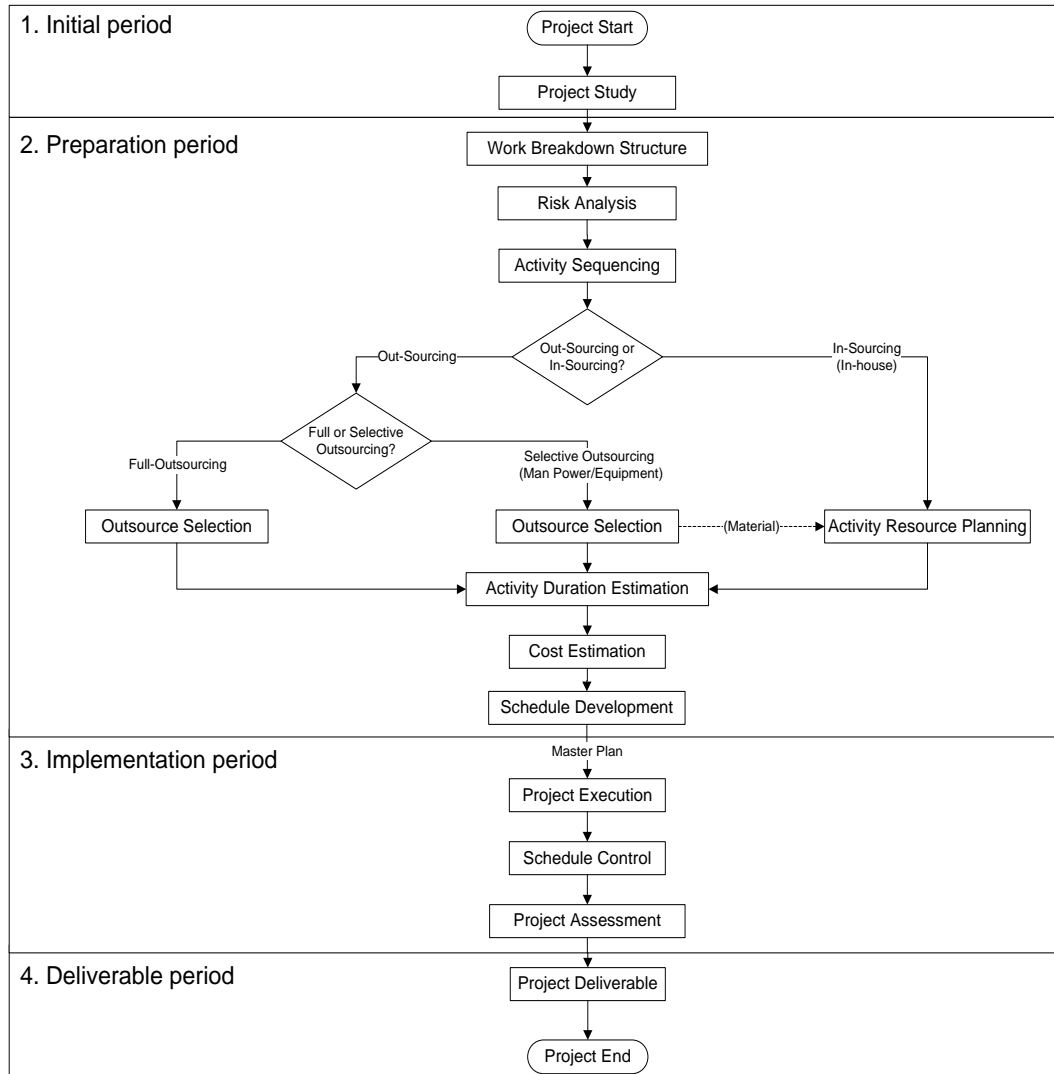


Figure 4-2 A new procedure for a small construction project management

## CHAPTER 5

### IMPLEMENTATION

To verify the effectiveness of the building construction procedure that has been developed, in this case, the previous project will be simulated by adopting this new procedure. Furthermore, a new construction project is going to be applied by using this procedure only in a phase of project planning, this is due to the limitation of time that cause incomplete project proceeding.

#### 5.1 Project simulation

In order to initial verify the effectiveness of outsourcing decision; the previous projects have been simulated. Many projects were gathered the data based on available historical data since 2010. Most of them are the projects which mainly encounter delay problems. The details of selected projects are shown as follows.

##### 1. *Phuttamonthon celebrating 750 years (2010)*

This project took place in 2010. It found that this project delayed over 93 days and got penalty from delay almost 70,000 Baht or over 9% of project cost. The main problem was caused by lacking skills of employees, inefficient sub-contractors, and inefficient suppliers, respectively. The trouble processes are;

- **Earthwork:** regarding to the fluctuation of weather and inefficient planning, this caused earthwork had to postpone and spend long time.
- **Foundation and Structure:** there was another project taking place during this scheme, this had an impact on resource allocation among 2 projects. Furthermore, planning work duration underestimated. This causes the schedule seems too tight while man power is insufficient.
- **Roof and Ceiling work:** there are two obstacles occurring during these tasks; firstly, roof supplier was chosen without considering transportation issue. This is because the familiar supplier is far from the site. At the same time, bad weather and rough road is a significant obstacle for transportation that causes the delay

delivery, eventually. Secondary, labour outsourcing only labour lead to uncontrollable material usage and work progress.

- **Plastering over masonry walls and Wall and floor tile installation:** Selecting unexperienced workers to do this work cause quality problems.
- **Baseboards and skirting board preparation:** Baseboards and skirting board preparation and baseboards installation is interrelated. Thus, it should be better to use the same people on both tasks.
- **Piping:** this work is able to do internally. However, material using and quality control is difficult.
- **Electrical work:** this work is difficult on material estimation and controllable usage. Moreover, after the task was completed, it found that there were many remaining electrical items, especially cable, in the inventory.

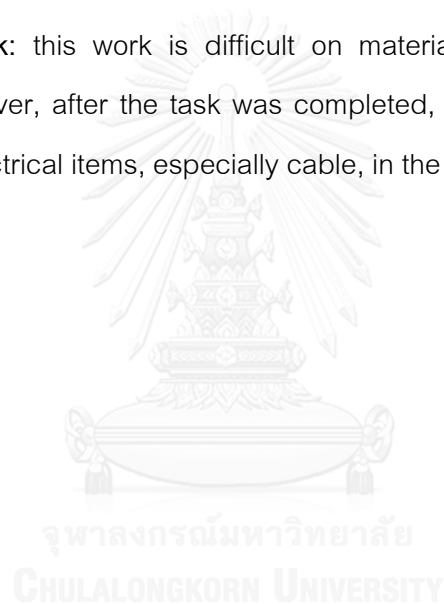


Table 5-1 Activity comparison of Phuttamonthon Celebrating 750 year (2010)

Project Activity	Old process							New process							Remark
	In-Source	Full Outsource	Selective Outsourcing					In-Source	Full Outsource	Selective Outsourcing					
			Labor	Material	Labor & Equipment	Labor & Material	Equipment			Labor	Material	Labor & Equipment	Labor & Material	Equipment	
<b>Phuttamonthon celebrating 750 years (2010)</b>															
<b>Civil work</b>															
Earthwork	✓						✓							Raining, soft soil, delay	
Foundation	✓										✓			Lack of man power	
Structure	✓								✓					Lack of man power	
The concrete masonry work	✓						✓								
Welding steel roof deck	✓						✓								
Road construction	✓						✓								
<b>Finishing work</b>															
<b>Roof and Ceiling work</b>															
Tile roofing installation	✓										✓			Inefficient suppliers due to transportation problem	
Gable eaves installation			✓					✓							
Porch ceiling (indoor and outdoor)			✓					✓						Delay and over material usage	
Porch ceiling/eaves			✓					✓						Delay and over material usage	
<b>Partition and Floor work</b>															
Plastering over Masonry walls		✓						✓						Cracked wall	
Install floor and wall tiles	✓								✓					Defects found after installation	
Railing installation for balcony	✓						✓								
Installing a bathroom wall	✓								✓					Defects found after installation	
Aluminium door and window installation		✓						✓							
Railing installation		✓						✓							
Polishing floor	✓						✓								
Polishing stone	✓						✓								
Install Baseboards/Skirting Boards			✓						✓						
Baseboards/Skirting Boards Preparation	✓								✓					Defects found after installation	
Outdoor Stairs installation	✓						✓								
<b>Piping</b>															
Piping	✓							✓						Water leaked and affect to construction humidity	
<b>Painting work</b>															
Pre-Painting	✓						✓								
Painting	✓						✓								
<b>Miscellaneous work</b>															
Miscellaneous work		✓						✓							
<b>Electrical work</b>															
Electrical work			✓					✓						Cable leftover	
High voltage electricity installation		✓						✓							
<b>Air condition work</b>															
Electricity for air condition		✓						✓							
Air condition installation		✓						✓							
<b>Sanitary work</b>															
Toilet installation	✓						✓								

After reviewing the previous data in this project, outsourcing decision was reconsidered by adopting the outsourcing process flow that has been developed. Based on new method, the new decision has been made showing in table above. The results can be summarised as following;

- **Foundation:** selective outsourcing on labour and equipment was selected instead of in-sourcing
- **Structure:** some external labour was hired to do some tasks in structure work
- **Tile roofing supplier:** new tile suppliers were determined together instead of considering only existing suppliers

- **Roof & ceiling work, piping, and electrical work:** full-outsourcing is a new choice which benefit for progress control and optimising material consumption
- **Plastering:** in-sourcing is a changing option comparing the old process. This is because company's worker has more skills than outsource. At the same time, using internal resource is easy for quality and delivery control
- **Tile installation:** it found that internal worker skill has limitation in terms of work complexity. Actually, our workers can do this task but their work is not delicate enough that cause quality appearance of this work. Thus, it should be better to hire skilled workers to completed this tasks

## 2. School of municipal building Tessaban 8 (2010)

This project was started in 2010 as well as Phuttamonthon celebrating 750 years project. The contract length of School of municipal building Tessaban 8 is 311 days, but it delay 71 days that cause the penalty over 876,779 baht or around 7.10% of project budget.

Considering historical data of this project, it found four main works causing project delay which are earthwork, roof and ceiling work, partition and floor work, and school equipment preparation. After using the new process to make the in-source or buy decision, it is represented that plastering and tile installation should be made in-house instead of hiring subcontract. In addition, there are other activities selected wrong subcontract and led to the problem in terms of time and quality. Although new process result the same solution as shown in table below, in red check mark, the next step that should be concerned is how to select the best subcontracts or suppliers by using outsource weighting method.

Table 5-2 Activity comparison of school of municipal building Tessaban 8 (2010)

School of municipal building Tessaban 8 (2010)	Old process						New process						Remark	
	In-Source	Full Outsource	Selective Outsourcing				In-Source	Full Outsource	Selective Outsourcing					
			Labor	Material	Labor& Equipment	Labor& Material			Labor	Material	Labor& Equipment	Labor& Material		
<b>Civil work</b>														
Earthwork		✓						✓						Soil level adjustment sub contractor
Foundation	✓						✓							
Structure	✓						✓							
The concrete masonry work	✓						✓							
Welding steel roof deck	✓						✓							
Road construction	✓						✓							
<b>Finishing work</b>														
<b>Roof and Ceiling work</b>														
Tile roofing installation			✓						✓					Inefficient sub-contractors
Gable eaves installation			✓						✓					Inefficient sub-contractors
Porch ceiling (indoor and outdoor)			✓						✓					Inefficient sub-contractors
Porch ceiling/eaves			✓						✓					Inefficient sub-contractors
<b>Partition and Floor work</b>														
Plastering over Masonry walls			✓				✓							Inefficient sub-contractors
Install floor and wall tiles			✓				✓							Inefficient sub-contractors
Wooden door casing installation			✓						✓					Inefficient sub-contractors
Wooden door installation			✓						✓					Inefficient sub-contractors
Aluminium door and window installation		✓						✓						
Polishing floor	✓						✓							
Sand wash work	✓						✓							
Polishing stone	✓						✓							
<b>Piping</b>														
Piping	✓						✓							
<b>Sanitary work</b>														
Toilet installation	✓						✓							
<b>Painting work</b>														
Pre-Painting	✓						✓							
Painting	✓						✓							
<b>Miscellaneous work</b>														
School equipment preparation				✓							✓			Company's employee lack of skill
<b>Electrical work</b>														
Electrical work		✓						✓						
High voltage electricity installation		✓						✓						
<b>Air condition work</b>														
Air condition installation		✓						✓						

### 3. Phuttamonthon celebrating 750 years Phase 2 (2010)

Phuttamonthon celebrating 750 years phase 2 is ongoing project of Phuttamonthon celebrating 750 years. This project was executed longer than plan 8 days and got penalty only 63,858 baht. Although, the project did not get much penalty, there were several obstacles during the project. Most of them were caused by either inefficient sub-contractors or suppliers. After using new process flow for deciding in-source or outsource, it is appeared the different options as shown in table below, the concrete masonry work is considered to outsource labour and equipment instead of full outsource, labour and material outsourcing is chosen instead of labour outsource in tile roofing installation activity, all work in plastering wall and tile installation is operated by in-source, while wooden door casing installation is going to be conducted by external labour instead of doing in-house due to lacking skill of internal employees. Moreover, many activities are considered to more focus on selecting outsources. This is because



the chosen outsource previously is inefficient that lead to the problems; such as defects, delay, installation payment, and so on.

Table 5-3 Activity comparison of Phuttamonthon celebrating 750 years phase 2 (2010)

Project Activity	Old process						New process						Remark	
	In-Source	Full Outsource	Selective Outsourcing				In-Source	Full Outsource	Selective Outsourcing					
			Labor	Material	Labor& Equipment	Labor& Material			Labor	Material	Labor& Equipment	Labor& Material		
<b>Civil work</b>														
Earthwork		✓						✓						Soil level adjustment sub contractor
Foundation	✓						✓							
Structure	✓						✓							
The concrete masonry work		✓									✓			Inefficient sub-contractors
Welding steel roof deck	✓						✓							
Road construction	✓						✓							
Landscape		✓						✓						Inefficient sub-contractors
<b>Finishing work</b>														
<b>Roof and Ceiling work</b>														
Tile roofing installation			✓									✓		Inefficient sub-contractors, inefficient suppliers
Gable eaves installation			✓						✓					Inefficient sub-contractors
Porch ceiling (indoor and outdoor)			✓						✓					Inefficient sub-contractors
Porch ceiling/eaves			✓						✓					Inefficient sub-contractors
<b>Partition and Floor work</b>														
Plastering over Masonry walls			✓				✓							Inefficient sub-contractors
Install floor and wall tiles			✓				✓							Inefficient sub-contractors
Wooden door casing installation	✓								✓					Company's employee lack of skill
Wooden door installation			✓						✓					Inefficient sub-contractors
Aluminium door and window installation		✓						✓						
Polishing floor	✓						✓							
Sand wash work	✓						✓							
Polishing stone	✓						✓							
<b>Piping</b>														
Piping	✓						✓							
<b>Sanitary work</b>														
Toilet installation	✓						✓							
<b>Painting work</b>														
Pre-Painting	✓						✓							
Painting	✓						✓							
<b>Electrical work</b>														
Electrical work		✓						✓						
High voltage electricity installation		✓						✓						
<b>Air condition work</b>														
Air condition installation		✓						✓						

#### 4. Tourist centre (2012)

Tourist centre is one of big project of the company. Its value is nearly 30 million baht. Owing to being a huge project, the firm is not much familiar with a large project like this, especially in terms of project planning. As a result, the project was implemented over the contract length one month, and pay for fine almost one million baht. Based on new outsourcing decision process, roof and ceiling work are changed from using subcontracts to outsource labour and equipment as demonstrated in table below.

Table 5-4 Activity comparison of Tourist centre (2012)

Tourist center (2012)	Old process							New process							Remark
	In-Source	Full Outsourcing	Selective Outsourcing					In-Source	Full Outsourcing	Selective Outsourcing					
			Labor	Material	Labor& Equipment	Labor& Material	Material& Equipment			Labor	Material	Labor& Equipment	Labor& Material	Material& Equipment	
<b>Civil work</b>															
Earthwork					✓								✓		
Foundation	✓						✓								
Structure	✓						✓								
The concrete masonry work		✓						✓							
Welding steel roof deck	✓						✓								
Road construction	✓						✓								
Landscape		✓						✓							Inefficient sub-contractors
<b>Finishing work</b>															
<b>Roof and Ceiling work</b>															
Tile roofing installation	✓		✓				✓						✓		Inefficient suppliers
Gable eaves installation			✓										✓		
Porch ceiling (indoor and outdoor)			✓										✓		
Porch ceiling/eaves			✓										✓		
<b>Partition and Floor work</b>															
Plastering over Masonry walls	✓						✓								
Install floor and wall tiles	✓											✓			Material transportation, Equipment ordering
Wooden door casing installation	✓						✓								
Railing installation for balcony	✓						✓								
Installing a bathroom wall	✓												✓		
Wooden door installation			✓						✓						
Aluminium door and window installation		✓						✓							
Polishing floor	✓						✓								
Sand wash work	✓						✓								
Polishing stone	✓						✓								
Install Baseboards/Skirting Boards	✓						✓								
Install Granite Baseboards	✓						✓								
Baseboards/Skirting Boards Installation	✓						✓								
Outdoor Stairs installation	✓						✓								
Conference room	✓						✓								
Reception room	✓						✓								
<b>Piping</b>															
Piping		✓						✓							
<b>Sanitary work</b>															
Toilet installation				✓									✓		Inefficient suppliers
<b>Painting work</b>															
Pre-Painting	✓						✓								
Painting	✓						✓								
<b>Miscellaneous work</b>															
Curtain installation		✓						✓							
Billboard		✓						✓							
Miscellaneous work		✓						✓							
<b>Electrical work</b>															
Electrical work		✓							✓						Inefficient sub-contractors
High voltage electricity installation		✓							✓						
<b>Air condition work</b>															
Electricity for air condition															
Air condition installation		✓							✓						Inefficient sub-contractors

## 5. Childcare centre (2012)

Childcare centre is a project which was started in 2012 after the tourist centre project. This project paid the penalty over 2% of project cost due to project delay. During the project, it found that project delay was mainly caused by inefficient subcontracts and employee's lack of skills.

Table 5-5 Activity comparison of child care centre (2012)

Child care center (2012)	Old process						New process						Remark
	In-Source	Full Outsourcing	Selective Outsourcing				In-Source	Full Outsourcing	Selective Outsourcing				
			Labor	Material	Labor& Equipment	Material& Equipment			Labor	Material	Labor& Equipment	Material& Equipment	
Project Activity													
<b>Civil work</b>													
Earthwork						✓		✓					Soil level adjustment sub contractor
Foundation	✓					✓		✓					
Structure	✓						✓						
The concrete masonry work		✓						✓					inefficient sub-contractors
Welding steel roof deck	✓						✓						
Road construction	✓						✓						
<b>Finishing work</b>													
<b>Roof and Ceiling work</b>													
Tile roofing installation			✓						✓				inefficient suppliers
Gable eaves installation	✓						✓						
Porch ceiling (indoor and outdoor)	✓						✓						
Porch ceiling/eaves	✓						✓						
<b>Partition and Floor work</b>													
Plastering over Masonry walls	✓						✓						
Install floor and wall tiles	✓						✓						
Railing installation for balcony	✓						✓						
Installing a bathroom wall	✓						✓						
Door and window installation	✓								✓				Defect works, Company's employee lack of skill
Railing installation	✓						✓						
Polishing floor	✓						✓						
<b>Piping</b>													
Piping		✓						✓					
<b>Painting work</b>													
Pre-Painting		✓						✓					
Painting		✓						✓					inefficient sub-contractors
<b>Miscellaneous work</b>													
Miscellaneous work	✓	✓					✓	✓					
<b>Electrical work</b>													
Electrical work		✓						✓					
High voltage electricity installation		✓						✓					
<b>Air condition work</b>													
Electricity for air condition		✓						✓					
Air condition installation		✓						✓					
<b>Sanitary work</b>													
Toilet installation			✓						✓				inefficient sub-contractors

## 6. Technology Kanchanaphisek (2012)

Technology Kanchanaphisek took place on July, 2012. Tourist centre and Child care centre were executed ahead of this project. According to three projects operating in the same period, this affects resource allocation among the projects, especially human resource. However, during operation period of those three projects, there were time lags that can transfer resources to each other. Nevertheless, it is needed to outsource for some activities that might not have enough resources at that time, or employees lack skills.

Based on new process, three in-house activities are changed to full-outsource, which are pump installation, window, door and accessory installation; while roof installation is switched from making in-house to hiring subcontractor.

Table 5-6 Activity comparison of Technology Kanchanaphisek (2012)

Technology Kanchanaphisek (2012)	Old process										New process						Remark
	In-Source	Full Outsource	Selective Outsourcing					In-Source	Full Outsource	Selective Outsourcing							
			Labor	Material	Labor & Equipment	Labor & Material	Equipment			Labor	Material	Labor & Equipment	Labor & Material	Equipment			
<b>Civil work</b>																	
Earthwork	✓							✓									
Foundation	✓							✓									
<b>Structure</b>																	
1st Structure installation	✓							✓									
2nd Structure installation	✓							✓									
3rd Structure installation	✓							✓									
4th Structure installation	✓							✓									
The roof beams installation	✓							✓									
<b>Roof work</b>																	
Assembly Painted Roof				✓						✓							
Roof frame installation	✓							✓									
Roof installation	✓								✓							Employees lack skills, spend long time to install	
<b>Partition and Floor work</b>																	
Plastering over Masonry walls 2nd floor			✓							✓						Inefficient sub-contractor	
Plastering over Masonry walls 3rd floor			✓							✓						Inefficient sub-contractor	
Plastering over Masonry walls 4th floor	✓							✓									
Plastering over Masonry walls 1st floor	✓							✓									
Installing a bathroom wall	✓							✓									
Wall grooving	✓							✓									
Glass block walls	✓							✓									
Install Baseboards/Skirting Boards	✓							✓									
<b>Electrical work</b>																	
Electrical work		✓							✓								
High voltage electricity installation		✓							✓								
<b>Piping</b>																	
Piping		✓							✓								
Pump installation	✓									✓						Inefficiency of job transfer	
<b>Drainage system</b>																	
Drainage installation	✓							✓									
SAT installation	✓							✓									
<b>Floor and Bench</b>																	
Polishing floor	✓							✓									
Bench work	✓							✓									
Polishing stone	✓							✓									
<b>Windows and Doors</b>																	
Production		✓							✓							Inefficient suppliers	
Installation	✓								✓							Inefficiency of job transfer	
Accessory installation	✓								✓							Inefficiency of job transfer	
<b>Rail work</b>																	
Railing installation	✓							✓									
Fall protection rail installation	✓							✓									
<b>Roof and Ceiling work</b>																	
Insulation installation	✓							✓									
Porch ceiling (indoor and outdoor)	✓							✓									
<b>Sanitary work</b>																	
Toilet installation	✓							✓									
<b>Painting work</b>																	
Pre-Painting	✓							✓									
Painting	✓							✓									
<b>Miscellaneous work</b>																	
Office equipment purchasing				✓								✓					

After in-source or outsource decision was made, outsources selection then is needed in order to choose the most suitable suppliers or subcontractors for the project.

In this project, there are three activities that outsourcing selection process is required. It concludes (1) Roof installation, (2) Plastering and masonry wall, and (3) Window and door making and installation, whereas the rest is not necessary because the company actually has the familiar suppliers and subcontractors.

Table 5-7 ,Table 5-8 and Table 5-9 represents outsourcing selection process by using QCD weighting of Roof installation, Plastering and Masonry wall, and Door and Window installation, respectively.

In a process of selecting roof installation labour, two familiar vendors are considered. Finally, the first vendor is chosen with score 2.9 which is higher than Vendor 2 0.07 (table 5-7). An existing vendor (familiar vendor) and new vendor (unfamiliar vendor) are determined in plastering and masonry wall process, and familiar vendor is selected (table 5-8), eventually. Furthermore, the company has no existing vendor for door and window made from wood. Thus, the firm is necessary to require new vendors in order to work for this job. There are 3 unfamiliar vendors which are considered. Consequently, vendor 5 is selected with highest score (table 5-9).

Table 5-7 Outsource selection for Roof installation (Technology Kanchanaphisek)

Activity >>>>		Roof (C-Pack, Cement)											
Outsource selection (Labor&Full)													
QCD	QCD Weight	Criteria for selection	Weight	Rating					Weighted Score				
				Familiar vendor		Unfamiliar vendor			Familiar vendor		Unfamiliar vendor		
				Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5
Q	20	Skill labors	0.08	3	3				0.24	0.24	0.00	0.00	0.00
		Minimum requirements (with certification)	0.07	3	2				0.21	0.14	0.00	0.00	0.00
		A number of defects	0.05	3	3				0.15	0.15	0.00	0.00	0.00
C	20	Proposing minimum price (Quotation)	0.10	2	3				0.20	0.30	0.00	0.00	0.00
		Minimum requirements (with certification)	0.06	3	2				0.18	0.12	0.00	0.00	0.00
		Flexibility in payment terms and conditions	0.04	3	2				0.12	0.08	0.00	0.00	0.00
D	60	Installation payment	0.30	3	3				0.90	0.90	0.00	0.00	0.00
		Minimum requirements (with certification)	0.18	3	3				0.54	0.54	0.00	0.00	0.00
		A number of job leaving	0.12	3	3				0.36	0.36	0.00	0.00	0.00
<b>Total</b>			<b>1.00</b>					<b>2.90</b>	<b>2.83</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	
Rating: 3 = Good, 2 = Fair, 1 = Poor								The best vendor is		Vendor1			

Table 5-8 Outsource selection for plastering and masonry wall (Technology Kanchanaphisek)

Activity >>>>		Plastering and Masonry wall											
Outsource selection (Labor&Full)													
QCD	QCD Weight	Criteria for selection	Weight	Rating					Weighted Score				
				Familiar vendor		Unfamiliar vendor			Familiar vendor		Unfamiliar vendor		
				Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5
Q	40	Skill labors	0.16	3		2			0.48	0.00	0.32	0.00	0.00
		Minimum requirements (with certification)	0.14	3		2			0.42	0.00	0.28	0.00	0.00
		A number of defects	0.10	3		2			0.30	0.00	0.20	0.00	0.00
C	20	Proposing minimum price (Quotation)	0.10	2		3			0.20	0.00	0.30	0.00	0.00
		Minimum requirements (with certification)	0.06	3		2			0.18	0.00	0.12	0.00	0.00
		Flexibility in payment terms and conditions	0.04	3		2			0.12	0.00	0.08	0.00	0.00
D	40	Installation payment	0.20	3		2			0.60	0.00	0.40	0.00	0.00
		Minimum requirements (with certification)	0.12	3		2			0.36	0.00	0.24	0.00	0.00
		A number of job leaving	0.08	3		2			0.24	0.00	0.16	0.00	0.00
<b>Total</b>			<b>1.00</b>					<b>2.90</b>	<b>0.00</b>	<b>2.10</b>	<b>0.00</b>	<b>0.00</b>	
Rating: 3 = Good, 2 = Fair, 1 = Poor								The best vendor is		Vendor1			

Table 5-9 Outsource selection for window and door installation (Technology Kanchanaphisek)

Activity >>>		Window and door production											
Outsource selction (Labor&Full)													
QCD	QCD Weight	Criteria for selection	Weight	Rating					Weighted Score				
				Familiar vendor		Unfamiliar vendor			Familiar vendor		Unfamiliar vendor		
				Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5
Q	40	Skill Labors	0.16			3	2	3	0.00	0.00	0.48	0.32	0.48
		Minimum requirements (with certification)	0.14			2	3	2	0.00	0.00	0.28	0.42	0.28
		A number of defects	0.10			2	2	2	0.00	0.00	0.20	0.20	0.20
C	30	Proposing minimum price (Quotation)	0.15			1	2	3	0.00	0.00	0.15	0.30	0.45
		Minimum requirements (with certification)	0.09			2	2	2	0.00	0.00	0.18	0.18	0.18
		Flexibility in payment terms and conditions	0.06			2	3	1	0.00	0.00	0.12	0.18	0.06
D	30	Installation payment	0.15			2	2	2	0.00	0.00	0.30	0.30	0.30
		Minimum requirements (with certification)	0.09			2	2	2	0.00	0.00	0.18	0.18	0.18
		A number of job leaving	0.06			2	2	2	0.00	0.00	0.12	0.12	0.12
<b>Total</b>			<b>1.00</b>						<b>0.00</b>	<b>0.00</b>	<b>2.01</b>	<b>2.20</b>	<b>2.25</b>
Rating: 3 = Good, 2 = Fair, 1 = Poor								<b>The best vendor is</b>		Vendor5			

## 5.2 New Project Planning and Evaluation

DG Municipal office building construction project is adopted as a case study by using the developed procedure. The municipal office building has three floors with 20.50 meter width and 40 meter length. It is located in the district in a northern area in Thailand. The value of the project based on reference price is 18 million baht defined by agency owner on September 10, 2012. The required duration of the project is 14 months (October 1, 2012 – January 30, 2014).

### 5.2.1 Project information

- The Contractor Agreement

The contractor agreement is made between Municipal office and company A. According to the agreement, the project owner requests the company to perform construction as follows:

Interim Payment Schedule (IPS) is separated into 5 terms as follows;

1. **1<sup>st</sup> term:** 15% of total payment when the basement work has been completed within 60 days. Then the first payment will be paid 2,697,750 Baht.
2. **2<sup>nd</sup> term:** 15% of total payment when beams of 2<sup>nd</sup>, 3<sup>rd</sup> floor, and roofs have been installed within 60 days. Then the second payment will be paid 2,697,750 Baht.

3. **3<sup>rd</sup> term:** 20% of total payment when plastering a brick wall and electrical system have been installed within 80 days. Then the third payment will be paid 3,597,000 Baht.
4. **4<sup>th</sup> term:** 20% of total payment when all work has been completed within 80 days. Then the third payment will be paid 3,597,000 Baht.
5. **5<sup>th</sup> period:** This is the last payment that will be paid when the building has been cleaned and completed within the contract period. The last payment is 5,395,500 Baht.

- Project Deliverables and Termination

Effective date October 1, 2012 the company shall provide the project owner with construction and shall complete it within January 1, 2016. In the event that the company cannot finish the project within the limit of time without reasonable argument, the project owner shall be able to terminate the agreement and request fee from the company.

- Compensation

Daily fee: 1 percentage of total project cost

- Building and Location

This project is a small size building with three floors. It is located in DG municipal district, Phukamyao, Pa-Yao province. Exterior design building and location of this project is shown Figure below.



CHULALONGKORN UNIVERSITY  
Figure 5-1 Building design and location

### 5.2.2 Initial project

- Drafting

In this step, drafting man is going to categorise the detail of material, size, and type, in order to select the most appropriate materials in terms of quality and price. The list of materials which are selected.

- Material price comparison

From the total material cost, it found that over 30% or highest material cost of the project is the expenses of Steel Bar, reinforced concrete, and Cement Concrete. The reason is



that they have highest usage; on the other hand, their unit cost is so expensive. Because of that, it is needed to get the lowest price in order to gain more margins from this. Hence, considering various suppliers is extremely required to obtain the cheapest price.

In the table below shows list of 2 suppliers who are able to supply Concrete strength, and 3 suppliers who offer steel bar for reinforced concrete and steel bar. As a result, based on the lowest price of required material, supplier A is selected to supply concrete strength 240 ksc. While, suppliers C who is able to provide steel bar for reinforce concrete DB16 and steel bar is chosen (Table 5-10).

Table 5-10 Main outsource comparison

Suppliers	Concrete strength 240 ksc.	Steel Bar for Reinforced concrete DB16	Steel Bar
A	1,682 Baht/m <sup>3</sup>		
B	1,691 Baht/m <sup>3</sup>		
C		396 Baht/Bar	560 Baht/Bar
D		398 Baht/Bar	565 Baht/Bar
E		398 Baht/Bar	563 Baht/Bar

- *Team Building*

To conduct this project, it needs 60 persons. It consists mainly of one project manager, one engineer, one foreman, one checker, and fifty-six labours.

Table 5-11 Work allocation

Position	Quantity (Person)	Job Description
Project Manager	1	To supervise the project and control
Engineer	1	Drafting and planning

Position	Quantity (Person)	Job Description
Supervisor	1	To control and monitor project
Checker	1	<ul style="list-style-type: none"> <li>● Following work progress</li> </ul>
Workers	56	<ul style="list-style-type: none"> <li>● Earthwork</li> <li>● Foundation</li> <li>● Structure</li> <li>● Masonry</li> <li>● Architecture</li> <li>● Landscape</li> <li>● Drainage</li> </ul>

### 5.2.3 Project Preparation

- Work Breakdown Structure

As work breakdown structure, it can divide the project into 8 work areas, which are;

1. Civil work
2. Finishing work
  - 1) Roof and Ceiling
  - 2) Partition and Floor
  - 3) Piping
  - 4) Painting
3. Miscellanies work
4. Electrical work
5. Air condition work
6. Sanitary work
7. Network system

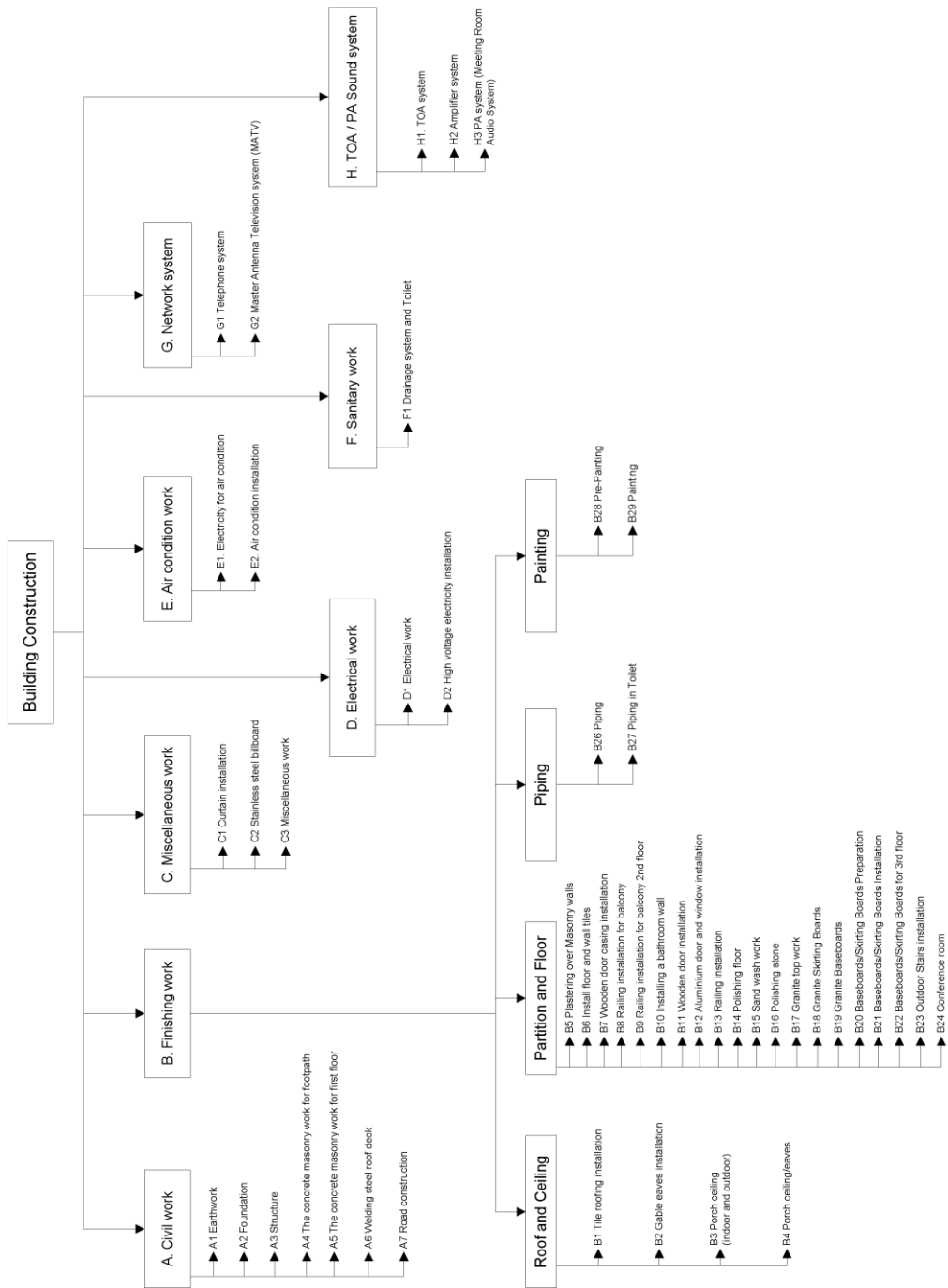


Figure 5-2 Work Breakdown Structure of DG project

- Risk Analysis

According to historical data about small building construction in previous projects, it points out the failures that frequently happen during project. Most of them tend to take place in 6 main work areas, which are;

1. Civil work
2. Finishing work
3. Electrical work
4. Air condition work
5. Sanitary work
6. Network system

Based on the method of FMEA shown in table below, it represents the possible failure that might occur during the project, which comprises of;

1. Unfinished earthwork due to fluctuation weather
2. Late delivery of construction materials due to either Delay delivery from suppliers or Shortage of construction materials
3. Baseboard/Skirting not completed due to Sub-contractor is not available
4. Pipe leak due to Sub-contractor use poor quality material or Poor sub-contractor
5. Short Circuit of electricity network due to Sub-contractor use poor quality material or Poor sub-contractor
6. Clogged sanitary vent due to Poor sub-contractor

However, when each failure mode was considered, it found the most failure mode are frequently caused by subcontract and weather. In the case of subcontract problem, it can be solved by the outsourcing selection process; whereas an obstacle of weather fluctuation can be prevented by project planning method.

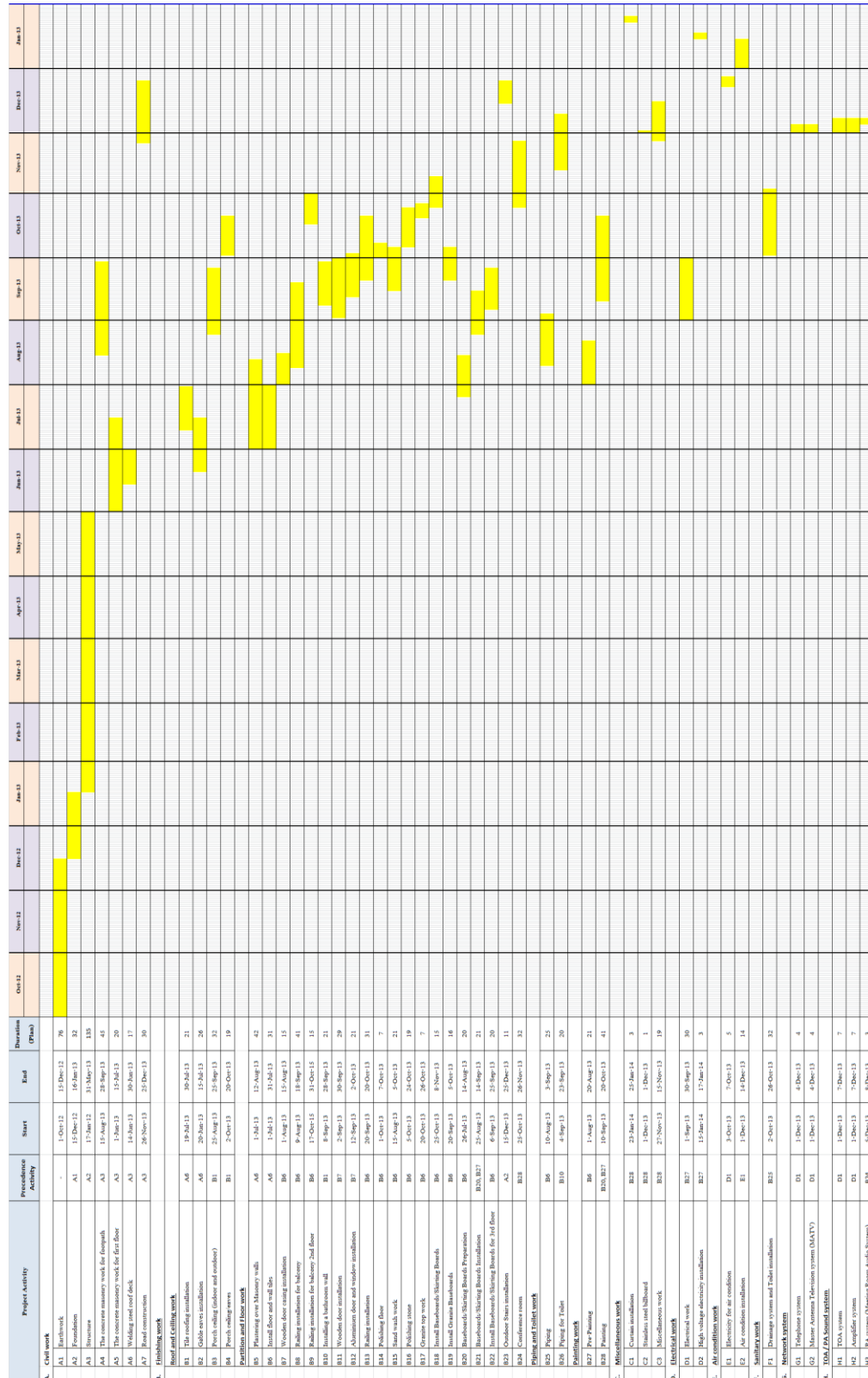
Table 5-12 Failure Mode and Effect Analysis of DG project

Processes or Activities	Potential Failure Mode	Potential Effects of Failure	SEV	Potential Causes of Failure	OCC	Current Process Control		DET	RPN
						Preventive Action	Detection		
A. Civil work	Subsidence earthwork	- Structure damage - Building Collapse	10	- Workers lack skills	2	N/A	Quality Control	1	20
				- Natural disaster(Eathquake, Flood)	1	N/A	N/A	10	100
	Unfinished earthwork	- Foundation cannot start - Warehouse cost, material damage	7	- Raining and Storm	7	N/A	Meteorology	5	245
				- Insufficient Machinery	1	Machinery Planning	N/A	2	14
	Structure damage	- Building Collapse - Fractalur structure	10	- Material is not follwing specification	1	In-coming process	N/A	2	20
				- An error in design process	1	Quality check by Government	N/A	1	10
				- Material mismatch by human error	1	N/A	N/A	8	80
	Broken roof deck	- Structure damage	7	- Workers lack skills	1	N/A	N/A	8	56
				- Material is not follwing specification	1	Material selection	In-coming process	8	56
				- Poor quality material	1	Material selection	In-coming process	2	14
	Late delivery of construction materials	- Activity delay - Penalty from delay project	6	- Delay delivery from suppliers	6	Suppiers selection process	N/A	10	360
				- Shortage of construction materials	6	N/A	N/A	10	360
- Delay from transportation				3	N/A	N/A	1	18	
B. Finishing work	Fractural wall	- Structure strength	6	- Workers lack skills	2	N/A	Visual Inspection	5	60
				- Poor quality material	1	Material selection, In-coming process	In-coming process	3	18
	Loose wall/floor tile	- Water leak - Tile damage	6	- Workers lack skills	2	N/A	Visual Inspection	8	96
				- Bloken granite work	5	- Poor sub-contractor	2	N/A	
	Baseboard/Skirting not completed	- Project delay	6	- Sub-contractor use poor quality material	1	N/A	N/A	7	35
				- Sub-contractor is not available	6	N/A	N/A	8	288
	Unleveling sand wash	- Confined Water	6	- Workers lack skills	2	N/A	Visual Inspection	8	96
				- Pipe leak	7	- Porch ceiling damage - Humidity	5	N/A	Visual Inspection
D. Electrical work	Short Circuit of electricity network	- Breaker and wiring damage	9	- Sub-contractor use poor quality material	6	N/A	N/A	7	378
				- Poor sub-contractor	5	N/A	Visual Inspection	5	225
E. Air condition work	Air con. Specification is not supported by installed electricity system	- Electricity system	9	- Poor sub-contractor	1	N/A	N/A	8	72
F. Sanitary work	Clogged sanitary vent	- Confined water - Confined sewage	8	- Poor sub-contractor	2	N/A	Visual Inspection	8	128
G. Network system	Network system is disconnected	- Usage of user	5	- Poor sub-contractor	1	N/A	Visual Inspection	8	40
H. TOA / PA Sound system	Sound wave interference	- Usage of user	5	- Poor sub-contractor	1	N/A	Visual Inspection	8	40

- Gantt Chart

As the result of risk analysis, it emphasises that a cause of project risk is caused by weather fluctuation that can be tackled by planning. Thus, in order to prevent risk from bad weather, it is needed to consider the weather comparing the period of time of each activities. For instance, as plan shown in table below, civil work will be started on October which is a period of raining season. So, it is essential to extend working day, so that if there is raining day which cause the disruption of operation, it will not affect the next process.

Table 5-13 Gantt Chart



- Out-In Source and Outsource Selection

According to out-in source consideration proposed in the procedure, it can be categorised activities into 3 main types of working which are in-source, full outsource, and material outsourcing. From table, it is noticed that many of work are conducted in-house. This is because during this project there are no other project is going to be executed, so there are sufficient resources throughout the project. Nevertheless, there are some works that the firm lack of capability to complete the job that cause making by using outsource. While, sanitary work can be made by itself but material is needed to be supplied by external supplier.

Table 5-14 In-house or Outsource decision making

Project Activity	New process						
	In-Source	Full Outsource	Selective Outsourcing				Material & Equipment
			Labor	Material	Labor & Equipment	Labor & Material	
<b>Civil work</b>							
Earthwork	✓						
Foundation	✓						
Structure	✓						
The concrete masonry work for footpath	✓						
The concrete masonry work for first floor	✓						
Welding steel roof deck	✓						
Road construction	✓						
<b>Finishing work</b>							
<b>Roof and Ceiling work</b>							
Tile roofing installation	✓						
Gable eaves installation	✓						
Porch ceiling (indoor and outdoor)	✓						
Porch ceiling/eaves	✓						
<b>Partition and Floor work</b>							
Plastering over Masonry walls	✓						
Install floor and wall tiles	✓						
Wooden door casing installation	✓						
Railing installation for balcony	✓						
Railing installation for balcony 2nd floor	✓						
Installing a bathroom wall	✓						
Wooden door installation	✓						
Aluminium door and window installation	✓						
Railing installation	✓						
Polishing floor	✓						
Sand wash work	✓						
Polishing stone	✓						
Granite top work	✓						
Install Baseboards/Skirting Boards	✓						
Install Granite Baseboards	✓						
Baseboards/Skirting Boards Preparation	✓						
Baseboards/Skirting Boards Installation	✓						
Install Baseboards/Skirting Boards for 3rd floor	✓						
Outdoor Stairs installation	✓						
Conference room	✓						
<b>Piping and Toilet work</b>							
Piping		✓					
Piping for Toilet		✓					
<b>Painting work</b>							
Pre-Painting		✓					
Painting		✓					
<b>Miscellaneous work</b>							
Curtain installation		✓					
Stainless steel billboard		✓					
Miscellaneous work		✓					
<b>Electrical work</b>							
Electrical work		✓					
High voltage electricity installation		✓					
<b>Air condition work</b>							
Electricity for air condition		✓					
Air condition installation		✓					
<b>Sanitary work</b>							
Drainage system and Toilet installation							
<b>Network system</b>							
Telephone system		✓					
Master Antenna Television system (MATV)		✓					
<b>TOA / PA Sound system</b>							
TOA system		✓					
Amplifier system		✓					
PA system (Meeting Room Audio System)		✓					

Although many tasks is needed to conduct by outsource, the firm has the regular vendors that can work or supply material for electric work, and sanitary work. While, there are few skilled vendors, who are expert in network system and TOA/PA sound system, so it is not essential to consider through the process of outsource selection.

Hence, the processes which required to take account of outsource selection can be explained as follows.

### 1) Piping

In piping process, there are two existing vendors that used to deal with the firm. First vendor is a local vendor that proposes minimum price for this task. On the other hand, it is experienced vendor which offer higher price. However, in the view of expertise and quality the second one has more qualification which relate with the characteristic of this task highly focusing on quality. Thus, the second vendor is selected as a full outsource with higher score than another one.

Table 5-15 Outsource selection for piping

Activity>>>>		Piping											
Outsource selection (Labor&Full)													
QCD	QCD Weight	Criteria for selection	Weight	Rating					Weighted Score				
				Familiar vendor		Unfamiliar vendor			Familiar vendor		Unfamiliar vendor		
				Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5
Q	60	Skill labors	0.24	3	3				0.72	0.72	0.00	0.00	0.00
		Minimum requirements (with certification)	0.21	2	3				0.42	0.63	0.00	0.00	0.00
		A number of defects	0.15	3	3				0.45	0.45	0.00	0.00	0.00
C	20	Proposing minimum price (Quotation)	0.10	3	2				0.30	0.20	0.00	0.00	0.00
		Minimum requirements (with certification)	0.06	2	3				0.12	0.18	0.00	0.00	0.00
		Flexibility in payment terms and conditions	0.04	2	1				0.08	0.04	0.00	0.00	0.00
D	20	Installation payment	0.10	3	3				0.30	0.30	0.00	0.00	0.00
		Minimum requirements (with certification)	0.06	3	3				0.18	0.18	0.00	0.00	0.00
		A number of job leaving	0.04	3	3				0.12	0.12	0.00	0.00	0.00
<b>Total</b>			<b>1.00</b>					<b>2.69</b>	<b>2.82</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	
Rating: 3=Good, 2=Fair, 1=Poor								The best vendor is		Vendor2			

### 2) Painting (Internal and External)

As same as piping process, there are two familiar vendors considered in painting process as well. In painting process, it is divided into two types; internal and external painting, which both are different in term of QCD. In the view of internal painting, quality



and delivery are considered as the most important factors comparing cost. In contrast, delivery is most important for external painting process.

The two familiar vendors offering quotation for internal and external outsources are similar, excepting external painting which has another unfamiliar vendor.

Table 5-16 Outsource selection for painting (internal)

Activity >>>		Painting (Internal)												
Outsource selection (Labor&Full)														
QCD	QCD Weight	Criteria for selection	Weight	Rating					Weighted Score					
				Familiar vendor		Unfamiliar vendor			Familiar vendor		Unfamiliar vendor			
				Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	
Q	40	Skill labors	0.16	3	3				0.48	0.48	0.00	0.00	0.00	
		Minimum requirements (with certification)	0.14	3	3				0.42	0.42	0.00	0.00	0.00	
		A number of defects	0.10	3	2				0.30	0.20	0.00	0.00	0.00	
C	20	Proposing minimum price (Quotation)	0.10	2	3				0.20	0.30	0.00	0.00	0.00	
		Minimum requirements (with certification)	0.06	3	3				0.18	0.18	0.00	0.00	0.00	
		Flexibility in payment terms and conditions	0.04	3	3				0.12	0.12	0.00	0.00	0.00	
D	40	Installation payment	0.20	3	3				0.60	0.60	0.00	0.00	0.00	
		Minimum requirements (with certification)	0.12	3	3				0.36	0.36	0.00	0.00	0.00	
		A number of job leaving	0.08	3	3				0.24	0.24	0.00	0.00	0.00	
<b>Total</b>			<b>1.00</b>					<b>2.90</b>	<b>2.90</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>		
Rating : 3 = Good, 2 = Fair, 1 = Poor										The best vendor is		Vendor1		

Table 5-17 Outsource selection for piping (external)

Activity >>>		Painting (External)												
Outsource selection (Labor&Full)														
QCD	QCD Weight	Criteria for selection	Weight	Rating					Weighted Score					
				Familiar vendor		Unfamiliar vendor			Familiar vendor		Unfamiliar vendor			
				Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	
Q	20	Skill labors	0.08	3	3	2			0.24	0.24	0.16	0.00	0.00	
		Minimum requirements (with certification)	0.07	3	3	2			0.21	0.21	0.14	0.00	0.00	
		A number of defects	0.05	3	2	2			0.15	0.10	0.10	0.00	0.00	
C	20	Proposing minimum price (Quotation)	0.10	2	3	3			0.20	0.30	0.30	0.00	0.00	
		Minimum requirements (with certification)	0.06	3	3	2			0.18	0.18	0.12	0.00	0.00	
		Flexibility in payment terms and conditions	0.04	3	3	2			0.12	0.12	0.08	0.00	0.00	
D	60	Installation payment	0.30	3	3	2			0.90	0.90	0.60	0.00	0.00	
		Minimum requirements (with certification)	0.18	3	3	2			0.54	0.54	0.36	0.00	0.00	
		A number of job leaving	0.12	3	3	2			0.36	0.36	0.24	0.00	0.00	
<b>Total</b>			<b>1.00</b>					<b>2.90</b>	<b>2.95</b>	<b>2.10</b>	<b>0.00</b>	<b>0.00</b>		
Rating : 3 = Good, 2 = Fair, 1 = Poor										The best vendor is		Vendor2		

Based on outsource selection process, it represents final decision of vendors who are going to be responsible for internal and external painting. Vendor 1 is selected for internal painting, while vendor 2 is picked up for completing external painting as shown table 5-16 and table 5-17, respectively.

### 3) Curtain installation

In curtain installation, there are two unfamiliar vendors considered that they have not worked with before. The most important factors influencing curtain vendor selection are cost, quality, and delivery, respectively. Comparing qualification between vendor 3 and

vendor 4 as shown in table 5-18, it obviously see that vendor 4 offers the cheapest cost for curtain installation which cost is the most significance for this kind of work. As this result, it is clear that vendor 4 is the most qualified curtain vendor.

Table 5-18 Outsource selection for curtain installation

Activity>>>		Curtain installation											
Outsource selction (Labor&Full)													
QCD	QCD Weight	Criteria for selection	Weight	Rating					Weighted Score				
				Familiar vendor		Unfamiliar vendor			Familiar vendor		Unfamiliar vendor		
				Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5
Q	30	Skill labors	0.12			2	2		0.00	0.00	0.24	0.24	0.00
		Minimum requirements (with certification)	0.11			2	2		0.00	0.00	0.21	0.21	0.00
		A number of defects	0.08			2	2		0.00	0.00	0.15	0.15	0.00
C	50	Proposing minimum price (Quotation)	0.25			2	3		0.00	0.00	0.50	0.75	0.00
		Minimum requirements (with certification)	0.15			2	2		0.00	0.00	0.30	0.30	0.00
		Flexibility in payment terms and conditions	0.10			3	2		0.00	0.00	0.30	0.20	0.00
D	20	Installation payment	0.10			2	2		0.00	0.00	0.20	0.20	0.00
		Minimum requirements (with certification)	0.06			2	2		0.00	0.00	0.12	0.12	0.00
		A number of job leaving	0.04			2	2		0.00	0.00	0.08	0.08	0.00
<b>Total</b>			<b>1.00</b>					<b>0.00</b>	<b>0.00</b>	<b>2.10</b>	<b>2.25</b>	<b>0.00</b>	
Rating : 3 = Good, 2 = Fair, 1 = Poor								The best vendor is		Vendor4			

#### 4) Stainless Billboard

This is a new task that the firm haven't deal before. So it is needed to find out the vendors who can provide qualified curtain. In this case, there are two suppliers available. After considering curtain vendors through outsource selection process, vendor 3 is selected mainly due to proposing the lowest price.

Table 5-19 Outsource selection for stainless billboard

Activity>>>		Stainless Billboard											
Outsource selection (Labor&Full)													
QCD	QCD Weight	Criteria for selection	Weight	Rating					Weighted Score				
				Familiar vendor		Unfamiliar vendor			Familiar vendor		Unfamiliar vendor		
				Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5
Q	30	Skill labors	0.12			3	2		0.00	0.00	0.36	0.24	0.00
		Minimum requirements (with certification)	0.11			2	3		0.00	0.00	0.21	0.32	0.00
		A number of defects	0.08			2	2		0.00	0.00	0.15	0.15	0.00
C	60	Proposing minimum price (Quotation)	0.30			3	2		0.00	0.00	0.90	0.60	0.00
		Minimum requirements (with certification)	0.18			2	2		0.00	0.00	0.36	0.36	0.00
		Flexibility in payment terms and conditions	0.12			2	3		0.00	0.00	0.24	0.36	0.00
D	10	Installation payment	0.05			2	2		0.00	0.00	0.10	0.10	0.00
		Minimum requirements (with certification)	0.03			2	2		0.00	0.00	0.06	0.06	0.00
		A number of job leaving	0.02			2	2		0.00	0.00	0.04	0.04	0.00
<b>Total</b>			<b>1.00</b>					<b>0.00</b>	<b>0.00</b>	<b>2.42</b>	<b>2.23</b>	<b>0.00</b>	
Rating : 3 = Good, 2 = Fair, 1 = Poor								The best vendor is		Vendor3			

## 5) Air condition work

As specification requirement of air condition, it is not usual as company used to order. Hence, it is needed to review outsource mainly in term of cost comparison. As a result, vendor 2 is selected.

Table 5-20 Outsource selection for air condition work

Activity >>>		Air condition work											
Outsource selection (Labor&Full)													
QCD	QCD Weight	Criteria for selection	Weight	Rating					Weighted Score				
				Familiar vendor		Unfamiliar vendor			Familiar vendor		Unfamiliar vendor		
				Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5
Q	10	Skill labors	0.04	3	3				0.12	0.12	0.00	0.00	0.00
		Minimum requirements (with certification)	0.04	3	2				0.11	0.07	0.00	0.00	0.00
		A number of defects	0.03	3	3				0.08	0.08	0.00	0.00	0.00
C	80	Proposing minimum price (Quotation)	0.40	2	3				0.80	1.20	0.00	0.00	0.00
		Minimum requirements (with certification)	0.24	3	3				0.72	0.72	0.00	0.00	0.00
		Flexibility in payment terms and conditions	0.16	3	2				0.48	0.32	0.00	0.00	0.00
D	10	Installation payment	0.05	3	3				0.15	0.15	0.00	0.00	0.00
		Minimum requirements (with certification)	0.03	3	3				0.09	0.09	0.00	0.00	0.00
		A number of job leaving	0.02	3	3				0.06	0.06	0.00	0.00	0.00
<b>Total</b>			<b>1.00</b>					<b>2.60</b>	<b>2.81</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	

Rating : 3 = Good, 2 = Fair, 1 = Poor

The best vendor is Vendor2

- Cost Estimation

As a result, this project can be estimated the project cost around 14 million baht, while it earns 18 million. This means that it is expected to gain margin around 4 million baht from this project, eventually. For the detail of individual cost, it can be seen in appendix.

- S-Curve

Base on individual cost taking place during each period, it can be demonstrated as S-Curve shown in figure below. This S-Curve assists the firm to perceive an overview of expenses which is going to happen in each quarter. Also, it can help the firm to provide cash in advance for any expenses occurring in each period. This enhances the effectiveness of cash flow as well.

From S-Curve, it can summarise that this project will totally cost almost 14 million baht. However, it can separate into 4 periods. The first period is expected to pay 3,270,450 Bath, this is mainly cost by labour cost and material cost of civil work, whereas the expenses occurring in second period is

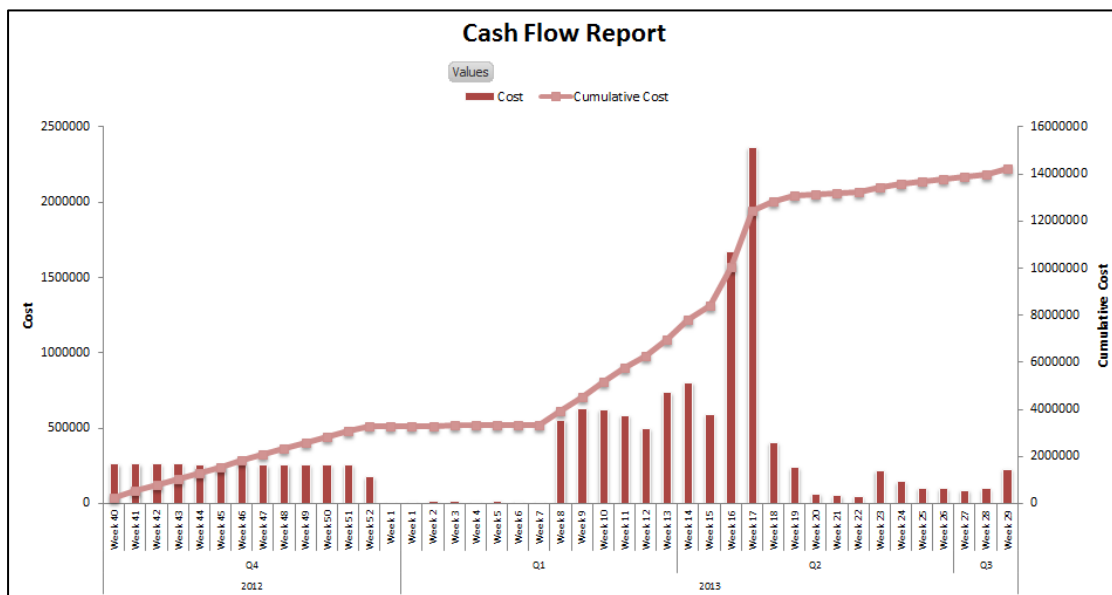


Figure 5-3 S-curve

#### 5.2.4 Project results

After the project was completed, it found that the project can be finished early than plan by 20 days. Considering in table below, it shows the actual time compared master plan. It is clear that most of activity, which is in-house work, spent less time than plan, while all outsource can deliver task on time as plan. However, there are only 3 activities, which are foundation, road construction, and Porch ceiling and eaves installation, take more time than plan. This is due to an impact from weather's fluctuation. Nevertheless, this project can be delivered to the owner on time under the satisfied quality. The total cost around 13.5 million baht or 3.57% decreased. The cost that can be saved is mainly due to; material cost is lower than plan, daily wage is lower than expectation regarding to shorter working time of some in-house activity.





## CHAPTER 6

### CONCLUSION AND RECOMMENDATIONS

#### 6.1 Conclusion and result

As the objective of this research, it aims to improve a small building construction (small building is a building which is not over 4 storeys and project cost is not more than 100 million baht) project management by focusing on time, cost, and quality. Company A, which is a construction company run business in northern of Thailand, was a selected case study. In the historical data since company A expand its business from infrastructure industry to a small building construction, it found that the company has been facing the problem relating delay deliverable. This causes the penalty that the company has to pay to the project owner for delay project. This does not only affects the firm in terms of the decrease of margin, but it also influences reliability and customer's perception, and losing opportunities for obtaining new projects.

In order to investigate the root causes of problem, researcher considered the current process through historical data of 6 previous small-sized building construction projects between 2006 to 2012 and adapting problem analysis tools and techniques; such as Fishbone diagram, Pareto Chart, and Fault tree diagram. It found that there are several causes resulting the delay problem. After analysis process, it is obvious that in the period of project execution there are the problems taking place during the process. Those are the root causes affecting project delay. However, most of the cause of delay is mainly caused by inefficient outsource and suppliers, while lack of internal employees and ineffective planning are the secondary causes of the problem. Based on the result, it can be assumed that the effectiveness of outsource and supplier is very necessary and needed to primarily improve. However, owing to the limit of research duration, only problem relating outsource, supplier and project planning were opted to consider, which if those problems are resolved, it means that over 55 percentages of cause of project delay can be tackled. Regarding to the problem analysis, it also discovered an inefficiency of project planning and a lack of risk analysis affecting decision-making in

terms of scheduling and time management, resource arrangement, consideration in making in-house or outsource, and outsource and supplier selection. Therefore, first of all, it is essential to make the project planning to be better than the current process which risks that might happen during the project is the priority concern. Then, the outsource selection process is needed to improve after the firm has already decided to employ an outsource or select a supplier. The detail of each step of development can be summarised as following;

#### 1. Developing new procedure for small-sized building construction

The new procedure that has been developed mostly concern risk in all activities in the project. This is because, an unexpected problem, which means risk, leads to work quality, high cost, and delay problem. Because of that, the new procedure has been developed tries to breakdown the project into individual activities because each activity nature is unique, at the same time; it is able to determine each activity deeply and completely.

As a result, the new procedure was developed which contains some changing points which are;

- Work Breakdown Structure – This helps planner to classify tasks into significant group that this will benefit for prioritising step of work.
- Risk Analysis – This is very important for project planning which it can reduce or avoid the risks that might take place during the project.
- Developing outsources decision-making process and outsources selection process – This assist the firm to analyse and make the decision systematically based on QCD aspects through the information of project requirement and the experience of concern members. At the same time, it also helps the firm to select an appropriate vendor or supplier.



- Schedule control – In order to make the implementation following the plan, project control is required. In the process of schedule control, the assigned checker plays an important role by monitoring the project progress in terms of quality, cost, and activity duration following the milestone defined by project planner.
- Project Assessment – This is a final step for checking and assessing an overall of project in terms of quality and cost before deliverable.

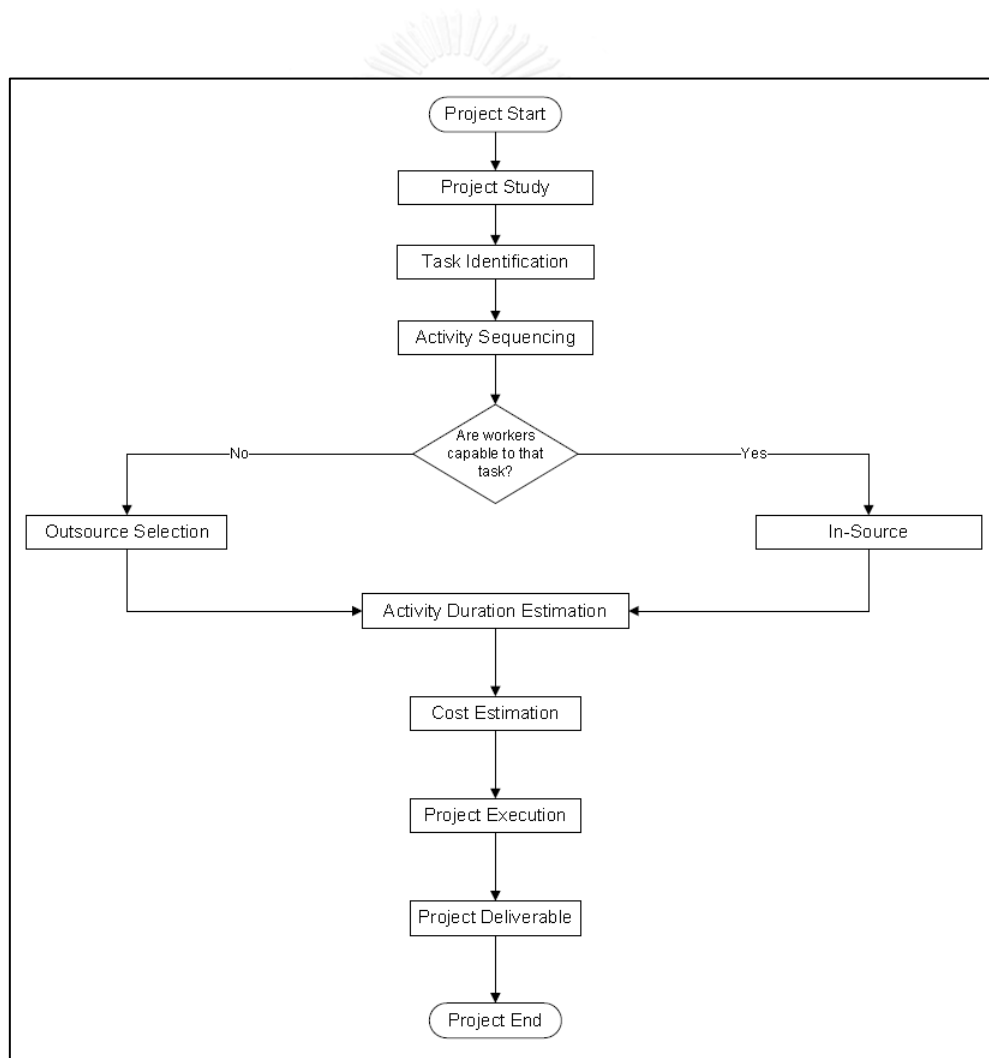


Figure 6-1 Old process for project planning

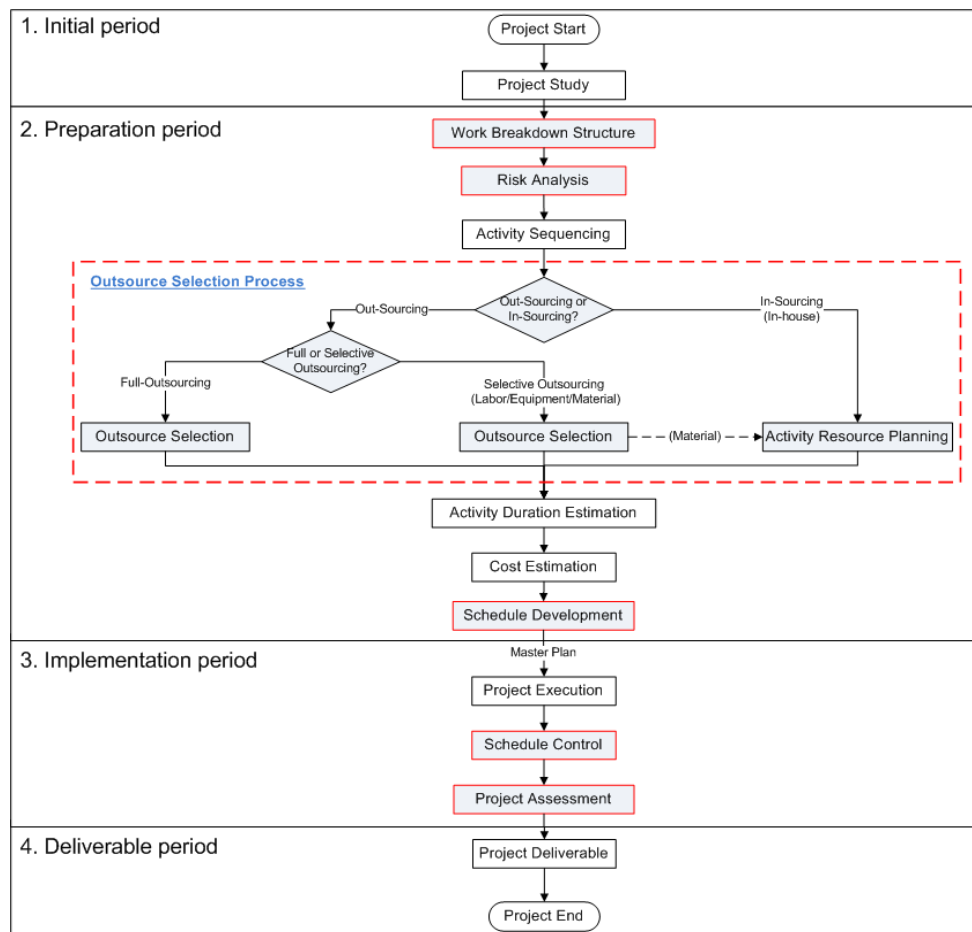


Figure 6-2 New process for project planning

## 2. Developing outsources decision making process

In the past, the consideration of making in-house or outsource is decided by CEO based on individual experience. This causes the mistake in some decisions which lack of incomplete information. Hence, to develop this process, process flow for making decision has been adopted which it contains the guidance and essential factors needed for consideration. Regarding to developed process flow, most of activities can be decided to make in-house or outsource by project planner or project team, while CEO is only responsible for final review and approval.

### 3. Enhancing outsources selection process

In the current process of outsource selection process, cost or expense tend to be a key factor for consideration. However, when the research has been studied through literature review and investigation from real problem, it points out that Quality, Cost, and Delivery (QCD) are three key aspects that influence all activities in any project. Nevertheless, the important of each aspect may not be equal in each activity. This means that cost is not a major factor for all tasks as the firm used to be familiar. Thus, weighting relating aspects in each activity was applied for developing a new process of outsources selection.

Indeed, there are various weighting methods have been widely adapted for outsource selection. However, they are different because each method has limitations under different situations. Thus, researcher utilised Internal Factor Evaluation or IFE method, which is weighting method for evaluating weaknesses and strengths of the company, for evaluate outsource. It is because this method is a systematic analysis. On the other hand, it can benchmark supplier's performance and building the suitable supplier selection mechanism, which should be better than choosing suppliers based on accumulated experience in not effective and reasonable.

Besides, in the process of improvement, the researcher has developed the channel to communicate to sub-contractors and suppliers by distributing the requirements via e-mail and telephone to both existing outsources and new one who are interesting. This helps the company to obtain various outsourcers that can increase the number of candidate and choose the best one who has portfolio, which is suitable with the requirements of the project. In addition, the method of bidding and a new contract agreement using for outsource are proposed.

After the new methodology for dealing with a small-sized building construction project has been developed as the proposed objective of this research. To verify an effectiveness of new approach, the researcher simulated this new process for decision in making in-house or outsources with the six projects in the past which most of them has delay problem. As a result, a new process can totally identify which task is going to make in-house or outsource, at the same time, it also correlate with problems occurring in the project.

Furthermore, in order to examine the outsource selection process developed; one previous project (Technology Kanchanaphisek project, 2012) was simulated in the processes which have a problem relating inefficient vendors. As a result, the vendors that were previously chosen by old method are different from vendors which are selected by using the new process.

To sum up, based on the simulation in 6 previous project or 184 activities, it shows the different decision making of in-source or outsource around 16%, while 15% of activities are needed to review the new outsource or suppliers. This clearly points out the mistake of old outsource selection process in the issues that were not considered.

In addition, to verify the effectiveness of a new procedure for a small building construction project management that have been developed in this research, a researcher applies it into a new project named "DG Municipal office building" since the step of project planning until project deliverable. This project is going to start at the last quarter in 2012 and expected to finish in the first quarter in 2014 (14 months). As a result, this project can be finished early than plan and delivered on time under the satisfied quality. Also, it gains profit from this project over 4.5 million or around 25%. Higher profit is caused by cost saving from; (1) material cost is lower than plan, (2) daily wage is lower than expectation regarding to shorter working time of some in-house activity.

## 6.2 Recommendations

### 1. Nature of work study

Studying a nature of work in each activity is very useful. At the same time, its result can help the firm to have more understanding in its own business. However, different project means dissimilar nature of work. Thus, using this method should be determined under specific of work and situation.

### 2. An application of weighting activity based on QCD

QCD weighting activity adapted in the research is designed for specific construction project based on individual project characteristic. In order to use this method in other construction project. It is recommended to adjust the QCD score by weighting relating aspects in each activity in order to suit for situation and nature of each work. This should be more useful for other kind of construction for using this method in their consideration.

### 3. Skill improvement and Multi-skilled labour

Based on problem analysis, lack of skill of company's employee is a second problem causing project delay. Thus, skill improvement of employees is required. Firstly, the company plan to enhance employee capability by training in specific job, while on the job training will be doing parallel. After that, when an employees expert in their tasks, developing labour ability by supporting work rotation, is likely to enhance the flexibility of work and cost reduction in the future.

### 4. Historical outsource data record

Performance of all vendors and suppliers who have been dealt with the firm should be recorded in the system as individual historical data. The historical data of each vendors or suppliers will be reached when they are considered in a new project.

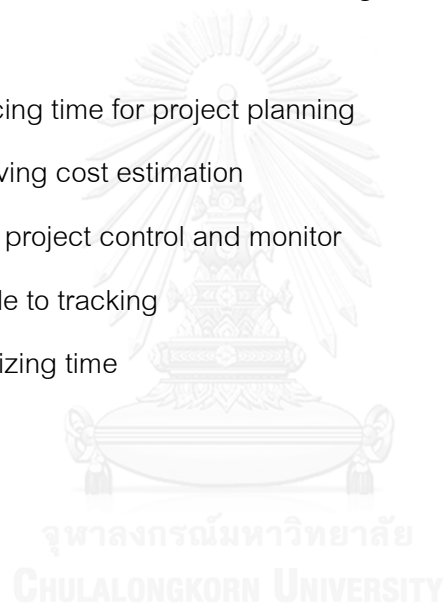
5. Coding system for building materials and suppliers

This will benefit for tracking in terms of price comparison, supplier, standard price, quality of material or vendor, and so on. This information can be used for selecting consideration.

6. MS project application

To develop the effectiveness of project planning, using Microsoft Project is likely to give benefit for the firm. The advantages that can obtain from using MS project are;

- Reducing time for project planning
- Improving cost estimation
- Better project control and monitor
- Be able to tracking
- Optimizing time



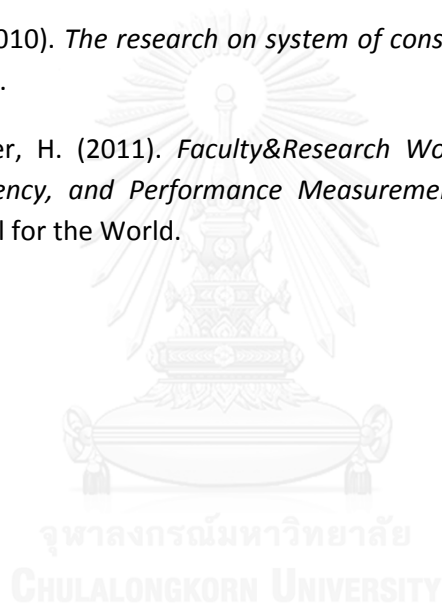
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APPENDICES



APPENDIX A  
CONTRACT AGREEMENT





206 ม.12 ครอบคลุม เชียง อ.เมือง จ.เชียงราย 57000 โทรศัพท์ 053-773898 , 087-0000690 , 081-8818999

## สัญญาจ้างเหมางาน

สัญญาจ้างเลขที่ **SP8/57**

โครงการ :

(งานก่อสร้างโครงสร้างคอนกรีตเสริมเหล็ก ตั้งแต่เขตรักษาพันธุ์สัตว์ป่าจนถึงเขตรักษาพันธุ์สัตว์ป่า)

เลขที่สัญญาจ้างเลขที่ **SP8/57**

ทำที่ **83 ม.9 ต.สันทราย อ.เมือง จ.เชียงราย**

หนังสือสัญญานี้ทำขึ้นระหว่าง **ห้างหุ้นส่วนจำกัด เชียงรายทราเวลเซอร์วิส** โดย **นายวิญญู เตชะธีราวัฒน์** เลขที่ **2513/1** หมู่ที่ **1** ตำบล **เมืองพาน** อำเภอ **พาน** จังหวัด **เชียงราย** เบอร์โทรศัพท์ **053-773898, 087-0000690** ซึ่งต่อไปในสัญญานี้เรียกว่า “**ผู้ว่าจ้าง**” ฝ่ายหนึ่ง

กับ **นายประสาน คำภักดิ์** เลขที่ **412/33** หมู่ที่ **1** ตำบล **ริมกก** อำเภอ **เมือง** จังหวัด **เชียงราย** เบอร์โทรศัพท์ **053-718089, 092-2613943** ซึ่งต่อไปในสัญญาเรียกว่า “**ผู้รับจ้าง**” อีกฝ่ายหนึ่ง

ทั้งสองฝ่ายได้ตกลงกันดังมีข้อความต่อไปนี้

### ข้อ 1. รายละเอียดราคาจ้าง

1.1 ผู้ว่าจ้างตกลงจ้างและผู้รับจ้างตกลงรับจ้างทำ **โครงสร้างอาคารผู้ป่วยนอก โรงพยาบาลดอกคำใต้ (งานก่อสร้างโครงสร้างคอนกรีตเสริมเหล็ก ตั้งแต่เขตรักษาพันธุ์สัตว์ป่าจนถึงเขตรักษาพันธุ์สัตว์ป่า)** สถานที่ทำงาน **โรงพยาบาลดอกคำใต้ อ.ดอกคำใต้ จ.พะเยา** รายละเอียดตามใบปริมาณงานและแบบแปลนแนบท้าย ร ..... ซึ่งราคาไม่รวมภาษีมูลค่าเพิ่ม และภาษีหัก ณ ที่จ่าย **10,360,000 บาท (สิบล้านสามแสนหกหมื่นบาทถ้วน)** ซึ่งราคานี้ไม่รวมภาษีมูลค่าเพิ่ม และภาษีหัก ณ ที่จ่าย

### ข้อ 2. ข้อตกลงว่าจ้าง “เพิ่มเติม”

2.1 กรณีที่ผู้รับจ้างทำงานทั้งหมดเสร็จสิ้นแล้ว หากปรากฏว่างานบางชนิดได้ถูกปรับลดโดยหน่วยงาน โดยทางหน่วยงานมีหนังสือแจ้งปรับลดถึงผู้ว่าจ้าง ผู้รับจ้างยินยอมให้ผู้ว่าจ้างปรับลด โดยลดราคางานนั้นลง ไป 80% ซึ่งคิดราคาตามส่วนที่เพิ่มหรือลดจริงจากรายการประกอบแบบเป็นสำคัญ ทั้งนี้ผู้ว่าจ้างจะแจ้งเป็นลายลักษณ์อักษรให้กับทางผู้รับจ้างทราบถึงเหตุนี้

ลงชื่อ.....ผู้ว่าจ้าง

ลงชื่อ.....ผู้รับจ้าง

2.2 กรณีที่มีงานเพิ่มเติมซึ่งเป็นการประสงค์ของหน่วยงานหรือของผู้ว่าจ้าง ให้ผู้ว่าจ้างและผู้รับจ้างทำการตกลงราคางานนั้นๆก่อนเข้าทำงาน (กรณีเช่นนี้จะไม่มีกรเบิกเงินก่อนเข้าทำงาน) โดยผู้ว่าจ้างจะออกเอกสารจ้างเหมาทำของให้แก่ผู้รับจ้าง

2.3 ผู้รับจ้างต้องไม่เอางานที่จ้างทั้งหมดหรือแต่บางส่วนของสัญญาฉบับนี้ไปจ้างช่วงอีกทอดหนึ่ง โดยไม่ได้รับความยินยอมเป็นลายลักษณ์อักษรจากผู้ว่าจ้าง และความยินยอมดังกล่าวไม่เป็นเหตุให้ผู้รับจ้างหลุดพ้นจากความรับผิดชอบ หรือพ้นหน้าที่ตามสัญญาฉบับนี้ และผู้รับจ้างยังคงต้องรับผิดชอบในความประมาทเลินเล่อของผู้รับจ้างช่วง หรือของตัวแทน หรือลูกจ้างของผู้รับจ้างช่วงนั้นทุกประการ

2.4 ผู้รับจ้างต้องรับผิดชอบต่ออุบัติเหตุ ความเสียหาย หรือภัยอันตรายใดๆอันเกิดจากการปฏิบัติงานของผู้รับจ้าง หรือของลูกจ้างของผู้รับจ้าง และผู้รับจ้างต้องรับผิดชอบแก้ไข ซ่อมแซมคืนให้ดี หรือเปลี่ยนใหม่ โดยค่าใช้จ่ายของผู้รับจ้างเอง ความรับผิดชอบดังกล่าวจะสิ้นสุดลงเมื่อผู้รับจ้างได้ส่งมอบงานงวดสุดท้ายแก่ผู้ว่าจ้างและผู้ว่าจ้างได้ตรวจรับไว้โดยถูกต้องแล้วเท่านั้น

2.5 ผู้รับจ้างจะต้องควบคุมงานที่ได้รับจ้างนี้อยู่ตลอดเวลาจนกว่างานจะแล้วเสร็จ หรือจะมอบหมายให้ผู้อื่นเป็นผู้ควบคุมงานแทนคนก็ได้ กรณีเช่นนี้ ให้ผู้รับจ้างแจ้งชื่อผู้ที่ได้รับมอบหมายให้กับผู้ว่าจ้างทราบเป็นหนังสือ คำสั่งต่างๆซึ่งได้แจ้งเป็นหนังสือแก่ผู้แทนของผู้รับจ้าง ถือว่าได้แจ้งแก่ผู้รับจ้างแล้ว

2.6 ผู้รับจ้างต้องป้องกันมิให้คนงานของตนมีวุ่นวายสุรา เล่นการพนัน ก่อเหตุทะเลาะวิวาท หรือส่งเสียงดัง ณ บริเวณสถานที่ก่อสร้างและที่พักคนงาน โดยเด็ดขาด หรือกระทำการใดอันก่อให้เกิดความเดือดร้อนรำคาญแก่ผู้ว่าจ้างหรือบุคคลอื่นในสถานที่ก่อสร้าง ให้ผู้ว่าจ้างทำหนังสือแจ้งแก่ทางผู้รับจ้างทราบ เพื่อให้ผู้รับจ้างดำเนินการปรับปรุง

2.7 เมื่อการก่อสร้างแล้วเสร็จ ผู้รับจ้างต้องขนย้ายเศษวัสดุจากการก่อสร้าง เครื่องมือเครื่องใช้ต่างๆของผู้รับจ้าง ออกจากบริเวณสถานที่ก่อสร้าง และจัดให้มีการทำความสะอาดให้เป็นที่เรียบร้อย หรือกรณีผู้ว่าจ้างเห็นสมควรให้ขนย้ายเศษวัสดุไป ณ ที่ใดก่อนการก่อสร้างแล้วเสร็จ หากคำขอนั้นชอบด้วยเหตุผล ผู้รับจ้างจะต้องจัดการตามที่ผู้ว่าจ้างร้องขอ

2.8 ห้ามมิให้ผู้รับเหมาหรือคนงานหรือช่างของผู้รับจ้าง เข้าพักในสถานที่ก่อสร้างเป็นอันขาด ถ้ามีการฝ่าฝืน ผู้ว่าจ้างหรือตัวแทนของผู้ว่าจ้างมีสิทธิว่ากล่าวตักเตือน และแจ้งต่อผู้ควบคุมงานก่อสร้างของผู้รับจ้าง

### ข้อ 3. ข้อตกลงเกี่ยวกับวัสดุ-อุปกรณ์ที่ใช้ในการก่อสร้าง

3.1 กรณีวัสดุเหลือจากการใช้งานตามสัญญาจ้างฉบับนี้ ให้ตกเป็นทรัพย์สินของผู้รับจ้าง

3.2 ค่าจ้างตามสัญญา รวมค่าไม้แบบ ค่าคอนกรีต และค่าเหล็กแล้ว

3.3 ค่าจ้างตามสัญญา รวมค่าจ้างแรงงาน ค่าสัมภาระ ค่าขนส่ง ค่าเครื่องจักรในการทำงานก่อสร้าง ค่า

ดำเนินการ ค่าไร่ ค่าอุปกรณ์สิ้นเปลือง และค่าใช้จ่ายอื่นๆที่เกี่ยวข้องกับงานโครงสร้างทั้งหมดจนงานแล้วเสร็จ

ลงชื่อ.....ผู้ว่าจ้าง

ลงชื่อ.....ผู้รับจ้าง

## 3.4 เครื่องจักรในการทำงาน ได้แก่

- 3.4.1 โม่บอยครน
- 3.4.2 แม็คโฮ
- 3.4.3 เครื่องจักรคอนกรีต

## 3.5 การส่งวัสดุเหล็กเสริมคอนกรีตและคอนกรีต ผู้ว่าจ้างจะเป็นผู้จัดหาให้ผู้รับจ้าง

3.6 ผู้ว่าจ้างรับประกันราคาเหล็กที่กิโลกรัมละไม่เกิน **22.80 บาท** หากราคาสูงกว่านี้ถือเป็นภาระของผู้ว่าจ้าง การส่งเหล็กทางผู้รับจ้างส่งเหล็กได้ครั้งละ 33 ตัน และผู้ว่าจ้างจะหักเงินค่าเหล็กออกจากเงินในงวดงานที่ส่งเหล็กนั้นเป็นหลัก ส่วนปริมาณที่เหลือจะหักออกในงวดต่อไปเท่านั้น

3.7 ผู้ว่าจ้างรับประกันราคาคอนกรีต ST240 ที่คิวละไม่เกิน **1.780 บาท** หากราคาสูงกว่านี้ถือเป็นภาระของผู้ว่าจ้าง และทางผู้ว่าจ้างจะหักเงินค่าคอนกรีตออกจากงวดที่ใช้นั้นๆ ตามความเป็นจริง

**ข้อ 4. กำหนดเวลาแล้วเสร็จ**

4.1 ผู้รับจ้างต้องเริ่มทำงานตามที่กำหนดในสัญญาข้อ 1. ให้แล้วเสร็จภายใน **200** วัน นับแต่วันที่รับเงินในงวดเตรียมการ

**ข้อ 5. การขอขยายระยะเวลาทำงาน**

5.1 กรณีที่เกิดเหตุสุดวิสัย ภัยธรรมชาติ การปิดกั้นถนนเข้าสู่พื้นที่ก่อสร้างหรือข้อผิดพลาดอันเกิดจากการสั่งการของผู้ว่าจ้างหรือตัวแทนของผู้ว่าจ้าง ซึ่งทำให้เกิดความล่าช้า อันเป็นเหตุให้การดำเนินงานต้องหยุดชะงัก โดยมีใช้ความคิดของผู้รับจ้าง ผู้รับจ้างต้องให้ผู้ว่าจ้างทราบโดยวาจาทันที และต้องทำหนังสือขอขยายระยะเวลาทำงานเป็นลายลักษณ์อักษรให้แก่ทางผู้ว่าจ้างภายใน 7 วันนับแต่เกิดเหตุดังกล่าว

5.2 หนังสือขอขยายระยะเวลาทำงานนั้นจะมีผลสมบูรณ์ต่อเมื่อผู้ว่าจ้างมีความเห็นชอบเป็นลายลักษณ์อักษรว่าสมควรที่จะขยายระยะเวลาการทำงานออกไป

**ข้อ 6. ค่าปรับ**

6.1 ในกรณีผู้รับจ้างทำงานไม่แล้วเสร็จตามเวลาที่กำหนด ผู้ว่าจ้างมีสิทธิ์ปรับผู้รับจ้าง วันละ **10,360 บาท (หนึ่งหมื่นสามร้อยหกสิบบาทถ้วน)** เว้นแต่จะมีการเปลี่ยนแปลงใดๆซึ่งได้รับความเห็นชอบจากทั้งสองฝ่าย

**ข้อ 7. วิธีการตั้งเบิกเงินค่าจ้างและการรับเงินค่าจ้าง**

7.1 เมื่อผู้รับจ้างทำงานตามงวดงานแล้วเสร็จ ให้ผู้รับจ้างทำการเขียนใบตั้งเบิกงวดเงินที่บริษัทของผู้ว่าจ้างหรือกรณีสถานที่ทำงานอยู่ไกล ผู้รับจ้างสามารถตั้งเบิกผ่าน โพรแมนหรือเช็คเกอร์ของทางบริษัทที่ควบคุมอยู่หน้างาน

7.2 ผู้รับจ้างสามารถส่งงวดงานได้ไม่เกินวันที่ 1 และวันที่ 15 ของเดือน เพื่อรอบจ่ายเงินของบริษัทผู้ว่าจ้าง ในวันที่ 5 และวันที่ 20 ของเดือน และให้ผู้รับจ้างแนบรูปภาพปริมาณงานตามงวดนั้นๆมาด้วยทุกครั้ง

7.3 เมื่อทำเรื่องตั้งเบิกเรียบร้อยแล้ว ภายใน 3 วัน ทางผู้ว่าจ้างจะส่งเจ้าหน้าที่เช็คเกอร์เข้าไปตรวจสอบ เมื่อเห็นว่าปริมาณงานและคุณภาพครบถ้วนตามสัญญา จึงจะถือว่าการตั้งเบิกครั้งนั้นเป็นอันเสร็จสมบูรณ์

ลงชื่อ.....ผู้ว่าจ้าง

ลงชื่อ.....ผู้รับจ้าง

7.4 กรณีงวดงานใดไม่ผ่านการตรวจรับ และต้องดำเนินการแก้ไขปรับปรุง ให้ผู้รับจ้างดำเนินการแก้ไขให้แล้วเสร็จและแจ้งให้ผู้ว่าจ้างหรือตัวแทนของผู้ว่าจ้างทราบ เพื่อทำการตรวจรับอีกครั้งหนึ่ง

7.5 ในงวดที่ 2,3,5 และ 8 การส่งงานของผู้รับจ้างจะสมบูรณ์ต่อเมื่อกรรมการตรวจการจ้างของหน่วยงานได้ตรวจสอบ และอนุมัติให้เบิกงวดเงิน ได้ ภายในระยะเวลา 3 วัน นับจากผู้ว่าจ้างทำเรื่องขอส่งงานกับหน่วยงาน

#### ข้อ 8. การวางเงินประกันผลงาน

8.1 ผู้รับจ้างตกลงรับประกันผลงานกับผู้ว่าจ้างภายในระยะเวลา 360 วัน นับตั้งแต่วันที่ส่งมอบงาน

8.2 ผู้รับจ้างยินยอมให้ผู้ว่าจ้างหักเงินประกันผลงานเป็นจำนวนเงิน 518,000 บาท (ห้าแสนหนึ่งหมื่นแปดพันบาทถ้วน) โดยหักเงินจาก ค่างวดเงิน งวดที่ 6,7 และ 8 งวดละ 172,667 บาท (หนึ่งแสนเจ็ดหมื่นสองพันหกหรือยหกสิบเจ็ดบาทถ้วน) วางไว้กับผู้ว่าจ้างเป็นระยะเวลา 180 วัน นับแต่วันที่วางเงิน

8.3 เมื่อได้วางเงินประกันแล้ว ผู้ว่าจ้างจะออกหนังสือวางเงินประกันผลงานให้แก่ผู้รับจ้าง เมื่อครบกำหนดระยะเวลาตามวรรคก่อนผู้รับจ้างสามารถนำสัญญาฉบับนั้นมาค้ำเบิกค้ำมรอบของบริษัทผู้ว่าจ้าง เพื่อรับเงินคืนได้

#### ข้อ 9. การควบคุมงานของผู้รับจ้าง และการบอกเลิกสัญญา

9.1 ผู้รับจ้างจะต้องควบคุมงานที่ได้รับจ้างอย่างเอาใจใส่ด้วยประสิทธิภาพ โดยใช้ความรู้ ความชำนาญของตนเองในระหว่างปฏิบัติงานอย่างเต็มที่เพื่อให้งานสำเร็จลุล่วง และต้องมีความซื่อสัตย์สุจริต โดยให้ผู้ว่าจ้างเสียค่าใช้จ่ายน้อยที่สุด

9.2 ในกรณีที่ผู้รับจ้างหรือบุคลากรของผู้รับจ้างมิได้กระทำการในหน้าที่ชอบเขตความรับผิดชอบตามงวดงานหรือกระทำการอื่นใด อันเป็นการจงใจหรือประมาทเลินเล่ออย่างร้ายแรง จนเป็นเหตุให้ผู้ว่าจ้างหรือบุคคลภายนอกได้รับความเสียหาย ผู้รับจ้างยินยอมให้ผู้ว่าจ้างบอกเลิกสัญญานี้ได้ทันที และยินยอมชดใช้ค่าเสียหายที่เกิดขึ้นแก่ผู้ว่าจ้างหรือบุคคลภายนอก

9.3 กรณีผู้ว่าจ้างได้บอกเลิกสัญญาตามวรรคบน “ผู้รับจ้าง” ยินยอม ให้ผู้ว่าจ้างเรียกบุคคลภายนอกเข้ามาทำงานที่ว่างงานนั้นจนแล้วเสร็จ โดย “ผู้รับจ้าง” ยินยอมให้ผู้ว่าจ้างเรียกค่าใช้จ่ายอันเกี่ยวเนื่องจากการจ้างที่ว่างงานนั้นจนกว่างานนั้นจะแล้วเสร็จ

9.4 กรณีที่ “ผู้ว่าจ้าง” ทัศนคติไม่ชำระเงินค่าจ้างตามที่ระบุไว้ในแต่ละงวดงาน ผู้รับจ้างสามารถบอกเลิกสัญญาได้ โดยแจ้งความประสงค์เป็นลายลักษณ์อักษรให้ผู้ว่าจ้างทราบ พร้อมกับค้ำเบิกเงินที่ยังคงค้าง

ลงชื่อ.....ผู้ว่าจ้าง

ลงชื่อ.....ผู้รับจ้าง

**ข้อ 10. ค่าใช้จ่ายที่เกี่ยวข้องกับงานตามสัญญา**

10.1 ค่าเช่าที่ดินทำที่พักคนงานของผู้รับจ้าง เดือนละ 10,000 บาทนั้น ผู้ว่าจ้างตกลงเป็นผู้รับผิดชอบค่าใช้จ่ายเป็นระยะเวลา 8 เดือน นับแต่วันเบิกเงินงวดเตรียมการ หากเกินระยะเวลา 8 เดือน ภาระค่าเช่าจะตกเป็นของผู้รับจ้าง

10.2 ค่าไฟฟ้า ค่าน้ำ ของหน้า ไซต์งาน ผู้รับจ้างตกลงเป็นผู้รับผิดชอบค่าใช้จ่ายจนกว่าจะเสร็จงานตามสัญญา

**ข้อ 11. เอกสารอันเป็นส่วนหนึ่งของสัญญา**

11.1 งวดการชำระเงิน

11.2 หนังสือการจดทะเบียนพาณิชย์ของทั้งสองฝ่าย

11.3 สำเนาบัตรประจำตัวประชาชนของทั้งสองฝ่าย

11.4 ตารางราคาคอนกรีต ของ หจก.ดวงแสงทอง และตารางราคาเหล็กเส้น ของ หจก.รุ่งถาวร

11.5 รายละเอียดวัสดุทั้งหมดที่ใช้ในการดำเนินงาน

11.6 รายละเอียดแบบแปลนของงานตามสัญญาทั้งหมด

11.7 รายการหักลดค่าวัสดุตามงวดงานของผู้รับจ้าง

**ข้อ 12. เบอร์โทรศัพท์ติดต่อผู้ว่าจ้างในการประสานงาน**

- สำนักงานใหญ่ 053-773898 , 088-2634005 คุณสรินทิพย์ ชันแก้ว (บี)

- ผู้รับผิดชอบสัญญา 093-0329455 คุณณัฐพล ปาลี (แม็ก)

- เช็คเกอร์ 089-8522320 คุณสิทธิศักดิ์ ภัคดี (หนู่ม)

- โฟร์แมน 084-4847040 คุณเมธเมธา ยะนา (ก้อง)

ลงชื่อ.....ผู้ว่าจ้าง

ลงชื่อ.....ผู้รับจ้าง



### งวดการชำระเงิน

**\*\*เอกสารนี้เป็นส่วนหนึ่งของสัญญา\*\***

ราคาในการจ้างงานทั้งสิ้น 10,360,000 บาท (สิบล้านสามแสนหกหมื่นบาทถ้วน) (ซึ่งยังไม่รวมภาษีมูลค่าเพิ่มและภาษีหัก ณ ที่จ่าย) โดยแบ่งออกเป็น 9 งวด ดังนี้

**งวดเตรียมการ** (5%) เป็นจำนวนเงิน 550,000 บาท (ห้าแสนห้าหมื่นบาทถ้วน) เมื่อเซ็นสัญญา/วางผังทำที่ปักคนงาน/ระบบสาธารณูปโภค และเคลื่อนย้ายไม้แบบ หรือวัสดุอุปกรณ์ที่เกี่ยวข้องกับการทำงานเข้ามายังสถานที่ก่อสร้างแล้วเสร็จ

**งวดที่ 1** - (10%) เป็นจำนวนเงิน 1,100,000 บาท (หนึ่งล้านหนึ่งแสนบาทถ้วน) เมื่อทำงานก่อสร้างฐานรากและหล่อเสาค่อมแล้วเสร็จ *ภายในวันที่.....เพื่อรอบเบิกเงินวันที่.....*

**งวดที่ 2** - (15%) เป็นจำนวนเงิน 1,650,000 บาท (หนึ่งล้านหกแสนหกหมื่นห้าพันบาทถ้วน) เมื่อทำงานหล่อคานคอดิน, งานแผงคสล., งานฐานรากถึงเก็บน้ำได้ดิน, งานถมและปรับดินภายในอาคาร และทำการส่งมอบงานกับกรรมการตรวจงานของหน่วยงานพร้อมผู้ว่าจ้าง แล้วเสร็จ *ภายในวันที่.....เพื่อรอบเบิกเงินวันที่.....*

**งวดที่ 3** - (15%) เป็นจำนวนเงิน 1,650,000 บาท (หนึ่งล้านหกแสนหกหมื่นห้าพันบาทถ้วน) เมื่อทำงานคอนกรีตถึงเก็บน้ำได้ดิน, งานพื้น, งานทางลาดขึ้นชั้น 1, งานหล่อเสารับพื้นที่ชั้น 2 และทำการส่งมอบงานกับกรรมการตรวจงานของหน่วยงานพร้อมผู้ว่าจ้าง แล้วเสร็จ *ภายในวันที่.....เพื่อรอบเบิกเงินวันที่.....*

**งวดที่ 4** - (10%) เป็นจำนวนเงิน 1,100,000 บาท (หนึ่งล้านหนึ่งแสนบาทถ้วน) เมื่อทำงานหล่อคาน, งานพื้นที่ชั้นที่ 2, งานกันสาด, งานหลังคาคสล. ส่วนที่เป็นชั้นเดียว และงานฝ้าถึงเก็บน้ำได้ดิน แล้วเสร็จ *ภายในวันที่.....เพื่อรอบเบิกเงินวันที่.....*

**งวดที่ 5** - (15%) เป็นจำนวนเงิน 1,650,000 บาท (หนึ่งล้านหกแสนห้าหมื่นบาทถ้วน) เมื่อทำงานหล่อเสารับพื้นที่ชั้นที่ 3, งานทางลาดขึ้นชั้นที่ 2, งานบันไดขึ้นชั้นที่ 2 และทำการส่งมอบงานกับกรรมการตรวจงานของหน่วยงานพร้อมผู้ว่าจ้าง แล้วเสร็จ *ภายในวันที่.....เพื่อรอบเบิกเงินวันที่.....*

**งวดที่ 6** - (10%) เป็นจำนวนเงิน 1,100,000 บาท (หนึ่งล้านหนึ่งแสนบาทถ้วน) เมื่อทำงานบันไดขึ้นชั้นที่ 2, งานหล่อคาน พื้นชั้นที่ 3 กันสาดชั้นที่ 3 แล้วเสร็จ *ภายในวันที่.....เพื่อรอบเบิกเงินวันที่.....*

**งวดที่ 7** - (10%) เป็นจำนวนเงิน 1,100,000 บาท (หนึ่งล้านหนึ่งแสนบาทถ้วน) เมื่อทำงานหล่อเสารับคานชั้นหลังคา และหล่อบันไดขึ้นชั้นที่ 3 แล้วเสร็จ *ภายในวันที่.....เพื่อรอบเบิกเงินวันที่.....*

**งวดที่ 8** - (10%) เป็นจำนวนเงิน 1,100,000 บาท (หนึ่งล้านหนึ่งแสนบาทถ้วน) เมื่อทำงานหล่อคานและกันสาดหลังคาทั้งหมด และทำการส่งมอบงานกับกรรมการตรวจงานของหน่วยงานพร้อมผู้ว่าจ้าง แล้วเสร็จ *ภายในวันที่.....เพื่อรอบเบิกเงินวันที่.....*

ลงชื่อ.....ผู้ว่าจ้าง

ลงชื่อ.....ผู้รับจ้าง

APPENDIX B

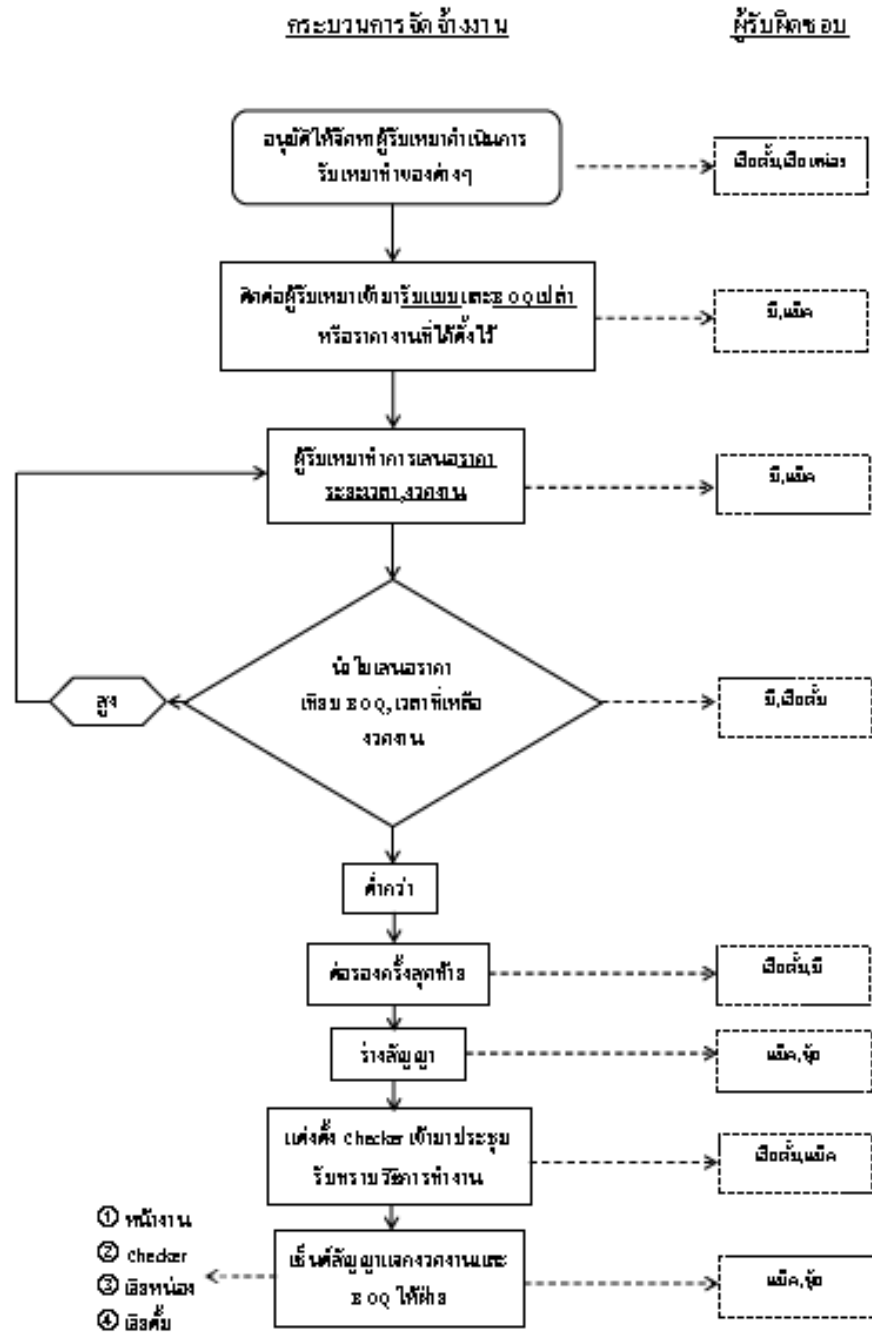
AN EXAMPLE OF VENDER LISTS



ทะเบียนประวัติผู้รับเหมา					
ลำดับ	ชื่อ-นามสกุล (ผู้รับเหมา)	ประเภท	ประเภทงาน/สถานที่ดำเนินการ	ทุนจดทะเบียน	ขนาดงานที่ได้รับ
1	นายภูวสิทธิ์ กิตติบัณฑิตน์โชติ	บุคคลธรรมดา	จ้างเหมาทำงานระบบประปา อาคารเทศบาลต.จ.พะเยา	-	215,000 บาท
2	นายบุญนาค เกียรติ	บุคคลธรรมดา	งานราวสแตนเลส อาคารเทศบาลต.จ.พะเยา	-	34,710 บาท
3	นายอานนท์ แก้วสีต (ช่างตั้ง)	บุคคลธรรมดา	งานไฟฟ้า,งานระบบไฟฟ้าสำหรับเครื่องปรับอากาศ,งานระบบโทรศัพท์,งานระบบ MATV,งานระบบเสียงตามสาย อาคารเทศบาลต.จ.พะเยา	-	1400,000 บาท
4	นายสุรชัย อภิวงศ์	บุคคลธรรมดา	งานติดตั้งเครื่องเสียงห้องประชุมและงานติดตั้งเครื่องกระจายเสียง อาคารเทศบาลต.จ.พะเยา	-	330,000 บาท
5	นายเรืองชัย ทองใบ	บุคคลธรรมดา	จ้างเหมาทำห้องประชุมสภา อาคารเทศบาลต.จ.พะเยา	-	15,000 บาท
6	นายสุรชัย คำคำ	บุคคลธรรมดา	จ้างเหมาทำพื้นพลาเนอ อาคารเทศบาลต.จ.พะเยา	-	ประมาณ 400,000 บาท (คิดตามปริมาณหน้างานจริง)
7	นายอัสราวุฒิ อินทรากรม	บุคคลธรรมดา	จ้างเหมาทำงานทาสี อาคารเทศบาลต.จ.พะเยา	-	230,000 บาท
8	บริษัท เอ็น.พี.ดี.อินเตอร์เนชั่นแนล จำกัด โดย นายพนพล ร่มสุข	บริษัทจำกัด	จ้างเหมางานติดตั้งเครื่องปรับอากาศ ชนิดแขวน อาคารเทศบาลต.จ.พะเยา	5,000,000 บาท	895,000 บาท
9	หจก.ป่ามิชา กาโรยธา	ห้างหุ้นส่วนจำกัด	จ้างเหมาทำประตู,หน้าต่างอลูมิเนียม อาคารเทศบาลต.จ.พะเยา	4,000,000 บาท	900,000 บาท
10	สมพงษ์ โพธิ์ยอด	บุคคลธรรมดา	จ้างเหมาทำงานทาสี อาคารเทศบาลต.จ.พะเยา	-	500,000 บาท
11	นายสุรศักดิ์ ไชยสิทธิ์ (เรื่องซ้อออลูมิเนียม)	บุคคลธรรมดา	จ้างเหมางานอลูมิเนียม อาคารพาณิชย์ตึกหน้า 4 ชั้น 37 ห้อง 19 คูหา	-	677,000 บาท
12	นายคณวัฒน์ ศรีจันทร์	บุคคลธรรมดา	จ้างเหมางานประตูด่าน อาคารพาณิชย์ตึกหน้า 4 ชั้น 37 ห้อง 19 คูหา	-	186,265.78 บาท
13	นายเกียรติกร สุภามา (ช่างตั้ง+ช่างหิ้ว)	บุคคลธรรมดา	จ้างเหมาเดินระบบไฟฟ้า อาคารพาณิชย์ตึกหน้า 4 ชั้น 37 ห้อง 19 คูหา	-	640,000 บาท
14	นายวิรัชศักดิ์ รัตนจันทร์	บุคคลธรรมดา	จ้างเหมาทำสแตนเลส อาคารพาณิชย์ตึกหน้า 4 ชั้น 37 ห้อง 19 คูหา	-	79,000 บาท
15	นายนเรศ นามะยอม	บุคคลธรรมดา	จ้างเหมางานถนนคอนกรีต,บ้านสันป่า หมู่ที่ 5 ต.ทานตะวัน อ.พาน จ.เชียงราย	-	86,220 บาท
16	นายประดิษฐ์ บัวอินทร์	บุคคลธรรมดา	จ้างเหมางานติดตั้งเฟอร์นิเจอร์และทาสี ห้องพักโรงแรมพินานอินทร์ จำนวน 73 ห้อง	-	677,450 บาท
17	นายชนวัฒน์ ยานสุวรรณ	บุคคลธรรมดา	ถนนลาดยาง CAPE SEAL บ้านป่าก้อ หน้าศูนย์วิจัยพืชสวน-วิทยาลัยเชียงราย ต.ป่าอ้อดอนชัย	-	1,000,000 บาท
18	นายประสาน คำภักดิ์	บุคคลธรรมดา	จ้างเหมางานโครงสร้างอาคารผู้โดยสารนอก โรงพยาบาลอานันท์จ.พะเยา (งานก่อสร้างคอนกรีตเสริมเหล็ก ตั้งแต่ฐานรากขึ้นไปจนถึงเสาเข็มหลังคา)	-	10,360,000 บาท
19	นายฉัฐพงษ์ พิสิทธ์	บุคคลธรรมดา	จ้างเหมาทำแรงดกเข็มเจาะ ขนาด 50 cm. ยาว 12 เมตร จำนวน 89 ต้น อาคารหอพักแพทย์ 24 ห้อง รพ.พะเยา	-	501,960 บาท
20	นายสมมิตร พิสิทธ์	บุคคลธรรมดา	จ้างเหมาทำแรงดกเข็มเจาะ ขนาด 50 cm. ยาว 12 เมตร จำนวน 152 ต้น อาคารผู้โดยสารนอก รพ.ดอกคำใต้	-	875,280 บาท
21	ว่าที่ร้อยตรี ปภาวิน ปวงใจ	บุคคลธรรมดา	พื้นที่แหล่งน้ำห้วยต้นฮ้าง หมู่ที่ 2 ต.โรงช้าง อ.ป่าแดด จ.เชียงราย	-	1,350,000 บาท
22	หจก.เชียงรายรุ่งถาวร	ห้างหุ้นส่วนจำกัด	จ้างเหมางานโครงสร้าง อาคารหอพักแพทย์ 24 ห้อง รพ.พะเยา	30,000,000 บาท	
23	บริษัท เชียงรายพัฒนาวันครบ จำกัด	บริษัทจำกัด	จ้างเหมางานโครงสร้าง อาคารหอพักแพทย์ 24 ห้อง รพ.พะเยา	1,000,000 บาท	
24	หจก.ธราเจริญทรัพย์	ห้างหุ้นส่วนจำกัด	จ้างเหมางานโครงสร้าง อาคารผู้โดยสารนอก รพ.ดอกคำใต้	1,000,000 บาท	
25	หจก.บสท์ ซิตี้ คอนสตรัคชั่น	ห้างหุ้นส่วนจำกัด	จ้างเหมางานโครงสร้าง อาคารผู้โดยสารนอก รพ.ดอกคำใต้	1,000,000 บาท	
26	หจก.สุกั๊ว เจริญทรัพย์	ห้างหุ้นส่วนจำกัด	จ้างเหมางานโครงสร้าง อาคารผู้โดยสารนอก รพ.ดอกคำใต้	1,000,000 บาท	
27	หจก.สมศักดิ์คอนกรีต	ห้างหุ้นส่วนจำกัด	จ้างเหมางานคอนกรีต งานอาคารเรียน 4 ชั้น 12 ห้องเรียน รร.บ้านเก่า อ.พาน	20,000,000 บาท	
28	บริษัท ไฟฟ้าคอนกรีตขันทุลส์ จำกัด	บริษัทจำกัด	จ้างเหมารับทำไม้แบบพลาสติก งานอาคารเรียน 4 ชั้น 12 ห้องเรียน รร.บ้านเก่า อ.พาน	5,000,000 บาท	300,000 บาท
29	บริษัท อุดมไม้แบบจำกัด	บริษัทจำกัด	จ้างเหมารับทำไม้แบบเหล็ก งานอาคารเรียน 4 ชั้น 12 ห้องเรียน รร.บ้านเก่า อ.พาน	2,000,000 บาท	250,000 บาท
30	ห้างหุ้นส่วนจำกัด วี พี สติล	ห้างหุ้นส่วนจำกัด	จ้างเหมารับทำงานหลังคาเหล็ก เมทัลชีท ก่อสร้างหลังคลุมลาน เอนกประสงค์ รพ.พานพสกสว.อ.พาน	1,000,000 บาท	200,000 บาท

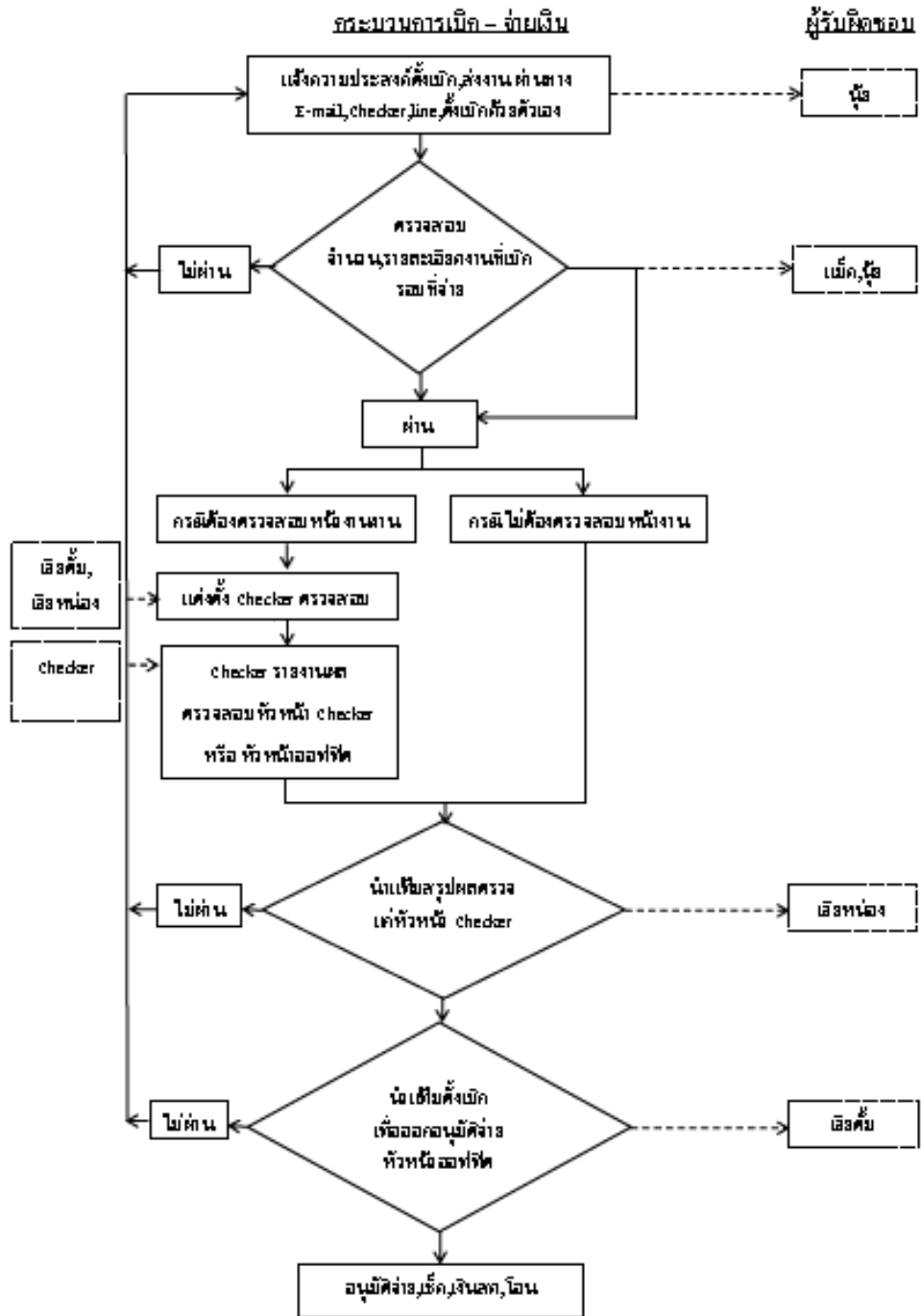
APPENDIX C  
PROCUREMENT PROCESS





APPENDIX D  
DISBURSEMENT





APPENDIX E  
CERTIFICATE PORTFOLIO





ที่ ศธ ๐๖๓๐.๓/ ๓๙๐



สถาบันการอาชีวศึกษาภาคเหนือ ๒  
วิทยาลัยเทคนิคกาญจนาภิเษกเชียงราย  
ถนนเด่นห้า-ดงมะตะ ตำบลป่าอ้อดอนชัย  
อำเภอเมือง จังหวัดเชียงราย ๕๗๑๐๐

หนังสือฉบับนี้ ให้ไว้เพื่อรับรองว่า ห้างหุ้นส่วนจำกัด เชียงรายทรายเพชร เป็นผู้รับจ้าง งานก่อสร้างอาคารเรียนและปฏิบัติการ พื้นที่ใช้สอยประมาณ ๑,๙๒๐ ตารางเมตร ณ วิทยาลัยเทคนิคกาญจนาภิเษกเชียงราย ตามสัญญาจ้าง เลขที่ ๐๐๑/๒๕๕๔ ลงวันที่ ๑๙ กรกฎาคม ๒๕๕๔ จำนวนเงินงบประมาณการก่อสร้าง ๑๕,๓๕๐,๐๐๐ บาท (สิบห้าล้านสามแสนห้าหมื่นบาทถ้วน) และได้ดำเนินการแล้วเสร็จ เมื่อวันที่ ๒๙ มกราคม ๒๕๕๖ คณะกรรมการตรวจการจ้างได้ตรวจรับงานจ้างไว้เป็นการถูกต้องตามสัญญาจ้างทุกประการ

ให้ไว้ ณ วันที่ ๒๐ เดือน มิถุนายน พ.ศ. ๒๕๕๖

(นายเกตุ บุญล้อม)

ผู้อำนวยการวิทยาลัยเทคนิคกาญจนาภิเษกเชียงราย

APPENDIX F  
INSPECTION CHECK LIST





APPENDIX G  
LIST OF BUDGET



Sequence	Activity	Material	Cost	Plant Equipment	Cost	Facility	Cost	People	Cost	Contractor	Cost	Total
<b>A. Civil work</b>												
A1	Earthwork	Reinforced concrete		Backhoe tractor							7,560	7,560
A2	Foundation	Steel										-
A3	Structure	Wood										-
A4	The concrete masonry work for footpath											-
A5	The concrete masonry work for first floor											-
A6	Welding steel roof deck											-
A7	Road construction		301,754						5,167			306,920
			<b>2,272,659</b>						<b>361,227</b>			<b>2,633,886</b>
<b>B. Finishing work</b>												
<b>Roof and Ceiling work</b>												
B1	Tile roofing installation	Tile	613,367					Workers	147,625			760,992
B2	Gable eaves installation	Aluminum foil Etc.										205,400
B3	Porch ceiling (indoor and outdoor)	Gavle eaves ypsum porch (inc. wage)	173,050						32,350			446,900
B4	Porch ceiling eaves	Vinyl eaves	90,000									90,000
			<b>1,323,317</b>						<b>179,975</b>			<b>1,503,292</b>
<b>Partition and Floor work</b>												
B5	Plastering over Masonry walls		571,000								375,400	946,400
B6	Install floor and wall tiles		910,848						236,706		1,147,554	1,147,554
B7	Wooden door casing installation		452,300						452,300			904,600
B8	Railing installation for balcony											-
B9	Railing installation for balcony 2nd floor											-
B10	Installing a bathroom wall		231,125						269,475			500,600
B11	Wooden door installation											-
B12	Aluminum door and window installation		481,500									481,500
B13	Railing installation		194,000						3,000			197,000
B14	Polishing floor	Liquid water proofing	13,310						5,070			18,380
B15	Sand wash work	Sand wash	37,583						20,295			57,877
B16	Polishing stone	Polishing stone	44,400						19,980			64,380
B17	Granite top work	Granite Countertop	70,000									70,000
B18	Install Baseboards/Skirting Boards											-
B19	Install Granite Baseboards											-
B20	Baseboards/Skirting Boards Preparation		27,750						7,400			35,150
B21	Baseboards/Skirting Boards Installation		63,000						79,800			142,800
B22	Install Baseboards/Skirting Boards for 3rd floor											-
B23	Outdoor Stairs installation											-
B24	Conference room		461,300									461,300
<b>Piping and Toilet work</b>												
B25	Piping		404,670						32,450			437,120
B26	Toilet installation	Installed American Stair	246,230						19,938			346,168
<b>Painting work</b>												
B27	Pre-painting		103,500						10,500			24,000
B28	Painting		301,350						67,300			168,650
			<b>4,403,865</b>						<b>1,599,614</b>			<b>6,003,480</b>

Sequence	Activity	Material	Cost	Plant Equipment	Cost	Facility	Cost	People	Cost	Contractor	Cost	Total
<b>C. Miscellaneous work</b>												
C1	Curain installation	งานฉาบปูนห้องประชุม										
C2	Stainless steel billboard	งานติดตั้งสเตนเลส										
C3	Miscellaneous work	งานแป้นเหล็ก	35,000									
			<b>35,000</b>									<b>35,000</b>
<b>D. Electrical work</b>												
D1	Electrical work	งานระบบไฟฟ้า โดยไฟตัวหลัก	583,739				143,790					727,529
D2	High voltage electricity installation	งานไฟสูงแรงสูง	363,876				40,674					404,550
			<b>947,614</b>				<b>184,464</b>					<b>1,132,078</b>
<b>E. Air condition work</b>												
E1	Electricity for air condition	งานติดตั้งเครื่องปรับอากาศ THW EMT ETC.	196,005					Worker	59,140			255,145
E2	Air condition installation	งานติดตั้งเครื่องปรับอากาศ								Wage (inc. Air con.)	1,127,600	1,127,600
			<b>196,005</b>						<b>59,140</b>		<b>1,127,600</b>	<b>1,382,745</b>
<b>F. Sanitary work</b>												
F1	Drainage system	งานวางระบบชักส.ส.	152,350									
			<b>152,350</b>									<b>152,350</b>
<b>G. Network system</b>												
G1	Telephone system	งานระบบโทรศัพท์	167,753								34,790	202,543
G2	Master Antenna Television system (MATV)	ระบบ MATV	44,599								15,430	60,029
			<b>212,352</b>						<b>50,220</b>			<b>262,572</b>
<b>H. TOA / PA Sound system</b>												
H1	TOA system	ระบบเสียงตามสาย	155,260								27,960	183,220
H2	Amplifier system	งานติดตั้งเครื่องขยายเสียง	237,300									237,300
H3	PA system (Meeting Room Audio System)	งานติดตั้งเครื่องเสียงห้องประชุม	242,500								2	242,502
			<b>635,060</b>								<b>27,962</b>	<b>663,022</b>
												<b>13,768,524</b>



## REFERENCES







## VITA

The author name is Mr. Winyu Taechateerawat who was born on 25 October 1987 at Prachanukor hospital in Chiang rai province. The author began primary education at Saint Marry school during 1993 – 1999 The author graduated from high school of Montfort College in 2005.

The author decided to study Mechanical Engineering at Thammasat University in May 2006. The program is double degree with author should transfer to majority of Aerospace Engineering at University of New south wale in 2009. The program allowed the students to work with world-class information company operated in Thailand. It has been the author's pleasure to be qualified for joining Thai Airways international with Summer Student Program. After finishing co-operative education program, the author has graduated within bachelor degree in Aerospace Engineering from University of New South Wales in 2011 and bachelor in Mechanical engineering from Thammasat University in 2009.

After graduation, author immediately joined AFEC of Airport of Thailand as corrective engineering. In the year 2011, the author has joined dual master degree program in Engineering Business Management from Chulalongkorn and Warwick University.

At this moment, the author is working as MD of Chiang rai Sai-Pet Ltd., a construction company since 2012.

