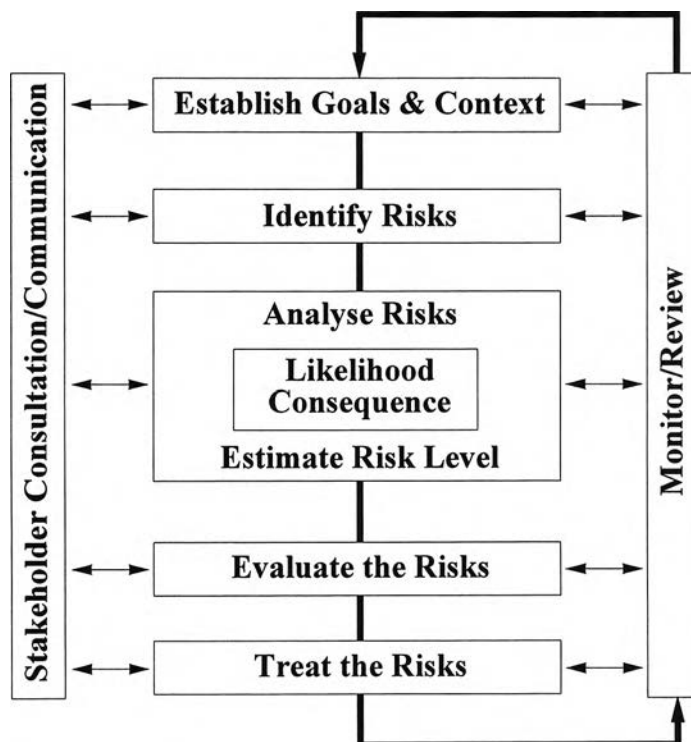


## CHAPTER 5

### FOUNDATION OF RISK MANAGEMENT SYSTEM

The Australian and New Zealand standard on risk management (AS/NZS 4360:2004) is the latest version of risk management standard. It provides systematically steps to facilitate the organization to manage the project, which composes of major steps as following:

1. Establish Goals and Context
2. Identify Risks
3. Analyze Risks
4. Evaluate Risks
5. Treat Risks
6. Monitoring and Review Risks



*Figure 5.1 Risk Management Standards (AS/NZS 4360:2004)*

Source: Standards Australia and Standards New Zealand (2004)

## 5.1 Establish Goals and Context

Establishment of goals and context of risk management enables the organization to understand the environmental of the business sector we operate. The objectives of this stage are to understand the external operating environment and internal organization culture. To establish the internal and external context, the analysis is undertaken through (ACTIA, 2004):

- Establishing the strategic, organizational and risk management context
- Identify the constraints and opportunities of operating environment

Since a competition in a petrochemical construction business has significantly increased, the organization has to face with various potential construction firms. Quality is now an important tool to provide an impression to the client in order to maintain our reputation. To maintain the current quality, many system and standard have been applied into strategic plan.

Since the organization has been established, fundamental objective is to provide the best quality into the construction project for client. The quality objective is *“Do the Right Things and Do it Right the First Time”*. From the director statement, the quality manual of organization is based on the regulations in the quality management systems of ISO 9001. The manual is specifically tailored and made applicable to all engineering and construction services. Quality objective is to direct every employee of organization to *“Do the Right Thing”* and *“Do It Right the First Time”*. Every employee of organization shall make the effort to improve the project quality both technically and efficiently to satisfy customers’ requirements. It is the Quality Assurance Manager’s duty and right to follow necessary guidelines and inspect all relevant documents in order to advise person in charge for correction or improvement in every project.

The organizational policy is to provide the best quality in conformance with contractual requirements and statutory regulations. The organization provides valuable customers with superb quality services to fulfill the contractual requirements and statutory

regulations. The quality manual has been prepared to enforce this quality policy for all our projects.

The important strategic and organizational context, when consider risk management, compose of (CPA Australia, 2004):

- financial
- operational
- competitive
- political
- social
- client
- cultural
- legal

To compete with current competition in this industry, the important strategies include:

- Apply up-to-date information technology.
- Expand to other fields of construction industry. (e.g. commercial building, warehouse)
- Environmental concerned with construction project to cope with current legal.
- Improve the organizational reputation by mean of:
  - quality standards
  - management tools
- Establish alliance plan with vendor and subcontractor.

Internal and external contexts of business we operate could be listed out, which are categorized into organizational strengths, weaknesses, opportunities and threats (SWOT analysis).

SWOT analysis of the case organization is being analyzed as below.:

***STRENGTHS:***

- Large international construction organization.
- Strong organizational culture.
- Flexible management team.
- Strong experience in specified field.

***WEAKNESSES:***

- Inappropriate current management system.
- Insufficient professional officer in various fields.
- Poor human resource management.
- High turnover rate of officer.

***OPPORTUNITIES:***

- Exchange rate becomes more attractive to invest.
- Increasing numbers of construction project.
- Relationship with various clients.
- Construction site is in proper strategic/geographic area.
- Project from domestic and oversea.

***THREATS:***

- Large numbers of competitors in petrochemical construction field.
- IT solutions are aging, which requires up-to-date technology.
- Limitation of petrochemical plant in specified areas.

Risk is generally the important part of any project. Managing of any project has to face with risks which can result from both internal and external factors. Risk can be categorized into major types as follow (AIRMIC et al., 2002):

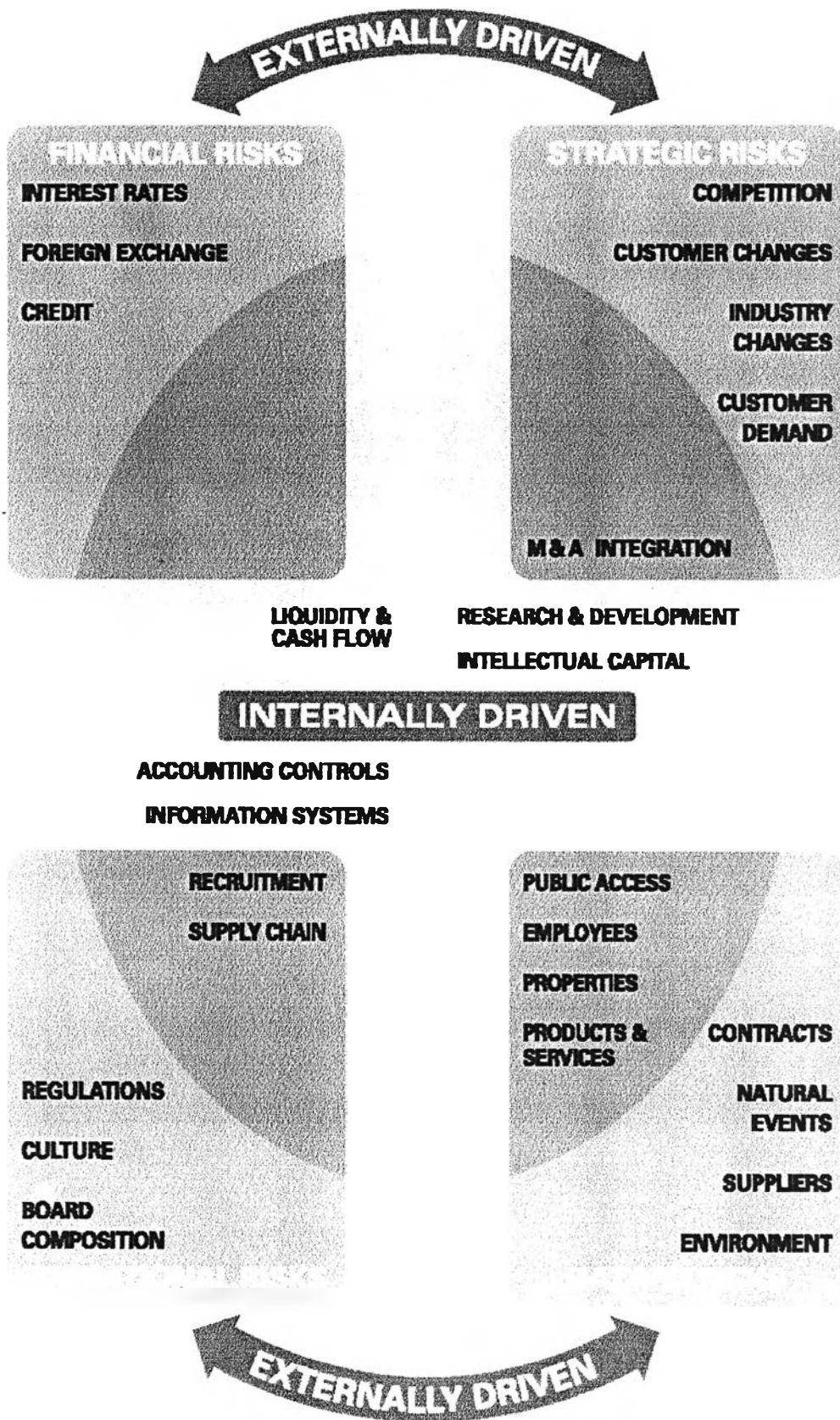


Figure 5.2 Examples of the Driver of Key Risks

Source: AIRMIC, ALARM and IRM (2002)

## 5.2 Identify Risks

Risk in construction project has been considered due to the importance of project objective on quality, cost and schedule to client. Risk is now recognized to the construction business, which involve with unknown, unexpected, undesirable and unpredictable. Typical risks on construction project generally include (Flanagan et al, 1993):

- Failure to complete within the stipulated design and construction time.
- Failure to obtain the expected outline planning, detailed planning or building code/regulation approvals within the time allowed in the design program.
- Unforeseen adverse ground conditions delaying the project.
- Exceptionally inclement weather delaying the project.
- Strike by the labor force.
- Unexpected price rises for labor and materials.
- Failure to let to a tenant upon completion.
- An accident to an operative on site causing physical injury.
- Latent defects occurring in the structure through poor workmanship.
- *Force Majeure* (flood, earthquake, etc.)
- A claim from the contractor for loss and expense caused by the late production of design details by the design team.
- Failure to complete the project within the client's budget allowance.

To identify the risk in any project, it is important to list out all potential risks as much as possible. Brainstorming technique is used to list out the problem or any idea in a short time, which allows members in the group open to show creative ideas. The important rules of brainstorming technique are:

- All participants in the group have to participate in brainstorming.
- All of the ideas must be recorded.
- Criticism of the ideas is not allowed in group session.
- Dominant person over participants in discussion is not allowed.

In petrochemical plant construction business, risk is not only limited within organization, but they are also dominated by customer requirement, vendor, subcontractor and competitor. Drivers of risks on each perspective for plant construction are included:

**Financial Risks**

- Economic downturn
- Exchange rate
- Interest rate
- Liquidity and cash flow

**Strategic Risks**

- Market share
- Level of competitor
- Customer constraint

**Operational Risks**

- Organizational culture
- Management planning
- Fraud
- Human capital

**Hazard Risks**

- Environmental change
- Vendor proficiency
- Contract agreement

## 5.2.1 Potential Risks

Potential risks are the risks that mainly affect the project's objectives. The objective of risk identification is to identify the risk that mostly affects the project progress and its performance for the organization.

Kindinger et al. (2000) studied the risk factor analysis on the project in order to aid in the identification of relevant risks, which is categorized into four board areas:

1. **Technical Risks:** Events or issues that could affect the level of performance in project objective.
2. **Schedule Risks:** The risk associates with the adequacy of time for planning, research and development, design, construction and operation.
3. **Cost Risks:** The risk associates with ability to achieve cost objective of the project.
4. **Funding Risks:** The risk associates with an action plan, which make project fail to meet its objective when it is not available.

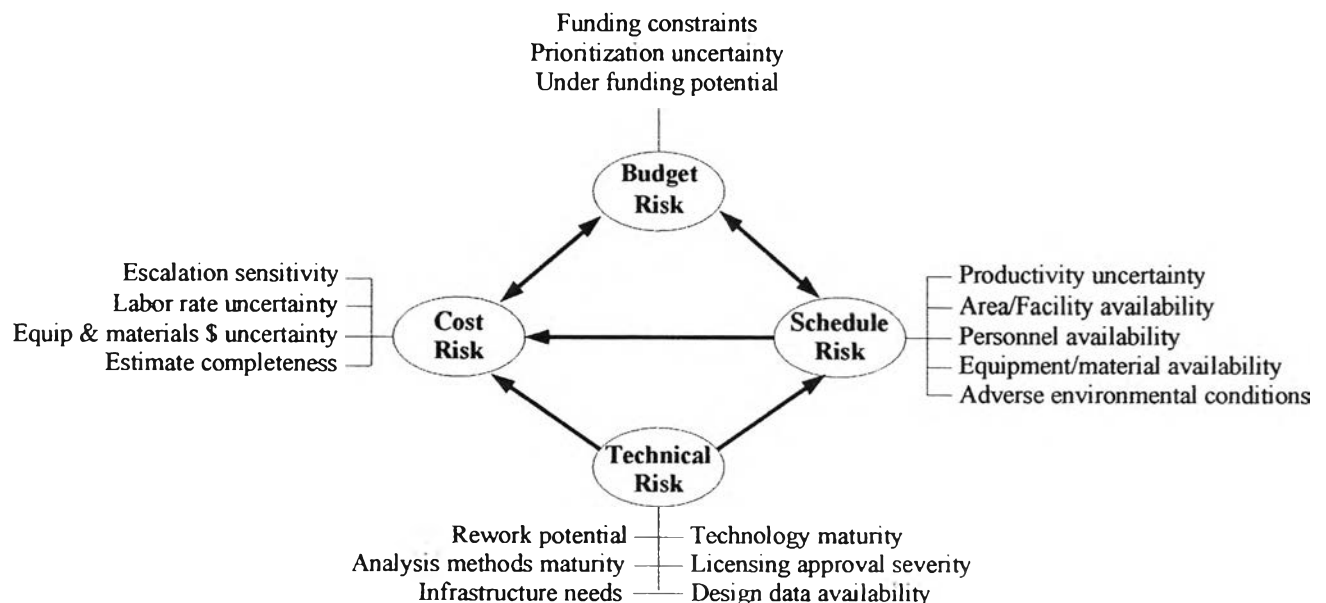


Figure 5.3 Example Qualitative Risk Factor Ranking Criteria

Source: Kindinger, John P. and Karby, John L. (2000)



To identify the potential risks of the case organization, categorized the potential risks for the project execution plan as mention in the previous chapter into three criteria: quality, cost, and schedule, which is easy to manage later.

## Potential Risks on Quality

### 1. Engineering

- ***Lack of understanding of client's requirement:*** Project composes of various details. The needs and understanding for client's requirement are important to control project quality as objective.
- ***Different interpretation of design specification:*** Detail in each component of the project is needed to be matched for each side of work agreement.
- ***Inadequate/Insufficient project estimate or budget:*** Budget is the basic resource of the project. Limitation of budget could cause the engineer to provide best quality into project detail.
- ***Inadequacy of design information:*** Requirement of information for the project details are the basic needs for engineer to further create concept of work.
- ***Uncertainty of design brief at bid stage:*** Bidding stage has to be cleared on all project detail. Quality of the project could be unsatisfied if the details are ambiguity.

### 2. Procurement

- ***Different interpretation of product specification:*** Understanding on product specification has to be considered before procure to project in order to meet requirement.
- ***Improper packing in shipping process:*** Materials or any products could be damaged in case of improper packaging during shipping.
- ***Improper documentation of procurement:*** Document is an evidence of transaction. It shows the materials for construction, which need to be matched with requirement.

### 3. Construction

- ***Unclear instruction to the job site:*** Supervisors are needed for the job site to command the workers to complete the identified work.
- ***Inspection error:*** Supervisor is also required to check whether the work is appropriately done as work plan.
- ***Inappropriate condition of material and equipment:*** Material and equipment status are directly important to the quality of the project.
- ***Inexperience worker for the job:*** Worker is the most important human resource. Experience of worker has to be qualified before recruitment.

## Potential Risks on Cost

### 1. Engineering

- ***Additional period of design work (OT.):*** Extension period of work requires more engineering man-hour to complete work. Thus, work-done over project plan causes cost overrun project budget.
- ***Design over specification requirement:*** Client requirement through the project detail needs the project to fit its purpose. Over specification leads to the higher price of material, which change the cost of project.
- ***Design change during progress:*** Change in detail design is one factor that extends working period for the engineer. Each unit of design change is the work done to the project.
- ***Over estimation of project configuration:*** Project estimation is the basic step prior to project starting. Over estimation causes the project to lose its objective for the client or even lose the bidding.

### 2. Procurement

- ***Price negotiation policy to vendor:*** Vendor supplies various materials to the project. Thus, materials are normally controlled by vendor, which force the organization to plan the negotiation policy to deal project cost change.

- **Taxation policy:** Taxation policy directly affects to the price of material. High tax rate causes expensive material, which results in cost overrun.
- **Uncontrollable material price from vendor:** Materials are generally provided by vendor. Price is also changed by the decision of vendor.
- **Exchange rate:** Project of construction business requires a large investment. Fluctuation of money exchange rate is the factor that can diverge project cost.

### 3. Construction

- **Over material consumption and equipment utilization:** Material consumption and equipment utilization are in job site, which are difficult to control. Each unit of material and equipment utilization is all expenditure.
- **Additional period of job site work (OT.):** Cost of project is directly affected by work done. Additional time is also the additional cost to the project.
- **Labor rate uncertainty:** Labor cost could be changed when the payment rate is changed. The fluctuation of labor rate could rely on present policy or even the type of work.
- **Alteration/Modification of construction:** Project modification lengthens the period of work, which requires more workforces to fix the problem leading to cost overrun.
- **Unpredictable cost change of subcontract work:** Project requires various parties, which outsource is an alternative way to finish inexperienced work. Subcontractor is outside organization, which is difficult to control work activity.

## Potential Risks on Schedule

### 1. Engineering

- ***Insufficient overall design time:*** Design is the process that spends much time to create idea for the project. Insufficient time could lengthen the project schedule.
- ***Revision of specifications and/or design changes:*** Design could be changed during progress. It will spend more time to review and check whether the design is appropriate.
- ***Lack of vendor data:*** Material specification from vendor is important for engineer to calculate detail of the project. Project could be late due to the data is not enough to design the project.
- ***Inadequacy of site investigation:*** Information from site investigation is important to engineering design. Without enough information could take time for engineer to collect more information.
- ***Poor drawing and data control:*** Drawing and data after design stage must be systematically prepared in order to easily trace back. Without systematically control, it could take time to collect the data for moving project forward.
- ***Poor information transfer:*** Information transfer within engineering section must be cleared during progress, because all information will pass through the engineers, which is needed for create the design of the project.
- ***Unstable client's requirement:*** Alteration of specification and design mostly affects the time. Change in client's requirement could happen all the time, when the process has been changed.

### 2. Procurement

- ***Delayed delivery of material and equipment:*** Material supply from vendor could take long time during shipment or even delay due to material preparation plan.

- **Shortage of materials:** In procurement section, planning of material to supply to the project is important to complete as schedule. Material supply to the project needs to be as planned to go along with schedule.
- **Nonconformity of material (Dimensional, quality, and other defects):** Specification of material is required to meet project specification. Procurement has to check material's details to avoid material return, which affects to consecutive plan.

### 3. Construction

- **Inappropriate instructions to the work:** Instruction from supervisor describes the work detail to workers, which is important to run the construction progress as plan.
- **Shortage of material:** Material is important part to construction work. Material shortage could affect to the construction plan.
- **Work load overloading:** Overloading of work requires extension time to finish construction work. This may diverge the schedule, which causes the change in schedule.
- **Accident:** Construction work always causes accident. Accident could happen with labor as well as the project itself. Schedule could be lengthened due to an unexpected accident.
- **Climate change:** Climate is an uncontrollable factor, which would halt the construction work. Outdoor work will be prolonged due to discontinuous work.
- **Unqualified workers:** Experience is important to be considered when recruits the worker. Qualified workers are the key to project success as expect.
- **Unavailability of materials and components:** Tool and equipment are the basic resources to construction work. They are used at the job site, which required the quantity to match each job. Shortage of equipment and tool leads to undesired work progress.



Identified potential risks are taken from many sources. Staff and participant in the organization use their own experience from the projects to identify risks, which associate to those projects. Some potential risks could be taken from other experiences such as research and study. Risks could be more than that of mention. Other risks could be potential risks, but they can be ignored due to their slightly consequences.

### 5.3 Analyze Risks

Identified potential risks from the previous step need to be analyzed in order to indicate their characteristics. In risk analysis step, the objective is to identify the significant of those risks that affect the organizational objective. Impact of potential risks does not have the same significant to the objective, which depends on their likelihood and consequence.

<i>Engineering</i>	<i>Current Control Strategy</i>	<i>Impact</i>
<b>Quality Risks</b>		
• Lack of understanding of client's requirement	-	Quality level
• Different interpretation of design specification	Standard handbook	Quality level
• Inadequate/Insufficient project estimate or budget	-	Quality level
• Inadequacy of design information	Communication with customer	Quality level
• Uncertainty of design brief at bid stage	Clarification in meeting	Quality level
<b>Cost Risks</b>		
• Additional period of design work (OT.)	OT. limitation	Cost overrun
• Design over specification requirement	Standard drawing	Cost overrun
• Design change during progress	-	Cost overrun
• Over estimation of project configuration	Project estimation standard	Cost overrun
<b>Schedule Risks</b>		
• Insufficient overall design time	OT. and expediting	Schedule plan
• Revision of specifications and/or design changes	-	Schedule plan
• Lack of vendor data	Standard handbook	Schedule plan
• Inadequacy of site investigation	Supplementary investigation	Schedule plan
• Poor drawing and data control	Drawing code control	Schedule plan
• Poor information transfer	Internal memorandum	Schedule plan
• Unstable client's requirement	-	Schedule plan

*Table 5.1 Risk Analysis for Engineering Work*

<i>Procurement</i>	<i>Current Control Strategy</i>	<i>Impact</i>
<b><i>Quality Risks</i></b>		
• Different interpretation of product specification	Standard handbook	Quality level
• Improper packing in shipping process	-	Quality level
• Improper documentation of procurement	Typical documentation	Quality level
<b><i>Cost Risks</i></b>		
• Price negotiation policy to vendor	-	Cost overrun
• Taxation policy	BOI agreement	Cost overrun
• Uncontrollable material price from vendor	-	Cost overrun
• Exchange rate	Forward contract	Cost overrun
<b><i>Schedule Risks</i></b>		
• Delayed delivery of material and equipment	Expediting	Schedule plan
• Shortage of materials	Inventory control	Schedule plan
• Nonconformity of material (Dimensional, quality, and other defects)	P.O. documentation	Schedule plan

*Table 5.2 Risk Analysis for Procurement Work*



<i>Construction</i>	<i>Current Control Strategy</i>	<i>Impact</i>
<b><i>Quality Risks</i></b>		
• Unclear instruction to the job site	Supervisor	Quality level
• Inspection error	Supervisor	Quality level
• Inappropriate condition of material and equipment	Continuous inspection	Quality level
• Inexperience of worker	Through subcontractor	Quality level
<b><i>Cost Risks</i></b>		
• Over material consumption and equipment utilization	Mat./Eq. utilization bill	Cost Overrun
• Additional period of job site work (OT.)	-	Cost Overrun
• Labor rate uncertainty	-	Cost Overrun
• Alteration/Modification of construction	-	Cost Overrun
• Unpredictable cost change of subcontract work	Contract agreement	Cost Overrun
<b><i>Schedule Risks</i></b>		
• Inappropriate instructions to the work	Supervisor	Schedule plan
• Shortage of material	Inventory control	Schedule plan
• Work load overloading	OT. And additional labor	Schedule plan
• Accident	-	Schedule plan
• Climate change	-	Schedule plan
• Unqualified workers	Through subcontractor	Schedule plan
• Unavailability of materials and components	Inventory control	Schedule plan

*Table 5.3 Risk Analysis for Construction Work*

### 5.3.1 Risk Estimation

Normally, level of risk could be classified by the value. Classifying the level of risk by a simple value is shown as below:

<b>Risk Ranking</b>	<b>Value</b>
None	0
Low	1
Medium	2
High	3

*Table 5.4 Simple Risk Ranking Level*

Source: Kindinger, John P. and Karby, John L. (2000)

From Australian and New Zealand standard on risk management, risk is assessed by the result from likelihood and its consequence. When assess identified potential risks, risk management team has to consider possibility of the risk occurring, as well as the result (level of seriousness) of the event occurring. Level of identified potential risks can be calculated by:

$$\text{Risk Level} = \text{Likelihood} \times \text{Consequence}$$

		CONSEQUENCE				
		1	2	3	4	5
LIKELIHOOD		Insignificant	Minor	Moderate	Major	Catastrophic
	5 Almost Certain	H	H	VH	VH	VH
4 Likely	M	H	H	VH	VH	
3 Possible	L	M	H	VH	VH	
2 Unlikely	L	L	M	H	VH	
1 Rare	L	L	M	H	H	

*Figure 5.4 AS/NZS Risk Matrix*

Source: Standards Australia and Standards New Zealand (2004)

Note: L: Low, M: Medium, H: High, VH: Very High

Once the identified potential risks has been analyzed their characteristics, estimation for each potential risks is the next process to clarify their levels. Each task of engineering, procurement and construction work is then evaluated by consideration on likelihood and consequence, which bases on AS/NZS Risk Matrix, to further manage.

At this stage, representative from each department is assigned to evaluate the likelihood and consequence for their related risks. Qualification of risk estimator is very important for evaluating risk level in order to get the accurate value. In this case, the manager and experienced staff (leader) of each department are assigned for estimation, because they have more experience from previous project.

Work Breakdown Structure for tasks of three departments is shown below.:

- Task No. for Engineering Work
  - Task 1: Process design and engineering
  - Task 2: Piping Design
  - Task 3: Civil and structural design
  - Task 4: Instrumentation design
  - Task 5: Electrical design
  - Task 6: Mechanical and Equipment Design
  
- Task No. for Procurement Work
  - Task 1: Purchasing/Subcontracting
  - Task 2: Expediting
  - Task 3: Inspection
  - Task 4: Shipping
  - Task 5: Customs Clearance and Inland Transportation
  
- Task No. for Construction Work
  - Task 1: Piling work
  - Task 2: Foundation for equipment and structure
  - Task 3: Steel structure fabrication and erection
  - Task 4: Equipment fabrication and erection
  - Task 5: Piping fabrication and installation
  - Task 6: Electrical equipment installation
  - Task 7: MCC modification and/or installation
  - Task 8: Electrical/Instrument cabling and wiring
  - Task 9: Field instrument calibration and installation
  - Task 10: Insulation
  - Task 11: Painting
  - Task 12: Fire proofing

<i>Estimation of Engineering Work (E)</i>																		
Potential Risks	Rating for task No.																	
	Task 1			Task 2			Task 3			Task 4			Task 5			Task 6		
	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level
<i>Quality Risks</i>																		
1. Lack of understanding of client's requirement	3	3	9	3	3	9	2	3	6	3	3	9	3	3	9	2	2	4
2. Different interpretation of design specification	2	3	6	2	3	6	3	2	6	2	4	8	2	4	8	3	3	9
3. Inadequate/insufficient project estimate or budget	2	4	8	1	4	4	1	3	3	2	4	8	2	4	8	2	4	8
4. Inadequacy of design information	1	5	<b>20</b>	3	1	<b>12</b>	2	3	6	4	4	<b>16</b>	4	5	<b>20</b>	2	3	6
5. Uncertainty of design brief at bid stage	2	3	6	2	2	4	2	3	6	2	2	4	2	2	4	1	3	3
Total Quality Risks	×	×	49	×	×	35	×	×	27	×	×	45	×	×	49	×	×	30
<i>Cost Risks</i>																		
6. Additional period of design work (O.T.)	3	3	9	3	4	<b>12</b>	3	3	9	3	3	9	2	3	6	2	2	4
7. Design over specification requirement	2	4	8	1	3	3	1	4	4	2	3	6	3	3	9	3	3	9
8. Design change during progress	2	2	4	3	3	9	2	4	8	2	3	6	3	3	9	2	2	4
9. Over estimation of project configuration	3	4	<b>12</b>	1	3	3	1	4	4	3	3	9	3	3	9	3	2	6
Total Cost Risks	×	×	33	×	×	27	×	×	25	×	×	30	×	×	33	×	×	23
<i>Schedule Risks</i>																		
10. Insufficient overall design time	3	3	9	2	4	8	2	4	8	2	3	6	2	3	6	2	2	4
11. Revision of specifications and/or design changes	4	2	8	3	2	6	2	4	8	2	3	6	4	2	8	2	2	4
12. Lack of vendor data	2	2	4	1	2	2	1	4	4	2	2	4	1	2	2	3	3	9
13. Inadequacy of site investigation	3	3	9	3	4	<b>12</b>	3	5	<b>15</b>	2	3	6	3	3	9	2	1	2
14. Poor drawing and data control	1	2	2	1	2	2	1	2	2	1	2	2	1	2	2	1	3	3
15. Poor information transfer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2
16. Unstable client's requirement	2	3	6	2	2	4	2	4	8	2	2	4	2	2	4	1	3	3
Total Schedule Risks	×	×	37	×	×	35	×	×	16	×	×	29	×	×	32	×	×	27
Total Tasks	×	×	119	×	×	97	×	×	98	×	×	104	×	×	114	×	×	80

Table 5.5 Risk Estimation for Engineering Work

<i>Estimation of Procurement Work (P)</i>																
Potential Risks	Rating for task No.															
	Task 1			Task 2			Task 3			Task 4			Task 5			
	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	
<i>Quality Risks</i>																
1. Different interpretation of product specification	3	5	15	2	2	4	3	4	12	1	1	1	1	1	1	
2. Improper packing in shipping process	3	5	15	3	5	15	3	4	12	3	5	15	3	4	12	
3. Improper documentation of procurement	3	3	9	3	2	6	3	3	9	1	3	3	1	3	3	
Total Quality Risks	×	×	39	×	×	25	×	×	33	×	×	19	×	×	16	
<i>Cost Risks</i>	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	
4. Price negotiation policy to vendor	2	3	6	0	0	0	0	0	0	1	2	2	0	0	0	
5. Taxation policy	1	3	3	0	0	0	0	0	0	2	3	6	0	0	0	
6. Uncontrollable material price from vendor	3	3	9	0	0	0	0	0	0	0	0	0	0	0	0	
7. Exchange rate	3	2	6	0	0	0	0	0	0	2	3	6	0	0	0	
Total Cost Risks	×	×	21	×	×	0	×	×	0	×	×	14	×	×	0	
<i>Schedule Risks</i>	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	
8. Delayed delivery of materials and equipments	3	5	15	3	3	9	3	3	9	1	4	4	2	2	4	
9. Shortage of materials	1	3	12	1	3	3	3	3	9	1	1	1	1	1	1	
10. Nonconformity of materials (Dimensional, quality, and other defects)	2	1	8	2	3	6	3	1	12	1	1	1	1	1	1	
Total Schedule Risks	×	×	35	×	×	18	×	×	30	×	×	6	×	×	6	
Total Tasks	×	×	98	×	×	43	×	×	63	×	×	39	×	×	22	

*Table 2.6 Risk Estimation for Procurement Work*

<i>Estimation of Construction Work (C) page 1/2</i>															
Potential Risks	Rating for task No.														
	Task 1			Task 2			Task 3			Task 4			Task 5		
	L	C	R. Level	L	C	R. Level	L	C	R. Level	L	C	R. Level	L	C	R. Level
<i>Quality Risks</i>															
1. Unclear instruction to the job site	1	5	5	2	4	8	2	4	8	2	4	8	2	4	8
2. Inspection error	2	4	8	2	5	10	2	5	10	2	4	8	1	5	5
3. Inappropriate condition of material and equipment	1	5	5	2	3	6	3	5	15	3	5	15	2	4	8
4. Inexperience worker	2	5	10	2	5	10	2	4	8	2	5	10	2	4	8
Total Quality Risks	×	×	28	×	×	34	×	×	41	×	×	41	×	×	29
<i>Cost Risks</i>															
5. Over material consumption and equipment utilization	3	4	12	2	4	8	2	5	10	2	5	10	2	5	10
6. Additional period of job site work (OT)	4	3	12	3	3	9	3	3	9	3	3	9	2	4	8
7. Labor rate uncertainty	1	1	1	1	4	4	1	4	4	1	4	4	1	4	4
8. Alteration/Modification of construction	1	5	5	2	5	10	3	4	12	3	5	15	2	5	10
9. Unpredictable cost change of subcontract work	2	5	10	2	5	10	2	4	8	2	4	8	2	5	10
Total Cost Risks	×	×	43	×	×	41	×	×	43	×	×	46	×	×	42
<i>Schedule Risks</i>															
10. Inappropriate instructions to the work	2	1	8	2	4	8	2	4	8	2	4	8	1	5	5
11. Shortage of material	2	4	8	3	3	9	3	3	9	3	3	9	2	4	8
12. Work load overloading	2	5	10	5	3	15	5	4	20	5	3	15	3	4	12
13. Accident	3	5	15	3	4	12	3	3	9	3	3	9	3	5	15
14. Climate change	3	5	15	3	5	15	3	3	9	3	2	6	3	5	15
15. Unqualified workers	1	5	5	1	1	1	1	3	3	1	3	3	1	1	1
16. Unavailability of materials and components	2	1	8	1	4	4	2	4	8	2	4	8	2	4	8
Total Schedule Risks	×	×	69	×	×	67	×	×	66	×	×	58	×	×	67
Total Tasks	×	×	140	×	×	142	×	×	150	×	×	145	×	×	138

Table 5.7 Risk Estimation for Construction Work (page 1/2)

**Evaluation of Construction Work (C) page 2/2**

Rating for task No.																				
Task 6			Task 7			Task 8			Task 9			Task 10			Task 11			Task 12		
L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level
1	5	5	1	4	4	1	5	5	2	4	8	1	3	3	2	1	2	1	3	3
2	5	10	1	4	4	1	5	5	2	5	10	1	4	4	1	1	1	1	5	5
1	3	3	1	3	3	2	1	8	3	4	12	2	2	4	1	1	1	2	1	2
1	5	5	1	5	5	1	3	3	1	5	5	1	2	2	1	2	2	1	3	3
✕	✕	23	✕	✕	16	✕	✕	21	✕	✕	35	✕	✕	13	✕	✕	6	✕	✕	13
L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level
1	2	2	2	3	6	3	2	6	1	2	2	2	3	6	3	1	3	2	3	6
1	3	3	2	3	6	2	2	4	1	1	4	2	2	4	2	2	4	2	2	4
1	1	1	1	5	5	1	1	1	1	5	5	1	4	4	1	4	4	1	4	4
2	3	6	1	5	5	1	3	3	3	4	12	1	1	1	1	1	1	1	1	1
2	3	6	2	3	6	2	1	2	1	5	5	2	1	2	1	1	1	2	2	4
✕	✕	21	✕	✕	28	✕	✕	19	✕	✕	28	✕	✕	17	✕	✕	13	✕	✕	19
L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level	L	C	R Level
1	5	5	1	5	5	1	1	1	2	3	6	2	2	4	2	1	2	2	2	4
2	2	4	2	3	6	2	1	2	2	4	8	1	2	2	1	1	1	1	2	2
2	3	6	2	2	4	2	2	4	1	2	2	2	1	2	1	2	2	2	1	2
1	4	4	2	3	6	2	2	4	1	2	2	2	1	2	2	1	2	2	1	2
3	3	9	3	1	3	3	3	9	2	3	6	3	2	6	3	1	3	3	2	6
1	5	5	1	5	5	1	3	3	1	5	5	1	3	3	1	1	1	1	4	4
2	3	6	2	1	8	2	2	4	1	5	5	2	3	6	1	1	1	2	3	6
✕	✕	39	✕	✕	37	✕	✕	30	✕	✕	34	✕	✕	25	✕	✕	21	✕	✕	26
✕	✕	83	✕	✕	81	✕	✕	70	✕	✕	97	✕	✕	55	✕	✕	40	✕	✕	58

*Table 5.8 Risk Estimation for Construction Work (page 2/2)*



## 5.4 Evaluate Risks

From the estimation of each risk for each task, results are established into risk level by the product of likelihood and consequence. Potential risks are prioritized to indicate the significant to further manage. From each department (engineering, procurement, and construction), the attitude for potential risks is different, which depends on the experience of each participant. All potential risks could not be managed at the same time.

As indicate in AS/NZS risk matrix, VH area is known as the significant potential risks, which need to be urgently considered. In order to manage potential risks, significant potential risks are selected in order to further manage, because not all of potential risks significantly affect to the project. Selection of significant potential risks to further manage will base on AS/NZS risk matrix.

In the case of the nature of each task is different, risk treatment may only apply to the tasks with significant potential risk in order to save the limited resources.

<b>Engineering</b>	
<b>Significant Potential Risks</b>	<b>Causes</b>
<ul style="list-style-type: none"> <li>• Inadequacy of design information</li> <li>• Additional period of design work (OT.)</li> <li>• Over estimation of project configuration</li> <li>• Inadequacy of site investigation</li> </ul>	<ul style="list-style-type: none"> <li>Limitation of the information from owner side</li> <li>Insufficient engineering design</li> <li>Scope of the project is not clear since the bidding stage</li> <li>Limitation of time and permission from owner</li> </ul>
<b>Procurement</b>	
<b>Significant Potential Risks</b>	<b>Causes</b>
<ul style="list-style-type: none"> <li>• Different interpretation of product specification</li> <li>• Improper packing in shipping process</li> <li>• Delayed delivery of material and equipment</li> <li>• Nonconformity of materials (Dimensional, quality, and other defects)</li> </ul>	<ul style="list-style-type: none"> <li>Unclear agreement of perspective on product specification</li> <li>No system for arrangement and handling of product at vendor transportation process</li> <li>Inefficiency of vendor's supply chain management</li> <li>Low consideration on investigation on product</li> </ul>
<b>Construction</b>	
<b>Significant Potential Risks</b>	<b>Causes</b>
<ul style="list-style-type: none"> <li>• Inspection error</li> <li>• Inappropriate condition of material and equipment</li> <li>• Inexperience worker for the job</li> <li>• Over material consumption and equipment utilization</li> <li>• Alteration/Modification of construction</li> <li>• Unpredictable cost change of subcontract work</li> <li>• Work load overloading</li> <li>• Accident</li> <li>• Climate change</li> </ul>	<ul style="list-style-type: none"> <li>Insufficient consideration in more detail</li> <li>Improper utilization</li> <li>Non-systematic recruitment of labor level</li> <li>No appropriate utilization control system</li> <li>Change in client's requirement or error</li> <li>Low experience of subcontractor</li> <li>Ineffective distribution of work on site</li> <li>Poor circumstance in workplace</li> <li>Uncontrollable climate in geographic</li> </ul>

*Table 5.9 Summary of Significant Potential Risks and Causes*

From the experience in petrochemical construction plant construction industry, the organization has to face with many problems during the project has managed. At the end of each project, project summary (project close out) would be prepared to show the result and the significant problems. The causes of risks are taken from the past experience. Score from likelihood and consequence is taken as a standard to make decision, which one should be considered. Accuracy of potential risks, risk level and causes depend on available information, experience, and dedication on risk management of the one who participates in risk management. At this stage, cause of each significant potential risks are explained in more detail.

- ***Limitation of the information from owner side:*** Technology or core competency of the project on owner (client) side is an important asset, which sometime cannot be distributed or exposed to others. From this reason, it forces the owner to limit some information to the organization who will manage the project. Limitation of the information may force an engineer to create work without adequacy of information, which the quality may not match the required quality.
- ***Insufficient engineering designer:*** Most of work in the project has been created by engineering designer. The organization tries to continuously bid the new projects in order to provide the work to engineer. Recruitment of more engineers is a fix cost to the project, which sometime the project is not available. Overlapping of the projects cause the engineers to work in additional period, which can cost more to overall project.
- ***Scope of the project is not clear since the bidding stage:*** Scope of the project is the factor that controls the organization to process the project as the owner requires. Without cleared scope of work from owner could lead the organization to over estimate the configuration of the project in order to cover the requirement.
- ***Limitation of time and permission from owner:*** Objective of investigation on site is for engineer to create an idea to the project. The engineer tries to collect the information as much as possible for design stage. Site investigation is generally limited by the owner due to the operating time and available of officer. When the

permission from the owner on site investigation is limited, engineer needs to investigate more information on the site, which lengthened the schedule, and it also affects the schedule of the other stages.

- ***Unclear agreement of perspective on product specification:*** Quality of the material to be used in the project is needed to be corresponded to the requirement. Agreement of product specification is needed to be cleared to both vendor and organization. Different interpretation on product specification causes an undesired quality on the detail of the project.
- ***No system for arrangement and handling of product at vendor transportation process:*** Some material for construction project could be imported from oversea. Without systematic arrangement and handling, product could be damaged during transportation. This directly affects the quality of material to be used for the project
- ***Inefficiency of vendor's supply chain management:*** Shipping and transportation of vendor side cannot be controlled by the organization. Efficiency of vendor to manage the product also affects the schedule of organization. Inefficient supply chain management of vendor side causes the delayed delivery to the organization. This makes the organization to reschedule the project plan.
- ***Low consideration on investigation on product:*** Responsibility of procurement department is to investigate the purchased material from vendor. Due to the number and various kind of material, procurement department may not have enough ability to investigate the technical material in more detail.
- ***Insufficient consideration in more detail:*** During construction progress, supervisor has to investigate the work in order to get job done as plan. Inspection is generally done at specific points as general standard. Concentration of inspection in more detail of the project is an important key to control quality of the project.

- ***Improper utilization:*** Material and equipment are normally in the hand of labor force. Utilization on those resources is needed the skill to make them in the proper status. Labor force level (in some country) lacks of technical skill to maintain the status of resources. Continuous working may be halted due to the inappropriate circumstance of material and equipment from the previous job.
- ***Non-systematic recruitment of labor level:*** Labor force is an important resource to construction work. Recruitment of labor force normally excludes from the organizational level. Due to the non-systematic recruitment of labor force, inexperience workers may be recruited into the job, which directly affect to the quality of the project.
- ***No appropriate utilization control system:*** Every unit of material for construction is the direct cost of the project. Material consumption and equipment utilization need to be controlled. Utilization control system is required to control the unit cost as identify in the plan in order to avoid additional unit cost from over utilization.
- ***Change in client's requirement or error:*** During the project management, requirement for the client could be changed due to the updated and new data in client side. Change in client requirement causes the modification on some detail of construction. Error information from client also cause the detail of construction has to be modified.
- ***Low experience of subcontractor:*** Qualification of subcontractor is also a factor to the project. Subcontractor is normally required to specified work or some work that required special technical skill. Subcontract work quality is in control of subcontractor. The experience, which could be checked form the previous job and company profile, is an indicator to support subcontract work quality.

- ***Ineffective distribution of work on site:*** Management on construction work requires efficient plan to distribute work. Overloading of construction work normally causes project delay. Overloading of work results from many reasons.
- ***Poor circumstance in workplace:*** From the experience in construction, accident in the project is normally caused by poor circumstance in workplace. Circumstance in this case means safety in workplace, which is mostly concerned in the organization. Accident could happen to the workforce and the project itself. Accident to the project must be controlled by any policy in order not to affect the project schedule.
- ***Uncontrollable climate in geographic:*** Climate is an uncontrollable factor, which generally happens to any construction project. Job site has to cope with an unavoidable climate change. Unexpected climate change could halt the project progress, which the schedule would be changed, and the project delay will happen.

## 5.5 Treat Risks

Since the significant potential risks have been evaluated, the characteristics of risks are clarified to the organization. It is difficult to make the right decision on those risks. The standard of risk treatment is now adapted to specify the scope to manage the risks. Once the organization experiences with the level of risk and its nature, the better decision is taken into each risk.

Risk treatment is the process to take action to the risk. Action to the risk is controlled by its outcome. The objective of risk treatment is to response identified risks. The previous plan and strategy, which were in management plan before risk management process started, have to be modified if the identified risks dominate the current control. From risk management standard, possible response options include:

1. **Risk Avoidance:** Discontinuous or change the project plan to protect objectives from the impact. Better decision will be implemented may need additional resources to sustain objective.
2. **Risk Mitigation:** Level of the risks can be reduced by controlling probability of risk occurring or/and impact of its consequence. Reduction of risk level can be managed by implementation of strategic plan or any control system.
3. **Risk Transfer:** Risk can be transferred from the organization to another party. Level of transferred risks is not changed, but the responsibility is transferred to the others. Transferring of risk may be in part or total. Risk transfer moves the responsibility to another party or sharing the risks through a contract. Transfer of risk can significantly increase if another party cannot manage that risk.
4. **Risk Acceptance:** Not all risk can be reduced or even transferred. Any response strategic plan cannot be implemented to deal with the risk. Risk in this case must be carefully considered and retained in the project.

Once the risks are evaluate to identify their natures, risk treatment options are formulated to each significant potential risk in order to create further action plan.

After the decision from project manager through the risk management team, risk treatment option and recommended action plan are taken into strategic plan to manage the significant potential risks.

<b>Significant Potential Risk</b>		
<b>"Inadequacy of design information"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Limitation of the information from owner side</li> </ul>	Quality Level	Avoidance
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Additional resources are required to protect its impact</li> </ul>		
<b>Significant Potential Risk</b>		
<b>"Additional period of design work (OT.)"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Insufficient engineering designer</li> </ul>	Cost Overrun	Mitigation
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Temporary recruitment for rushing period</li> <li>• Subcontract work</li> </ul>		
<b>Significant Potential Risk</b>		
<b>"Over estimation of project configuration"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Scope of the project is not clear since the bidding stage</li> </ul>	Cost Overrun	Avoidance
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Re-organize the estimation procedure</li> </ul>		
<b>Significant Potential Risk</b>		
<b>"Inadequacy of site investigation"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Limitation of time and permission from owner</li> </ul>	Schedule Plan	Mitigation
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Relocation of workplace for related unit work</li> <li>• Increase number of investigation officer</li> </ul>		

*Table 5.10 Risk Treatment Plan for Engineering Work*



- ***Inadequacy of design information:*** Due to the information from the owner side sometime is limited, and the information cannot be further requested. Additional resources, such as some standard design from the organization could be accepted by the client, could be applied to support the limitation to avoid this risk.
- ***Additional period of design work (OT.):*** Unit cost of OT. work is normally higher than normal work period. Temporary staff for a specific job, and subcontract work could be applied in order to mitigate the risk due to the lower cost rate, while OT. is still included in the plan.
- ***Over estimation of project configuration:*** Normally, the information at bidding stage is not clear enough to make the right decision. It is better to re-organize project estimation procedure to avoid this risk.
- ***Inadequacy of site investigation:*** Time and permission from the owner is very important to the investigation. Increase the number of investigator to reduce investigation time and relocate the related unit work to the owner place to save traveling time in order to reduce the risk of time limitation.

<b>Significant Potential Risk</b>		
<b>"Different interpretation of product specification"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Unclear agreement of perspective on product specification</li> </ul>	Quality Level	Mitigation
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Database updating for product specification</li> </ul>		
<b>Significant Potential Risk</b>		
<b>"Improper packing in shipping process"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• No system for arrangement and handling of product at vendor transportation process</li> </ul>	Quality Level	Transference
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Prepare recommendation on technical shipping.</li> <li>• Prepare guarantee agreement or even cost back</li> </ul>		
<b>Significant Potential Risk</b>		
<b>"Delayed delivery of materials and equipments"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Inefficiency of vendor's supply chain management</li> </ul>	Schedule Plan	Transference
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Implementation of e-commerce through resource ordering</li> </ul>		
<b>Significant Potential Risk</b>		
<b>"Nonconformity of materials (Dimensional, quality, and other defects)"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Low consideration on investigation on product</li> </ul>	Schedule Plan	Mitigation
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Develop and implement technical training program</li> </ul>		

Table 5.11 Risk Treatment Plan for Procurement Work

- ***Different interpretation of product specification:*** Updating the product specification helps the organization to maintain current specification, which has to be continuously managed to reduce unclear product specification.
- ***Improper packing in shipping process:*** Defected product during the transportation process is the responsibility of vendor. Hence this risk can be transfer to the vendor. Technical recommendation will improve the knowledge of handling, and guarantee on shipping helps the organization to transfer the responsibility of product change because of its defect.
- ***Delayed delivery of materials and equipments:*** Delivery is also the responsibility of vendor, hence it is recommended to transfer this risk to vendor. Implementation of e-commerce can reduce the data transaction time, and it is easy to manage the overall resource, which can improve supply chain management.
- ***Nonconformity of materials (dimensional, quality, and other defects):*** Material checking after delivery is very important to get the conformity materials. Technical training is applied to increase the technical knowledge level as well as reduce the effect from nonconformity, which directly increases the knowledge of officer.

<b>Significant Potential Risk</b>		
<b>"Inspection error"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Insufficient consideration in more detail</li> </ul>	Quality Level	Mitigation
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Develop inspection check sheet for each project area in more detail.</li> </ul>		
<b>Significant Potential Risk</b>		
<b>"Inappropriate condition of material and equipment"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Improper utilization</li> </ul>	Quality Level	Mitigation
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Continuous checking plan.</li> <li>• Technical training for proper utilization.</li> </ul>		
<b>Significant Potential Risk</b>		
<b>"Inexperience worker for the job"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Non-systematic recruitment of labor level</li> </ul>	Quality Level	Mitigation
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Develop and implement the recruitment for labor force.</li> </ul>		
<b>Significant Potential Risk</b>		
<b>"Over material consumption and equipment utilization"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• No appropriate utilization control system</li> </ul>	Cost Overrun	Mitigation
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Create data tracking system for resource utilization</li> </ul>		

Table 5.12 Risk Treatment Plan for Construction Work (page 1/3)

- ***Inspection error:*** The error can be reduced by increasing level of consideration to the project. Inspection check sheet helps the inspector to carefully and systematically investigate all areas in order to reduce the error.
- ***Inappropriate condition of material and equipment:*** Due to the improper utilization, material and equipment will be degraded, which leads to the decreasing of their quality. Continuously checking their quality and improving the skill through technical training can make sure that the condition of material and equipment are in proper condition in order to mitigate the risk level.
- ***Inexperience worker for the job:*** Skill of the worker is very important to the project. Systematic recruitment for labor force helps the organization to reduce this risk by screen out the unqualified labor force, which is an important factor to improve project quality.
- ***Over material consumption and equipment utilization:*** Material consumption and equipment utilization in the project needs to be controlled in order to reduce the cost of the project. It is easy to control the resource utilization by create data tracking system, which make sure that the additional cost of utilization is in control.

<b>Significant Potential Risk</b>		
<b>"Alteration/Modification of construction"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Change in client's requirement or error</li> </ul>	Cost Overrun	Transference
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Establish Modification agreement in contract.</li> <li>• Clearing the scope of change in case applicable.</li> </ul>		
<b>Significant Potential Risk</b>		
<b>"Unpredictable cost change of subcontract work"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Low experience of subcontractor</li> </ul>	Cost Overrun	Transference
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Establish cost back statement in contract for inappropriate work.</li> <li>• Alternative subcontractor.</li> <li>• Study profile and past experience before selection.</li> </ul>		
<b>Significant Potential Risk</b>		
<b>"Work load overloading"</b>		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Ineffective distribution of work on site</li> </ul>	Schedule Plan	Mitigation
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Revise work distribution control system</li> </ul>		

*Table 5.13 Risk Treatment Plan for Construction Work (page 2/3)*

- **Alteration/Modification of construction:** Change in detail construction from the client's requirement leads to the increasing of cost. It can be transferred back by the agreement in contract, which helps the organization to avoid the cost of change. In case applicable, clearing the scope of change as much as possible can reduce the cost beyond agreement.

- **Unpredictable cost change of subcontract work:** The margin of cost change can be transferred to subcontractor in case of inappropriate work, which helps the organization to prevent the cost of modification. Alternative subcontractor can be applied if it is cheaper than the current one, can reduce the overall project cost. Subcontractor profile can simply notify the organization about its experience in order to make the right selection.
- **Work load overloading:** Ineffective work distribution directly affects the schedule plan. Risk of overload of distributed work can be reduced by work distribution control system, which facilitates the project team to work without pressure because of overloading work.

<b>Significant Potential Risk</b> "Accident"		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Poor circumstance in workplace</li> </ul>	Schedule Plan	Mitigation
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• Promote accident free program by subsidy</li> <li>• Establish and implement safety standard program</li> <li>• Periodical safety training program for all level</li> </ul>		
<b>Significant Potential Risk</b> "Climate change"		
<b>Cause</b>	<b>Impact</b>	<b>Risk Treatment Option</b>
<ul style="list-style-type: none"> <li>• Uncontrollable climate in geographic</li> </ul>	Schedule Plan	Acceptance
<b>Recommended Action Plan</b>		
<ul style="list-style-type: none"> <li>• No change of strategy due to the uncontrollable factor</li> </ul>		

Table 5.14 Risk Treatment Plan for Construction Work (page 3/3)

- **Accident:** Accident in the workplace can happen at all time. It can be reduced through the worker by the safety training program, which has to periodically

instruct to the worker. Alternative method by subsidy for accident free can attract the worker to carefully working. The proposed plans could make the worker to consider to the overall safety of the project.

- **Climate change:** Climate can change at all time, which cannot be controlled by any approach. The project has to accept this type of risk, and face with any effect from the change of climate by suspend or continue working depending on how serious of the situation.

## **5.6 Monitoring and Review Risks**

Generally, risks in the project change at all time. The current identified risks need to be continuously monitored to sustain or even reduce their likelihood and consequence at an acceptable level. The current identified risks are monitored by apply a warning sign or risk trigger. Attention from all level in organization is required in order to achieve effective risk management.

### **5.6.1 Risk Trigger**

Risk management for each project needs to be continuously considered since the project has been kicked off in order to maintain the project objectives. Due to the level of risk can change at all time, there must be a sign to indicate the change of risk. Risk trigger must be set in order to facilitate the team to take action with the change.

Risk level consideration normally depends on each project the organization. Risk level consideration in this study is categorized into four levels:

1. Low
2. Medium
3. High
4. Very High



Each risk has various risk level of each project task. The highest risk level of each risk factor is set as a considered level. The objective of this study will focus on the significant potential risks (very high). Other risk level could be managed after significant potential risks are in control. Risk level, after the action plan has been taken, normally reduce from its initial level, at least not change.

Monitoring and Review Risks for Engineering Work (E)														
Risk (Ref. No.)	Impact	Treatment Option	Risk Trigger	Risk Level Status										
				Initial				Current						
				L	M	H	VH	L	M	H	VH			
R 1	Quality Level	-	-				X							
R 2	Quality Level	-	-				X							
R 3	Quality Level	-	-				X							
R 4	Quality Level	Avoidance	Frequency of requesting						X					
R 5	Quality Level	-	-		X									
R 6	Cost Overrun	Mitigation	No. of additional O.E.						X					
R 7	Cost Overrun	-	-				X							
R 8	Cost Overrun	-	-				X							
R 9	Cost Overrun	Avoidance	Expectation of project profit						X					
R 10	Schedule Plan	-	-				X							
R 11	Schedule Plan	-	-				X							
R 12	Schedule Plan	-	-				X							
R 13	Schedule Plan	Mitigation	No. of incremental investigation						X					
R 14	Schedule Plan	-	-		X									
R 15	Schedule Plan	-	-	X										
R 16	Schedule Plan	-	-				X							

Table 5.15 Monitoring and Review Risks for Engineering Work

Note: R 1 to R 16 see Table 5.5

L: Low	M: Medium	H: High	VH: Very High
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Monitoring and Review Risks for Procurement Work (P)													
Risk (Ref. No.)	Impact	Treatment Option	Risk Trigger	Risk Level Status									
				Initial				Current					
				L	M	H	VH	L	M	H	VH		
R 1	Quality Level	Mitigation	Requesting time for information				X						
R 2	Quality Level	Transference	No. of defected material				X						
R 3	Quality Level	-	-			X							
R 4	Cost Overrun	-	-		X								
R 5	Cost Overrun	-	-		X								
R 6	Cost Overrun	-	-			X							
R 7	Cost Overrun	-	-		X								
R 8	Schedule Plan	Transference	Range of delayed period				X						
R 9	Schedule Plan	-	-			X							
R 10	Schedule Plan	Mitigation	No. of returned piece				X						

Table 5.10: Monitoring and Review Risks for Procurement Work

Note: R 1 to R 10 see Table 5.6

<b>L: Low</b>	<b>M: Medium</b>	<b>H: High</b>	<b>VH: Very High</b>
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Monitoring and Review Risks for Construction Work (C)														
Risk (Ref. No.)	Impact	Treatment Option	Risk Trigger	Risk Level Status								Comment		
				Initial				Current						
				L	M	H	VH	L	M	H	VH			
R 1	Quality Level	-	-				X							
R 2	Quality Level	Mitigation	No. of defected inspection point					X						
R 3	Quality Level	Mitigation	Correction time					X						
R 4	Quality Level	Mitigation	Turnover of worker					X						
R 5	Cost Overrun	Mitigation	Additional unit of resources					X						
R 6	Cost Overrun	-	-				X							
R 7	Cost Overrun	-	-				X							
R 8	Cost Overrun	Transference	Customer satisfaction index					X						
R 9	Cost Overrun	Transference	No. of modification area					X						
R 10	Schedule Plan	-	-				X							
R 11	Schedule Plan	-	-				X							
R 12	Schedule Plan	Mitigation	Employee satisfaction index					X						
R 13	Schedule Plan	Mitigation	Frequency of halting period					X						
R 14	Schedule Plan	Acceptance	Frequency of halting period					X						
R 15	Schedule Plan	-	-				X							
R 16	Schedule Plan	-	-				X							

Table 5.17 Monitoring and Review Risks for Construction Work

Note: R 1 to R 16 see Table 5.7

<b>I: Low</b>	<b>M: Medium</b>	<b>H: High</b>	<b>VH: Very High</b>
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