EVALUATING RISKS IN CONSTRUCTION PROJECTS BASED ON INTERNATIONAL RISK MANAGEMENT STANDARD AS/NZS ISO 31000:2009

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ABSTRACT

Risk management nowadays has significant important role in ensuring the project implemented successfully, so it is extremely necessary process during undertaking project. In the case of construction projects, they are risky venture, in which implementing risk management framework to mitigate uncertainties and unexpected situations has been received great care recently by most construction companies. There are variety tools and techniques used for managing risks but among them the international risk management standard AS/NZS ISO 3100:2009 is seen as the most feasible framework which can be applied to all kinds of organisations regardless differences related to size, industries and products. This paper aims to introduce AS/NZS ISO 3100:2009 through illustrating identification, analysis and evaluation risks for Hanoi Urban Railway Construction Project, Line 1 (HURC-1) in Vietnam as a case study. Based on qualitative and quantitative method, there are eight events including scope changes, selecting contractors that do not have appropriate skills and experiences to carry out their work, uncertainties concerning the data, applying new technology which has not been sufficiently tested, difficulties in integration vendors, financial problems, government policy changes, the bad weather and political problems. These events are considered as high risk level which required involving parties have appropriate and particular plans to minimizing negative impacts caused by them during project period.

Keywords:
Risk Analysis, Risk Evaluation, AS/NZS ISO 3100:2009, Risk Management, Hanoi Urban Railway Construction Project

INTRODUCTION

Many organisations with their own projects of all types and sizes have faced uncertain events which have an influence on their objectives, which entail risk. Especially, in the case of construction projects with their own unique characteristics, there are a large number of complex and diverse risks **(**Zhao, Hwang & Low 2013), which requires project teams to continuously improve their capacities for identifying, analysing, evaluating and treating risks effectively in order to minimise negative impacts caused by risks on project objectives.

It is the fact that a number of studies related to project risk management in the construction area are conducted in developed countries in which risk management is widely used in most organisations and projects, while some developing countries including Vietnam, risk management is still in infancy stage and lacks of implementation frameworks (Ling 2012). In the case of Vietnam, recently, risk management process has not been concerned by

authorized people and it is seen a complementary aspect of project management areas. This leads to the fact that project team lacks overview picture relating to using appropriate tools and techniques for managing risk, especially in the case of construction projects in which uncertain events can cause huge negative impacts on the project success such as delaying schedule, over budget, out of scope and unsatisfied quality.

Therefore, the paper aims to expand existing literature to establish risk management framework for Vietnamese construction projects by introducing a risk management process based on AS/NZS ISO 3100:2009 - a Joint Australian/New Zealand Standard prepared by Joint Technical Committee OB-007 including seven steps which are context establishment, risk identification, risk analysis, risk evaluation, risk treatment, communication & consultation and monitoring & review. This paper, therefore, is significant as a guide for Vietnamese construction project in risk management.

Moreover, through identifying, analysing and evaluating some critical risks which often happen in the technical, economic, commercial, organisational and political aspects of the construction projects, the paper intends to analyse the Hanoi Urban Railway Construction Project, Line 1 (HURC-1) as a case study. Based on the project's information provided, both the quantitative and qualitative methods will be applied in risk management process. As a result, some suggestions will be presented to manage risks effectively in Vietnamese construction projects.

The objectives of this paper are introducing the principles of International Risk Management Standard **AS/NZS ISO 31000: 2009**, outlining the framework for risk management process based on this standard, defining, analysing and evaluating general risks occurring during implementing the construction project as an example and providing several recommendations that organisations must pay more attention before designing and implementing the risk management framework.

BACKGROUND

According to Rosa (1988), risk is defined as an event where the outcome is uncertain. Another new risk definition that "risk refers to uncertainty about severity of the evens on consequences (or outcomes) of an activity with respect to something that human value (Aven & O 2010). Adrian, R, Malcolm, R & Julia, H (2001) states that risk management is a group process referring to the architecture including principles, framework and process so as to manage risk effectively.

AS/NZS ISO 31000: 2009

ISO 31000 is a standard involving risk management created by the International Organisation for Standardization. ISO 3100:2009 is one of the members in the ISO 31000 family; its purpose is to provide principles, framework and the process for risk management to practitioners and organisations regardless of size, major or activities. AS/NZS ISO 31000-2009 Risk Management – Principles and Guidelines replaces AS/NZS 4360-2004 revised in 2004 by the Joint Australian/New Zealand Committee OB-007 and became revision in 2009, which is seen as the top level executives and others responsible for managing an organisation's risks and achieving objectives.

This standard can be applied to manage risks happening throughout the project life from the beginning to ending with seven process including communication, establish the context,

identification, analysis, valuation, treatment and monitoring & review, which are illustrated below.

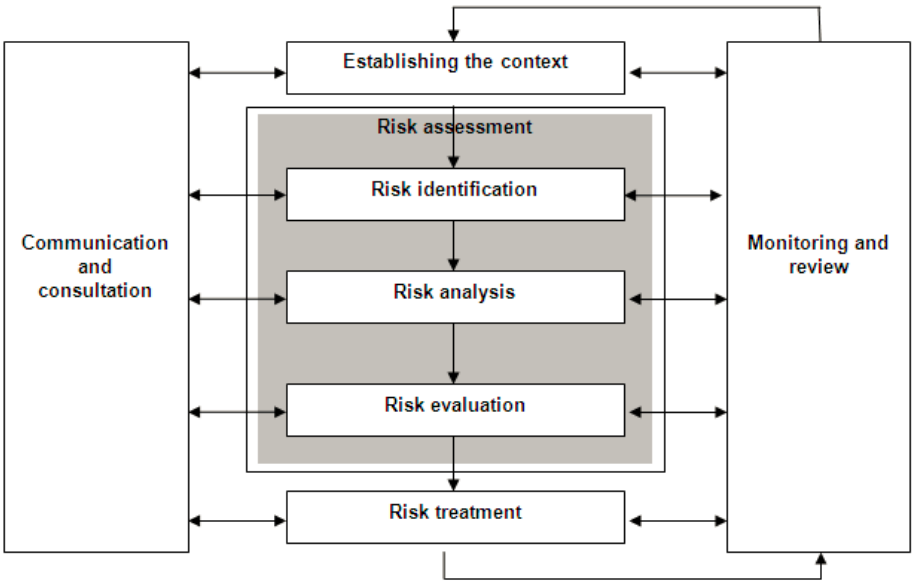

Figure 1: The Risk Management Process
(Adopted from AS/NZ/ISO 31000:2009)

Establish the Context

Establishing the context for risk management seems to be critical due to the reason that this process will identify the objectives, set up scope for the risk assessment process. This process is going to analyse the current risk level of the company by answering the Inherent risk assessment questions as well as discover the internal and external environment by using SWOT matrix to know which are the strengths, the weaknesses, opportunities and threats impacting on the company activities. To be more clear, to establish the internal context for the risk management process, the company should concern some issues relating to the organisation's culture, processes, structure and strategy impacting on the particular way used to manage risk. Regarding external environment, it is very important aspect needed to have deep understanding because it can provides information relating to identify who are stakeholders and what do they expect, which tends to be the objectives of the risk management process. The external context may include analysis involving the social and cultural, political, legal, regulatory, financial, technological and economic issue surrounding the company.

Risk Identification

Risk identification is very important when providing the comprehensive list of risks which probability takes place in all activities during the project period. In this stage, the organisation

tends to identify the risks by creating scenarios happening in different circumstances. They will then discover the causes of risks as well as the potential consequences impacting on the project whether the causes are under organisation control or not. In order to identify risks comprehensively, the organisation should assign the staff who have appropriate knowledge involved in identifying risk and use suitable tools and techniques such as brainstorming, interviews, questionnaires, workshops, feedback, and so on.

Risk Analysis

Risk analysis is a process aiming to identify the causes and sources of risks based on the risk identification. Risk analysis involves discovering the likelihood of the risks as well as multiple consequences impacting on the project objective.

The risk management team can use the qualitative, quantitative or combining of these approaches to analyse risk effectively, which are illustrated in the explanation of qualitative and quantitative assessment (Mike 2013).

Risk Evaluation

After using qualitative and quantitative approach to analyse risk criteria, the project risk management team will calculate the sum up of risk and then define the variances of the objective in comparison with accepted target to identify which risks needed to be considered.

Risk Treatment

The aim of this activity is reducing the likelihood and improving the consequences, which can create positive outcomes for the project activities. After identifying the risks that need to be taken into account, the manager will define options for risk treatment including avoid, accept, reduce or transfer after evaluating the strengths and weaknesses of each option based on the existing resources of the organisation including humans, materials, equipment, management ability and so on. Next, the project team will establish risk treatment plans to provide information about who have responsibilities to treat risks, what they need to do as well as when they will finish.

METHODOLOGY

In order to manage risks effectively, both qualitative and quantitative approach are used.

Quantitative Assessment

Quantitative risk assessment can be applied across whole project period from the starting to the ending point, by identifying the likelihood and potential consequences based on the judgments method using the historical data and other variables combined with expert experience to calculate an estimate for activity parameters.

There are three steps needed to be carried out to assess the risks.

The first step: deciding objectives, KPI's (key performance indexes) /measures, designed target, worst-tolerated outcomes, tolerance value for each component.

The second step: Identify the risk and analyse in term of likelihood, impact and risk level. In other words, the risk management team will estimate the likelihood of each objective together with consequences impacting on the project and then calculate the risk level by multiplying likelihood and consequences.

Risk Level = Likelihood x consequences

The third step: Calculate the risk exposure for every objective such as cost, time, operation capacity and so on by summing up the risk level for each objective.
The fourth step: Make the comparison between the risk exposure of each objective and its tolerance to identify which objectives are under greatest threat or not acceptable (for the case of objectives that their risk level is higher than tolerance).

Qualitative Assessment

Quality risk assessment technique is a form of using words or descriptive scales to identify the likelihood and potential consequences of risk in each activity during the project period. The likelihood and consequences are usually presented as a risk matrix.
The first step is that the scales of likelihood are ranked as a list such as rare, unlikely, possible, likely, almost certain.

The second step is regarding consequences, these rates are listed as insignificant, minor, moderate, major and catastrophic.

The third step is that the project risks management team will then calculate the risk level by combining the likelihood and consequence of each event which shown in the Heat Matrix and recognize the Acceptance Line.

Based on the position of the activity in the Risk level matrix, the project risk management team will identify risks which display high or extreme risk level before analysing and treating risks

Table 1: Likelihood (Adopted from AS/NZS 4360)

Scale	Description	Range
Almost certain	This situation expected to occur in most circumstances	>75%
Likely	This situation is likely to occur in most circumstances	60-75%
Moderate	This situation can occur in moderate	40-60%
Unlikely	This situation can occur in sometime	20-40%
Rare	This situation can rarely	<20%

	occur in sometime	

Table 2: Consequence Scale
(Adopted from AS/NZ/ISO 31000:2009)

Rating	Consequence Description
Insignificant	Impact can be easily absorbed without requiring management effort
Minor	Impact can be readily absorbed but some management effort is required
Moderate	Impact cannot be managed under normal operating conditions; requiring moderate level of resource and management input
High	Impact requires a high level of management attention / effort and resources to rectify
Extreme	Disaster with potential to lead to business collapse and requiring almost total management attention / effort to rectify

Table 3: Risk Matrix (Adopted from AS/NZ/ISO 31000:2009)

Likelihood	Impact				
	I[1]	L[2]	M[3]	H[4]	E[5]
Almost certain	H	H	E	E	E
Likely	M	H	H	E	E
Moderate	L	M	H	E	E
Unlikely	L	L	M	H	E
Rare	L	L	M	H	H

CASE STUDY

The case study in this research paper is Hanoi Urban Railway Construction Project, Line 1 (HURC-1), phase 1. The project owner is Corporation of Vietnam Railways. The Management Board of the rail project (RPMU) plays the role as representing Investors. The project has been going through seven districts of Thanh Tri, Hoang Mai, Thanh Xuan, Dong Da, Hoan Kiem, Ba Dinh and Long Bien. The elevated railway line, 15.36 km of total length, will run south-north

[1] I: Insignificant
[2] L: Low
[3] M: Moderate
[4] H: High
[5] E: Extreme

from Giap Bat to Gia Lam together with Ngoc Hoi station, including many elevated stations, viaducts, depots, and the Red River Railway bridge, which have constructed during 114 months from July 2008 to December 2017 within the estimated budget up to VND 19,553 billion (Hanoi Metropolitan Rail Transport Project Board (HRB) (Board 2011).

This project aims to respond to the increasing demands for transport, making the traffic in Hanoi smoother and alleviating the atmospheric pollution, thus contributing to urban development and environment improvement. This will be achieved through the construction of the urban railway from Gia Lam and Giap Bat Stations (approximately 11 km) and around Ngoc Hoi Station (approximately 4 km), through Hanoi Station (Board 2011).

The entire project is being carried out by Hanoi Metropolitan Rail Transport Project Board (HRB), formerly known as the Hanoi Authority for Tram and Public Transport Development Management (HATD).

Within the research scope, our team will concentrate on risk definition, risk analysis and evaluation process as examples of applying the framework from AS/NZS ISO 31000:2009 Risk identification.

According to Wang, Dulaimi and Aguria (2004), there are numerous ways for categorizing risks occurring during construction projects. For example, some risks are defined based on external risks and internal risks whereas others are categorized in more detail level such as political, financial and market social risks. In the case of Railway construction project in Vietnam, we prefer to identify risks following external and internal categorization.

There are variety of internal risks being identified, based on research of Munier (2014). He also states that high-technology industries such as construction, energy and so on seem to face the same challenges related to uncertainty, complexity and potential risks. Based on this, potential risks relating to technical and organisational elements are chosen to illustrate applying ISO 31000:2009 into this project.

Table 4: Risk Scenarios

Risk ID	Risk scenarios
Internal risks	
1.1	The scope of the project is not very well defined, which lead to scope changes when implementing the project
1.2	The selected contractors do not have appropriate skills and experiences to carry out their work
1.3	There are uncertainties concerning the data; unreliable data related to geographical survey are collected
1.4	Applying new technology which has not been sufficiently tested
1.5	There are many vendors coming from other countries, creating difficulties in integration among them
1.6	The contractors and consultant do not have the adequate structure for the project
1.7	Financial problems related to documented delays by the sponsors
1.8	Relationship among owners and contractors/consultants is considered problematic
1.9	The project jobsite is in an isolated area, which will complicate logistics and personnel movement

1.10	There are some changes related to sending human resources
External risks	
2.1	Government policy changes impacting on the project such as inflation, salaries, negotiation with foreign governments supporting financial resources
2.2	The bad weather which can delay or stop the working process
2.3	Supplier and vendor delays
2.4	Inflation in both the countries including Vietnam and foreign countries supporting ODA
2.5	Political problems or factions fighting on the jobsite
2.6	Religion and culture beliefs in region where the project takes place
2.7	Differing site conditions

Risk Analysis

Risk analysis involves discovering the likelihood of the risks and multiple consequences impacting on the project objectives for both qualitative and quantitative method. Regarding qualitative method, based on professional views in metro construction projects, the risk level of each risk scenario will be defined, following particular steps mentioned in the methodology.

In terms of quantitative method, the impacts of each risk scenario on the project budget, duration and operating capacity will be measured by numeric data.

Table 5: Risk Objectives Adopted by Board (2011)

Objectives	**Type 1**	
KPI's	**Cost**	**Duration**
	VND Billions	Months
Designed target	19,553	114
Tolerance value	5,866	34.2
Worst acceptable target	25,419	148.2

The detail result of risk analysis used both quantitative and qualitative method showed in the Risk Register.

Risk Evaluation

Qualitative Method

After analysing all risk scenarios, the risk management team has concrete evidence to recognize high risk scenarios needed to be pay more concentration, which extracted from Risk register.

Table 6: High Risk Level Events

Risk ID	Risk scenarios	Risk Level
1.1	The scope of the project is not very well defined, which lead to scope changes when implementing the project	H
1.2	The selected contractors do not have appropriate skills and experiences to carry out their work	E
1.3	There are uncertainties concerning the data; unreliable data related to geographical survey are collected	H
1.4	Applying new technology which has not been familiar and sufficiently tested	H
1.5	There are many vendors coming from other countries, creating difficulties in integration among them	H
1.7	Financial problems related to documented delays by the sponsors	H
2.1	Government policy changes impacting on the project such as inflation, salaries, negotiation with foreign governments supporting financial resources	H
2.2	The bad weather which can delay or stop the working process	H

Quantitative Method

(1) Calculating the risk exposure for each objective including cost, time and operation capacity by summing up the risk level for each objective from the Risk register.

(2) Making the comparison between the risk exposure of each KPI and its tolerance to identify whether objectives are under greatest threat or not.

Table 7: The Risk Variance

KPI's	**Behind Schedule** (Months)	**Over Budget** (VND Billion)
Tolerance	34.2	5,866
Total risk level	32.376	4,096
Variance	95%	70%

RESEARCH DISCUSSION

After following the three stages consisting of identifying, analysing and evaluating risks, based on AS/NZS ISO 31000:2009 framework, the team members can have an overview relating to the project risk status. Particularly, identified risks can make the project over the budget up to 4,096 Billion VND and 32 months late in comparison with the established plan. Based on the Risk register summary and following table about the likelihood and consequences of risks, it is clear that conducting the Hanoi Urban Railway Construction Project, Line 1 (HURC-1) has faced extreme level of risks regarding duration and high risk level in terms of budget.

Table 8: The Level of Risk

KPI	**Likelihood**	**Consequences**	
		Duration (Months)	**Cost (VND Million)**
Tolerance value		34.2	5,838.0
E-Extreme	>75%	> 25.65	> 4,399.4
H-High	60-75%	20.52 - 25.65	4,399.4 - 3,519.5
M-Medium	40-60%	13.68 -20.52	3.502.8 -2,335.2
L-Low	20-40%	6.84 -13.68	3.502.8 -2,346.4
I-Insignificant	<20%	<6.84	<1,173.2

By focusing on some risk scenario examples in terms of internal and external aspects, there are eight potential events with abilities to create the project's failure due to high level of risks, through qualitative and quantitative analyse.

The first high risk event relates changes when the scope of the project is not very well defined. This metro system has not been built in Vietnam previously, so there is lack of required skills for development and implementation. This can create a number of mistakes when defining scope of the project. Therefore, changes of scope such as emergence of new task, design changes, new technology equipment replaced and so on during implementing the project can lead to the project failure. Particularly, with the 10% of happening probability, this event can lead to 2 months behind schedule and 2,933 billion over budget.

The second high risk event is that selected contractors do not have appropriate skills and experiences to carry out their work. Besides Japanese consultant organisations, Korean companies including Dealim, Posco E & C and Vietnamese construction company – Hancorp are contractors of the project. It is possible that some of contractors do not have enough capacities to finish their work, negatively influenced on the project quality, scope, time and cost. As a results from the risk register, the probability of this event is unlikely or 20%, creating nearly 6 months late and 977 billion cost over runs.

There are several uncertainties concerning the data; unreliable data related to geographical survey collected. It is the fact that the soil and ground in which the project takes place exist a numerous of risks causing schedule delays, cost increase and dangerous working condition or invalidate designs (Munier 2014). Therefore, if the assessment of site surface is not accurate enough, unexpected situations may occur and have significantly negative impacts on the project objectives. Through quantitative analysis, if this event occurs during carrying this project, the project schedule will extent more than 11 months and extra 1,564 million will be required to finish the project. The next uncertainty comes from applying new technology which has not been familiar and sufficiently tested. Particular, Dr Hosomi (2012) asserts that the latest technology will be used to build up this project while Vietnam is building such kind of systems for the first time. This can lead to high level of risks during implementing project period. In this case, even though the probability is unlikely with 15% of likelihood, if this situation occurs, it will create significantly negative impacts on the project duration and budget. To be more specific, nearly 23 months behind schedule and 1,759.8 million required are seen as the consequences caused by risks.

There are many vendors coming from other countries, creating difficulties in integration among them. Based on announcement of JICA Vietnam Office, several Japanese organisations have participated in carrying the projects as a roles of consulting engineering services such as Association of Japan Transportation Consultants, Inc.; Japan Railway Technical Service; JR East Consultants Company; Japan Electrical Consulting Co. Ltd; Koken Architects, Inc; Transport Investment and Construction Consultants, Jsc.; Transport Engineering Design Inc. and Transport Engineering Design Inc. South, JSC. Moreover, some companies coming from Germany (DOSRCH), Korea and Vietnam also work together in this project. Due to difficulties related to language, communication, techniques as well as experience and skills of each vendor, the integration among them sometimes create problems. The extraction from risk register illustrates that with 30% of likelihood, problems related to vendor integration can lead to closely 6 months late and 586,59 billion needed to expend.

Financial problems related to documented delays by the sponsors. According to research of Global Mass Transit (Hanoi Metro: Vietnam's first metro rail project on track 2013), JICA Vietnam Office and Vietnamese transportation ministry report, the Hanoi Urban Railway Construction Project, Line 1 (HURC-1) is financed by the ODA loan from Japan International Cooperation Agency. It means that required budget for carrying out the project significantly depends on budget allocation plan from the Japan International Co-operation Agency (JICA), which may lead to time delays to finish the project. It is clear from the Risk register that this event can make the project over budget more than 977.65 and behind schedule up to 11 months. Government policy changes impact on the project such as inflation, salaries, negotiation with foreign governments supporting financial resources. The project has been supported by Japanese government with an ODA loan up to JPY 106,053 million. This can make the project duration extend up to 17 months and the project cost requires more than 1,759.8 billion.

The bad weather can delay or stop the working process. It is the fact that the north of Vietnam has 4 different seasons per year, in which raining season will be from May to end of

July, so heavy rain and flood can lead to schedule delay and the increasing of cost. During that moment, project cannot be carried out continuously, leading to more than 9 months behind planned duration and economic loss up to 977 million.

From these results, appropriate suggestions and particular strategies must be created to treat risks proactively as well as monitor and review the risk management process effectively so as to minimise the negative influences generated by identified risks on the project outcomes.

CONCLUSION AND RECOMMENDATION

By introducing AS/NZ/ISO 31000:2009, this paper is significant as a guide for Vietnamese Construction projects in risk management. It provides framework and principles for managing risks, which helps project team and involving people have background knowledge and increase awareness related to how to manage risk by using effective tools and techniques. The risk identification, analysis and evaluation based on AS/NZ/ISO 31000:2009 for the case of the Hanoi Urban Railway Construction Project, Line 1 (HURC-1), phase 1- Ngoc Hoi are illustrated as a case study. However, this research paper also have some limitations regarding providing the project information, collecting data, generating risk scenarios related to the Hanoi Urban Railway Construction Project, Line 1 (HURC-1). Nevertheless, these general materials may be seen as basic background knowledge for further research and application in terms of risk management in developing context including Vietnamese projects and organisations.

There are several recommendations to be concerned when implementing the risk management framework. Firstly, before starting the design and implementation of the frame work for managing risk, it is extremely important to evaluate and understand both the external and internal context of the organisation and the carried project (Adrian, R, Malcolm & Julia 2001). Secondly, organisations should clearly state the organisation's objectives and commitment for risk management. They should ensure that there is accountability, authority and appropriate competence for managing risk. Thirdly, risk management should be integrated with all the organisation's practices and processes in the way that it is relevant, effective and efficient. Fourthly, the organisation must allocate appropriate resources for managing risks, which may include some considerations such as people, skills, experience, training programs, methods & tools used to manage risk.

Furthermore, in order to ensure the results of activities are accurate and reliable; several activities must be carried out. First, workshops or meetings celebrated to generate potential risk scenarios should be taken part in by experts coming from different areas to guarantee that all aspects of the project relating to technical, economic, organisational and political are discussed. Additionally, several valuable methods and techniques such as Expert Judgement methods which are based on the expert experience and historical data collected from previous projects or events to evaluated risk likelihood and consequences efficiently; Monte-Carlo simulation which is seen as the quantitative model to provide a variety of possible outcomes which may occur for any given scenarios should be used to make the risk analysis and evaluation activities become more reliable.

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