FUZZY-MONTE CARLO SIMULATION FOR RISK ANALYSIS IN INVESTMENT PROJECT EVALUATION

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by

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LIST OF ABBREVIATION

NPV	Net Present Value
IRR	Internal Rate of Return
MCS	Monte Carlo Simulation
FL	Fuzzy Logic
AHP	Analytic Hierarchy Process
CF	Cash Flow
FMCS	Fuzzy-Monte Carlo Simulation
CCF	Cummulative Cash Flow
ROI	Return of Investment
COC	Cost of Capital
PI	Profitabilty Index
NPW	Net Present Worth
PV	Present Value
NCF	Net Cash Flow
ACF	Annual Cash Flow
ROR	Rate of Return
DCFOR	Discounted Cash Flow Rate of Return
MARR	Minimum Attractive Rate of Return
RMP	Risk Management Plan
EA	Earned Value
TPM	Technical Performance Measurement
SVR	Supper Vector Regression
BCR	Benefit, Cost and Risk

PT	Perseroan Terbatas (Limited Liability Company)
MERR	Middle East Ring Road
PP	Peraturan Pemerintah (Government Regulation)
PBB	Pajak Bumi dan Bangunan (Land and Building Tax)
GR	Government Rule and Policy Risk
RC	Risk During Construction
FE	Financial and Economic Risk
EN	Environment Risk
TT	Toll Tariff Rate Risk
IR	Interchange and Ramp Risk
MT	Mass Transportation Moda Risk
RT	Rate of Toll Road Tax Risk
CP	Change of Economic and Politic Policy Risk
IF	Inflation Risk
UF	USD Currency Rate Risk
BiR	Bank Interest Rate Risk
MP	Monopoly Risk
TV	Traffic Volume Risk
WI	Failure in Working and Maintenance Insurance
CL	Contingent Liability Risk
CCR	Construction Cost Risk
DR	Construction Design Risk
ER	Equipment Risk
LA	Land Acquisition Risk
CC	Construction Cost Risk

PS	Contract Payment Stoppage
FS	Feasibility Study Risk
IS	Investor Selection Risk
WP	Change of Working Unit Price Risk
BP	Offering Price in Bidding Process
AvP	Quality of Actual Design Unequal with the Plan
DWS	Design Modification and Extra for Volume of Working Scope
CQ	Toll Road Construction Quality Risk
SQ	Supervision Quality Risk
SL	Change of Material Stock Location Risk
SwA	Skill Worker Availabilty Risk
WA	Worker Accident Risk
ET	Material Deffect and Equipment Trouble
FM	Force Majeure
PC	Public Complain
DA	Dirrect Action
VaR	Value at Risk
MF	Membership Function
FIS	Fuzzy Inference System
COA	Centroid of Area
MOM	Mean of Maximum
PDF	Probability Density Function
ROT	Revenue From Toll
SBI	Suku Bunga Bank Indonesia (Interest Rate of Indonesia Central Bank)
BPS	Biro Pusat Statistik (Central Bureau of Statisctics)

IDR	Indonesian Rupiahs
PPP	Public Private Partnership
BOT	Build Operate Transfer

SIMULASI FUZZY-MONTE CARLO UNTUK ANALISIS RISIKO PENILAIAN PROJEK PELABURAN

ABSTRAK

Untuk masa yang lama, memasukkan pengurusan risiko ke dalam rancangan projek pelaburan telah menjadi kaedah yang popular bagi mengurangkan risiko pelaburan. Walau bagaimanapun, masih ada masalah dalam analisis risiko, seperti kesukaran untuk melibatkan risiko-risiko bukan kewangan dalam model ekonomi untuk menilai projek pelaburan. Salah satu penyelesaian bagi pemodelan ketidakpastian dan pengetahuan kualitatif adalah menggunakan logik kabur. Oleh itu, tesis ini mencadangkan simulasi Fuzzy-Monte Carlo yang mampu menghubungkan risiko kewangan dan bukan kewangan untuk mengunjur kebarangkalian aliran tunai kumulatif (CCF), nilai kini bersih (NPV) dan kadar pulangan dalaman (IRR).

Dalam mewujudkan pendekatan yang dicadangkan, tesis ini menjalankan dua kaedah. Pertama, analisis risiko kualitatif untuk mengenal pasti risiko-risiko penting dengan menggunakan analitik proses hierarki (AHP). Kedua, mencari kesan risiko-risiko penting bagi keluaran projek pelaburan melalui analisis risiko kuantitatif dengan simulasi Fuzzy-Monte Carlo. Keluaran fuzzy dan data risiko kewangan ditentukan dalam pengagihan kebarangkalian yang sesuai sebelum simulasi. Tesis ini menjalankan simulasi penglibatan risiko dalam model ekonomi satu kajian kes projek pelaburan bagi keperluan validasi. Keputusan simulasi menunjukkan kepastian kerugian adalah 75% dengan julat rugi USD0-6,792,500 sebagai data sebenar CCF pada tahun 2008. Tambahan pula, unjuran NPV dan IRR, dan juga cadangan untuk perancangan tindakbalas risiko dibentangkan. Keputusan pendekatan yang dicadangkan mengesahkan objektif penyelidikan ini bagi merapatkan risiko kewangan dan bukan kewangan dalam analisis risiko penilaian projek pelaburan.

FUZZY-MONTE CARLO SIMULATION FOR RISK ANALYSIS IN INVESTMENT PROJECT EVALUATION

ABSTRACT

For a long time, incorporating risk management into the investment project plan has been a popular method in order to mitigate a risk of the investment. However, the problem still exists in risk analysis, such as the difficulties to involve the non-financial risks in an economic model for evaluating the investment project. One of the solutions for modeling of imprecise and the qualitative knowledge is employing fuzzy logic. Therefore, this thesis proposes Fuzzy-Monte Carlo Simulation that is able to bridging the financial and non-financial risk for estimating the probability of Cumulative Cash Flow (CCF), Net Present Value (NPV) and Internal Rate of Return (IRR).

In order to realize the proposed solution, this thesis performs two methods. Firstly, the qualitative risk analysis for identifying significant risks by using Analytic Hierarchy Process (AHP). Secondly, the quantitative risk analysis to discover the impact of the significant risks to the investment project output by using Fuzzy-Monte Carlo Simulation. The fuzzy inference system output and historical data of financial risks are assigned in appropriate of probability distribution before simulation. The simulation conducted several scenarios of risk involvement in an economic model of the case study project for validating our approach. The simulation result shows the certainty of loss with a range of loss USD0-6,792,500 as actual data of CCF in year 2008 is 75%. Furthermore, the NPV and IRR estimation and also recommendation for the risk response planning is presented. The results of the proposed solution validate the objective of this work to bridging the financial and non financial risk for risk analysis in investment project evaluation.

CHAPTER 1

INTRODUCTION

1.1 Background

Investment project is putting money into a project with the expectation of gain attractive Net Present Value (NPV) and Internal Rate of Return (IRR) through investment project evaluation (Borgonovo & Peccati, 2004). By deciding to invest in a project, it means that the company is ready to spend money, time, and other valuable resources (Sheng, 2008). However, every investment project is surrounded by uncertainty or risks that potential affecting the project performance such as cost increase, revenue decrease, and over time. The investment project that has not been thoroughly analyzed can be highly risky with respect to the owner's investment due to the possibility of losing money is not within the owner's control (Ngai & Wat, 2005). Thus, the decision makers in the company have to produce an analysis that incorporates the risks into the investment project for mitigating these risks that will affect the project performance (Anthony, 2001; Bannerman, 2008; Finne, 2000).

The process for analyzing the risk or uncertainty factor is referred to risk analysis. It is employed through the process of exploring all impact of the risks that adversely affect the output of a project. Risk analysis is the vital connector between systematic risk identification and realistic significance of risk response (Ngai & Wat, 2005; Zhao, Tong, & Sun, 2009). Indeed, risk analysis technique for an investment project should consider the involvement risks that are multidimensional. Hastak (2000) identified three risks levels: country, market and project in the risk assessment system for international construction project evaluation. Chu (2009) defined the

financial and non-financial risks in corporate loan evaluation. Chen et al. (2009) classified for evaluating information technology investment is under systematic risk that contains financial markets risks and private risks such as team experience, project complexity, planning and controlling.

Nonetheless, the risk analysis method that always used in an investment project evaluation such as probability theory is limited to the financial dimension or the factors that associated with any form of financing (Chiara & Garvin, 2008). probability theory has been studied and applied to various areas of evaluation that perform the economic model of investment decision by using Monte Carlo Simulation (Hacura, Jadamus-Hacura, & Kocot, 2001). Unfortunately, this simulation cannot involve the risks those are non-financial variables (Martinez, 2003). In fact, the risk that impact to project can be derived from the non-financial risks as well. Typically, these non-financial risks are subjective, which were used by decision makers in preliminary phase of the project life cycle to analyze the impact of risk. The subjective approach constantly in linguistic term contains ambiguity data that might lead to inaccurate representation of the uncertainty lack of historical data. Therefore, a risk analysis which is able to handling the non-financial risks that have a strong impact to the project performance of the investment project is necessary.

From above circumstances, there are two different conditions for handling the uncertainty factors in risk analysis of an investment project:

a. The risks in the form of historical data, which is in a financial manner.
b. The non-financial risks, which is subjective or the sufficient historical data is not available.

Fortunately, Fuzzy logic (Zadeh, 1965) provides an approach for handling linguistic variables and solving processes when have to deal with imprecise, uncertain and vague data. Fuzzy logic has been widely used because of its obvious advantages of effectively dealing with uncertainty and capturing experts' knowledge on a specific problem and using its knowledge to make decisions. Many applications of Fuzzy logic have been used successfully in several fields. For example, Bates and Young (2003) deployed Fuzzy logic for medical decision-making in intensive care units, predicting industrial construction labour productivity (Fayek & Oduba, 2005) and cost estimating (Ahmed, Aminah Robinson, & AbouRizk, 2007).

In this research, risk analysis which can handle the financial risk and the non-financial risk in an investment project is conducted. Hence, the hypothesis in this thesis is the probabilistic and fuzzy logic approach can be used for risk analysis in an investment project evaluation.

1.2 Problem Statement

The risk analysis in an investment project evaluation is necessary for anticipating the possibility of cost increases and revenue decreases. For example, in public investment project likes a toll road project, Rose (1998) argued that cost increases, and revenue decreases have been a serious issue in Melbourne-Australia during the early years of the toll road development program. The monte carlo simulation is used by Rose (1998) to evaluate the impact of risk to the project output. The relevant example of cost increases and revenue decreases as a serious issue in the toll road project is the Chinese highway project (Zayed, Amer, & Pan, 2008). The AHP is used by Zayed, et.al (2008) for determining the probability of occurrence of

various risk factors in the Chinese highway project. Among the many explanations, unanticipated risks or unmanaged risks are two of the main causes of the cost increase and revenue decrease in an investment project (Fatih & Cengiz, 2006). Thus, the presence a correct risk management that consists of risk identification, risk analysis, and risk response planning for mitigating the risk is required due to the possibility of cost inincreases,nd revenue decreases always threaten the investment project (Dey, 2002; Zhao, et al., 2009).

Generally, the risk analysis in investment project evaluation begins with assessing the range of uncertain variables that influence to the project. The assessment is attained from historical data and pure subjective judgments. Although the analyst could get the historical data and expert's statistics, an amount of subjective assumptions is needed to be combined with this information for avoiding the apprehension of not including possible scenarios of risk in evaluating the attractiveness of the investment project. However, a number of non-financial risks which are typically subjective are hard to be included in an economic model because of the linguistic nature. Additionally, these risks are separately analyzed from a financial risks and force decision-makers to be a subjective decision without taking into account the overall effects on the project. William (2000) explains that the decision-makers formulate a preliminary decision based on analysis of the non financial risk, whether the project meets a certain scoring criterion, or it is simply discarded. If the project is accepted, a detailed risk analysis of the financial information is performed with an economic model. Otherwise, if the analysis of the non financial risk decided that project could not be considered, then the economic model is not conducted. Due to the separation of both analysis, it is possible that the

subjective decision performed at the beginning is inaccurate, reducing the importance or eliminating the project as an investment opportunity (Jan Emblemsvåg, 2006). In addition, the economics point of view can provide answers to many questions rather than a just technical explanation that has no satisfying answer (Bojanc & Jerman-Blazic, 2008).

The problems have been tried to be solved by bridging the financial and non-financial risks for risk analysis in an investment project evaluation. For example, Fatih and Cengiz (2006) consider multidimensional of nature risks in project risk evaluation. They utilize the AHP as the multi criteria decision-making method that associate with fuzzy set theory for evaluating project risk based on the heuristic knowledge of experts. Dey (2010) combined AHP and Risk-Map to manage the project risk. All of these methods above allow non-financial risk as well as financial risk in one analysis to be considered in the decision-making process. However, these methods do not measure the probability of potential loss in a numerical manner and the divergence of the parameters of investment feasibility such as net present value (NPV) and internal rate of return (IRR). The measurement actually can be obtained by conducting an economic analysis (Bojanc & Jerman-Blazic, 2008).

Since the correct representation of uncertain variables highly affects the reliability of the realistic output of investment project evaluation, having an approach that can bridge the financial and non-financial risks for risk analysis and able to conduct the risk management is very necessary for decision making. In this thesis, Fuzzy-Monte Carlo Simulation (FMCS) for risk analysis is designed to build the relationship among the financial and non-financial risks and provide the probability

of Cumulative Cash Flow (CCF), expected net present value (NPV) and Internal Rate of Return (IRR) for each scenario of risk involvement with an intention to determine the properly risk response planning according to the severity level of each risk.

1.3 Research Objectives

With the purpose of dealing to the problems as discussed in Section 1.1 and 1.2, the objectives of this research are specified as follows:

1. To develop a technique for identifying the significant risks that adversely affects the investment project and an approach that can bridge the financial and non-financial risks for risk analysis in investment project.
2. To discover the impact of risks on a case study investment project output in a form of the probability distribution of Cumulative Cash Flow (CCF), Internal Rate of Return (IRR), and expected Net Present Value (NPV) in order to know the severity level of each risk and the reliability of the proposed approach.
3. To recommend the risk response planning for mitigating the risk in a case study investment project according to severity level of each risk impact to the project.

1.4 Thesis Contribution

The main contribution of this thesis is a tool in quantitative risk analysis. This thesis provides the method that can bridge financial and non-financial risk for quantitative risk analysis. The major contributions in this thesis are:

a. Simplified mechanism for reducing exaggerates the range of variability of uncertainties variables with the intention to obtain the significant financial and non-financial risk by using Analytic Hierarchy Process (AHP).

b. Intelligent decision support system that can bridge the financial and non-financial risks for risk analysis in an investment project by using Fuzzy Logic and Monte Carlo Simulation.
c. Mathematical model for representing the influence of risk to economic analysis of an investment project.

1.5 Thesis Outline

This thesis is organized into six chapters. The organization of each chapter is outlined as follows:

Chapter 1 gives an introduction that corresponds to the main problem in risk analysis of an investment project. The main problem is deep explored in the problem statement, and the research objective is also stated in this chapter. At the end of this chapter, this chapter present the contributions of our thesis with its relation to the body of knowledge.

Chapter 2 is the literature review on investment project evaluation, describes the process of investment decision-making, including the project budgeting aspect and risk management. The literature review is referred to the description of how related works in risk analysis is currently being performed with the methods that have been used for evaluating an investment project, including their limitation.

Chapter 3 provide the research methodology, which contains of five main steps such as problem analysis, comprehensive literature study, the development of a conceptual

design of risk analysis for the investment project, the validation of the conceptual design via a case study of investment project, and performance analysis.

Chapter 4 describes a conceptual design of risk analysis for the investment project. The design utilizes Fuzzy-Monte Carlo simulation for bridging financial and non-financial risk factors with the intention to be quantitatively risk analysis. Furthermore, the relationship between risk and attractiveness parameters of investment project is discussed. Finally, mathematical model that represents the relationship between risk impacts with the variables in the economic model is formulated.

Chapter 5 implements the solution design to one case study project. It provides the primary and secondary data of the project, including the knowledge acquisition and mathematical model that represent the influence of financial and non financial risks to an economic analysis of the case study project. Furthermore, this chapter provides variable definitions and assumptions for the economic model. Finally, the simulation scenario is established to measure the severity level of each risk that involve to the project.

Chapter 6 present results from the simulation of the economic model of a case study project in terms of probability of cumulative cash flow (CCF) in year 2008, net present value (NPV) and internal rate of return (IRR). The result of cumulative cash flow (CCF) in year 2008 is compared with the actual data of the case study project. Furthermore, this chapter analyzes its forecast result of CCF, NPV and IRR in order to obtain the severity level of each risk that involves to the project. Finally, the most

influence risk based on probability distribution of NPV, and IRR is compared to the result of empirical study by using Analytic Hierarchy Process. Hence, the risk response planning for mitigating risk of the case study project can be recommended.

Chapter 7 contains the conclusions, limitations, and recommendation for further research in this thesis area.

CHAPTER 2

LITERATURE REVIEW

This Chapter provides literature review, which related to the risk analysis in investment project evaluation. It begins with a description of what is the investment project evaluation in Section 2.1, while the capital investment concept, including the parameters that considered in the evaluation of investment project attractiveness is described in Section 2.2. In Section 2.3, the concept of risk management such as classification of risk, risk identification, risk analysis and risk response planning are presented. After risk management is introduced, the economic model of an investment project is discussed in section 2.4. The section that provides some related works for risk analysis in investment project evaluation is discussed in Section 2.5. The current issue regarding the risk analysis works is provided in Section 2.6. Finally, the summary of this chapter will be provided in Section 2.7.

2.1 Investment Project Evaluation

Investment project is a long-term allocation of funds for disbursing project costs to gain profitable returns in a form of interest, income (dividend), or appreciation of the value of the project (Agar, 2005; Brennan, Constantinides, Harris, & Stulz, 2003). According to the field of business management, the investment decision or capital budgeting is one of the fundamental decisions of business management which managers estimate will obtain a benefit from disbursing the investment costs (Sullivan, 2003). The assets might be physical such as buildings,

information technology infrastructure or machinery, and intangible assets such as patents, software, goodwill, which is used to produce streams of revenue.

With regard to evaluation, Rossi et al. (2004) defined that evaluation is a series of activities incorporate understanding, measurement and assessment to determine the value of an object. It is either a conscious or tacit process which aims to establish the value of or the contribution made by a particular situation, and it can also relate to the determination of worth of an object. Combining the definitions of investment project and evaluation, investment project evaluation is understood as a process for judging worth or forecasting the return of an investment project that is carried out by one or more individuals in a particular organization, with a particular objective, at a particular phase during a system's life cycle, using one or more particular methods (Borgonovo & Peccati, 2004). The understanding is fragmented by identifying a number of separate, yet interrelated, contextual elements that are determined based upon the circumstances of a particular situation. Brown (2005) supported this view by noting that evaluation involves several elements, where all of which must complement each other. These elements include such as what about what the subject of the investment project, which aspects about the parameters or measurement that is used for evaluating investment project attractiveness, when about the time frame that is used for evaluating an investment project, who about the people who have a role in investment project evaluation, and how about the methodologies or tools that will be used for evaluating the investment project.

Before deciding to invest, the manager must verify whether the parameters of the investment project attractiveness are positive or negative by using the marginal

cost of capital involving to that particular area of business. However, investment comes with the risk of the loss of the principal sum. The investment that has not been thoroughly analyzed can be highly risky with respect to the investor because the possibility of losing money is not within the investor control. Therefore, a company needs to consider the factors which have interdependencies to return of investment, whether deliver profit or loss before deciding to undertake the project.

Investment project evaluation is conducted in the context of particular organisational operating units or departments, within specific organisations, operating under industrial sector and competitive conditions. In light of these contextual influences, the following related element should be included in investment project evaluation such as capital investment, parameters for evaluating the project attractiveness which is measured by the economic model of investment project, and risk management concept as well.

2.2 Capital Investment

Capital investment is the financial support to cover investment cost and operational costs of the project (Dimov & Gedajlovic, 2010). With the purpose to support the investment fund, companies can obtain the capital sourced from the equity or debt from a bank loan (Agar, 2005). Debt source is obtained by borrowing from outside of the company likes bank with the principal repaid at a stated interest rate following a specified time schedule. Debt financing includes borrowing via bonds, loans, and mortgages. Furthermore, the equity capital is corporate money which is comprised such as the owner's funds and retained earnings. Owners' funds are further classified as common and preferred stock proceeds or owners' capital for

a private or non-stock-issuing company. Generally, a company combines the equity capital and debt from a bank loan as the capital structure to disburse the project. The debt from a bank loan is borrowed due to the unreliability of the equity as single capital for covering all cost of a project. In addition, the benefit of capital investment which is debt from a bank loan or obligation can force the aggressiveness of project management for delivering good project performance in terms of the cost and time efficiency (Tarquin & Blank, 2002). It is caused by the responsibility of the project owner as debtors, who have to return not only the loan but also the interest rate of the bank loan.

In practical, the utilization of these capitals should pay out the cost of capital (COC). The COC can be used as the parameter to decide whether to accept or to eliminate the investment in terms of a discount rate beside of evaluating the other parameters such as net present value (NPV) and internal rate of return (IRR). There are a lot of main economic parameters for budgeting such as Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PB), and Profitability Index (PI). The parameters are usually used for project quality estimation, but in practice they have different importance. It is earnestly shown in Kahraman et al. (2006) and Bojanc (2008) that the most important parameters are NPV and IRR. Therefore, in this thesis further consideration will be based only on the analysis of the NPV and IRR.

2.2.1 Net Present Value (NPV)

Net present value (NPV) is used to evaluate the profitability and attractiveness level of an investment project (Bruce, 2003). NPV or net present worth

(NPW) of a time series of cash flows, both incoming and outgoing, is defined as the sum of the present values of the individual cash flows (Lin & Nagalingam, 2000). In the case when all future cash flows are incoming such as coupons, principal of a bond and the only cash outflow is the purchase price, the NPV is simply the present value of future cash flows minus the purchase price, which is its own present value.

Tarquin and Blank (2002) formulated NPV as the present value (PV) of net cash flow after tax and minus the initial investment as shown in Equation (2.1)

$$\boldsymbol{NPV} = \sum_{t=1}^{n} \frac{\boldsymbol{ACF}_t}{(1+\boldsymbol{k})^t} - \boldsymbol{IO} \qquad (2.1)$$

ACF_t is Annual net cash flow after tax for period-*t, k* is the discount rate, *IO* is the initial investment, and *n* is economic life of a project. Present value is gained by annual net cash flow that calculated using the discount rate. It is important to know whether the attractiveness of a project is good or bad depending on the differences with the initial investment. NPV is more than null can be said that the investment decision is accepted. Otherwise, the investment decision is eliminated. For instance, the data about net cash flow (NCF) with initial investment of USD 5,000,000 and discount factor of 15% as follows.

Year	2004	2005	2006	2007	2008
NCF (USD)	1,750,000	1,900,000	2,050,000	2,250,000	2,450,000

Then, the Annual Cash Flow (ACF) for NPV calculation as shown in Table 2.1:

Table 2.1 *Illustration of NPV Calculation*

Year	NCF	*Discount factor* k = 15%	ACF / $(1+k)^n$
2004	USD1,750,000	0.869565217	USD1,521,739
2005	USD1,900,000	0.756143667	USD1,436,673
2006	USD2,050,000	0.657516232	USD1,347,908
2007	USD2,250,000	0.571753246	USD1,286,445
2008	USD2,450,000	0.497176735	USD1,218,083

Table 2.1 (continued)
Illustration of NPV Calculation

Year	NCF	*Discount factor* k = 15%	ACF / $(1+k)^n$
Total PV			USD6,810,848
IO			USD5,000,000
NPV			USD1,810,848

According to Table 2.1, it can be concluded that the attractiveness of investment project is positive because the NPV value is more than zero.

2.2.2 Internal Rate of Return (IRR)

Interest is the manifestation of a time value of money, which is defined as the difference between an amount of money value at the end of the period and the beginning amount (Kellison & Stephen, 1970). There are two insights about interest; it is categorized as interest paid and interest earned. The condition when a company obtained an obligation and paid the return more than the initial, it is called as interest paid. On the contrary, the interest earned is defined as interest while companies invest or deposit the money and then gain the return more than what it invested.

Normally, interest rates are expressed in percentage of interest paid per unit of time to the amount of money at beginning. Meanwhile from the investor point of view, the interest generated is important. The percentage of interest paid for a specific time period compared with the initial value is called the rate of return (ROR), while the internal rate of return (IRR) is a rate of return used in capital budgeting to measure and compare the profitability of other investments. It is also called the discounted cash flow rate of return (DCFROR) or simply the rate of return (ROR). Internal rate of return is defined as the discount rate that produces the rate of return of future net cash flow, which has been similar with the initial investment

(Bruce, 2003). It is frequently used as a first step of the economic analysis to determine the attractiveness of the project based on an accepted threshold value that had been established. In the arithmetic manner, IRR is formulated as shown in Equation (2.2) (Tarquin & Blank, 2002).

$$\boldsymbol{IO} = \sum_{t=1}^{n} \frac{\boldsymbol{ACF}_t}{(1+\boldsymbol{IRR})^t} \tag{2.2}$$

ACF_t is net cash flow after tax for period-*t*, *IRR* is the project internal rate of return, *IO* is the initial investment, and *n* is economic life of a project.

In terms of investment decision criteria, the investment is accepted even if IRR is equal or more than minimum attractive rate of return (MARR); otherwise, do not accept the investment. Generally, a company sets the MARR value more than the rate of return by Bank offering. MARR is determined by the financial management department, and it is employed as the criteria for selecting which the project that will be executed according to its rate of return (ROR). There are some steps for determining the IRR, which are summarized as follows (Tarquin & Blank, 2002):

Step 1: Take randomized the discount rate and utilized it to calculate the present value of net cash flow.

Step 2: Compare the discount rate in step 1 with the initial investment. If the present value is similar with the initial investment, it means that the discount rate in step 1 is its project IRR.

Step 3: Even if the present value of net cash flow is more or less than initial investment, then scale up or scale down the discount rate which has taken in step 1

Step 4: Calculate more the present value of net cash flow, and repeat the step 2.

The illustration of IRR calculation of variation for annual net cash flow is shown in Table 2.2.

Table 2.2 *Illustration of IRR Calculation*

Description	Amount	Description	Amount
Initial Investment	-USD 3,817	Net cash flow in year-2	2,000
Net cash flow in year-1	1,000	Net cash flow in year-3	3,000
Completion			
1. Test for *i = 15%*			
	NCF	PV factor for *i* = 15%	Present Value
Net cash flow in year-1	1,000	0.870	870
Net cash flow in year-2	2,000	0.756	1,512
Net cash flow in year-3	3,000	0.658	1,974
Total PV			4,356
IO			-3,817
2. Test for i = 20%			
Completion	NCF	PV factor for i = 20%	Present Value
Net cash flow in year-1	1,000	0.833	833
Net cash flow in year-2	2,000	0.694	1,388
Net cash flow in year-3	3,000	0.579	1,737
Total PV			3,958
IO			-3,817
3. Test for i = 22%			
Completion	NCF	PV factor for i = 22%	Present Value
Net cash flow in year-1	1,000	0.820	820
Net cash flow in year-2	2,000	0.672	1,344
Net cash flow in year-3	3,000	0.551	1,653
Total PV			3,817
IO			-3,817

According to Table 2.2, it can be concluded that a suitable IRR is 22%. Refer to the rule; if the IRR of 22% is more than the MARR value, then the investment project is feasible; otherwise the investment project is eliminated.

2.3 Economic Model of Investment Project

The process that is normally used to gain the important decision variables such as net present value (NPV), internal rate of return (IRR), and debt service coverage ratio is with the development an economic model of investment project. This is referred to revenue model, cash flow model, profit-loss model with simple annual model that derived into monthly or quarterly figures with all the numerical

information needed for calculating the probability of investment project attractiveness (Ustundag, KilInç, & Cevikcan, 2010).

All the elements that influence the successful completion and profitable operation of a project including the entire elements that influence the costs, revenues, and returns of the project must be carefully analyzed. Hence, it is necessary to construct a computer model, usually through the use of spreadsheet software, to model and process the comprehensive list of numerical input assumptions and provide the corresponding output figures that reflect the robustness and profitability of the project. Generally, the model is built around an agreed base case. Additional alternatives are then explored to perform sensitivity analysis and find the key components that most affect the final objective.

The principle of economic models of the project begins as an initial assessment of project feasibility and then evolves into later uses such as: (i) determination of the optimum financing structure, (ii) support for ongoing negotiations or as support of a competitive bidding process, and (iii) preparation of sensitivity analysis for potential lenders and investor. Finally, the model then becomes part of the loan agreement and the project documentation.

All economic models are unique to every project, unless the projects which are very similar. There are no rules or standards governing the economic model form. However, certain principles are the same with any model if all follow the accounting principles of the calculation of the internal rate of return and net present value from

the expected projects cash flow. The different parts of the economic model use the common principles such as follows (Bojanc & Jerman-Blazic, 2008).

a. Cover page that consist worksheet including the basic project information.
b. Assumptions that provides a text description of the main variables used in the model. It is only used for information purpose or reporting
c. Key Inputs that includes all the manually input variables and switches that are changed to perform different scenarios and sensitivity analysis. This part should include timeline data, capital cost data, finance data, operating data, tax and accounting data, and legal and administrative fees.
d. Key Results, which is created only for the purpose of showing the results of the analysis such as Debt Coverage Ratios, Internal Rate of Return, Net Present Value, Cash Flow and Book Income summaries
e. Capital Budget includes the costs from the development phase and the production of construction or establishment phase. It also should include some minor Operation and Maintenance costs
f. Draw Schedules that shows the cash outflow during the development and construction phases, including the debt payments
g. Financing that includes all the information related to the financing and tax projects. The terms of the short-term loan and the long-term loan
h. Debt Schedules that shows the calculation of the debt payments for all the different loans according to their financing terms
i. Operating Assumptions that includes all the information associated with the calculation of the expected output of the project; available capacity of the project for its economic life; calculations of the estimated outputs that will be produced; and fuel cost calculations. This worksheet is related to the long-term market

analysis of the country. At the end, it should calculate the Operating Revenues for the estimated life of the project

j. Operating Expenses that includes a schedule of the estimated operating expenses for the economic life of the project

k. Escalation Depreciation, which is developed for the calculation of the corresponding depreciation of the equipment used in the project

l. Projections, which is an important thing in the economic model. It shows the complete Cash Flow of the project, including the revenues, expenses, taxes, debt service, and finally, the calculation of the Internal Rate of Return and Net Present Value

2.4 Risk Management Concept

The risk is considered as a deviation from the project plan that may occur unexpectedly. Although an activity or business is well planned, there is still containing uncertainties, whether it will be run according to plan or not. It does not matter how different or unique a project is; no doubt that every project contains some degree of uncertainty and there is no risk-free project (Kaidi, Jimei, & Yanjun, 2009; Tah & Carr, 2000). In terms of business side, the risks are managed to make sure that the activities undertaken will benefit and there is no obstacle that causes the activity ceased. The following section will describe the definition for the risk and the process that include in the risk management.

2.4.1 Definition of Risk

Risk is the potential that a chosen action or activity (including the choice of inaction) will lead to a loss (an undesirable outcome). There are two components in

risk (Anli & Cunbin, 2007) : (1) probability or likelihood of failed to reach a particular outcome and (2) consequence or effect of failed to achieve the result. The probability and consequence of risk should clearly determine to avoid the confusion result in risk assessment. Other factors that may significantly help the emergence of risk such as frequency of occurrence, time sensitivity, and dependence with the appearance of other risks can also be used directly or indirectly in the risk ranking methodology.

In the project point of view, risk is an uncertain event or condition which has a positive or negative effect on project objectives (Galasyuk & Galasyuk, 2007). Risk refers to the factors that produce the possibility of an objective project cannot be achieved. Fortunately, some risks can be anticipated and controlled. Thus, risk management should be an integral part of project management throughout the project cycle. Conceptually, the risk for each event can be defined as a function of the probability (likelihood) and consequences (impact). It s defined as follows.

$$Risk = f\ (probability, impact) \tag{2.3}$$

In general, if the possibility or consequences increases then the risk will increase. The correlation of risk variables is shown in Figure 2.1. Hence, both of them should be considered in risk management.

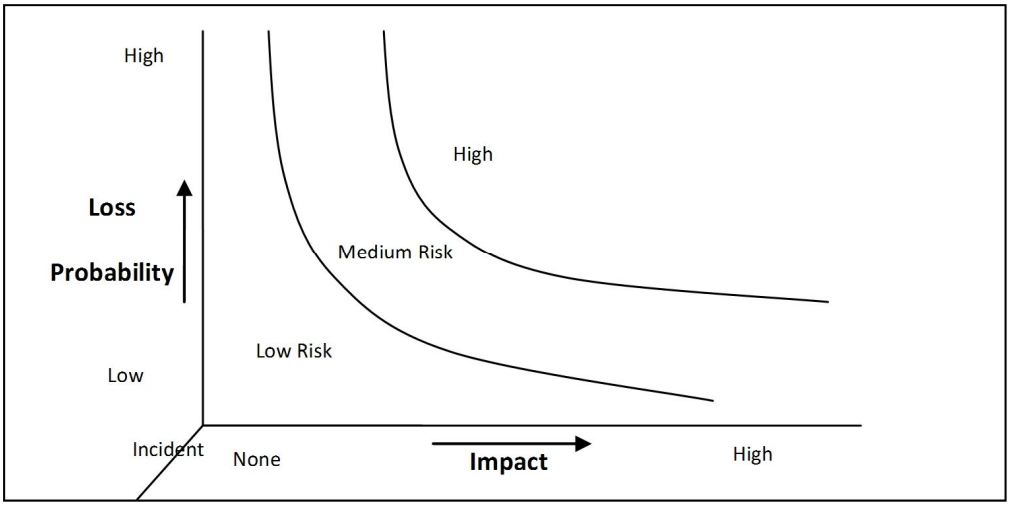

Figure 2.1 Correlations of Risk Variables (Kerzner, 2003)

2.4.2 Risk Management Process

The term of risk management had been used since 1956, written by Russell B. Gallagher at the Harvard Business Review, which states that the organization should have a responsibility to manage pure risks of the organization (Dey, 2010). Risk management is a systematic process of planning, identification, analysis, response, and monitor project risks. The processes include the methods and techniques that will help project managers to maximize the probability of profit and minimizing the probability and consequences of negative events. Risk management is very effective to start the project as early and continuously applied in the project. Project risk management process aims to help investor in making a proper decision on project alternatives. Furthermore, risk management can encourage the project team to take appropriate action for minimizing the negative effects of risks toward the project scope, cost, and schedule (Zhao, et al., 2009).

From the definitions above, the risk management has six stages as shown in Figure 2.2 such as risk management planning, risk identification, risk analysis, risk response planning, and monitoring and controlling risk.

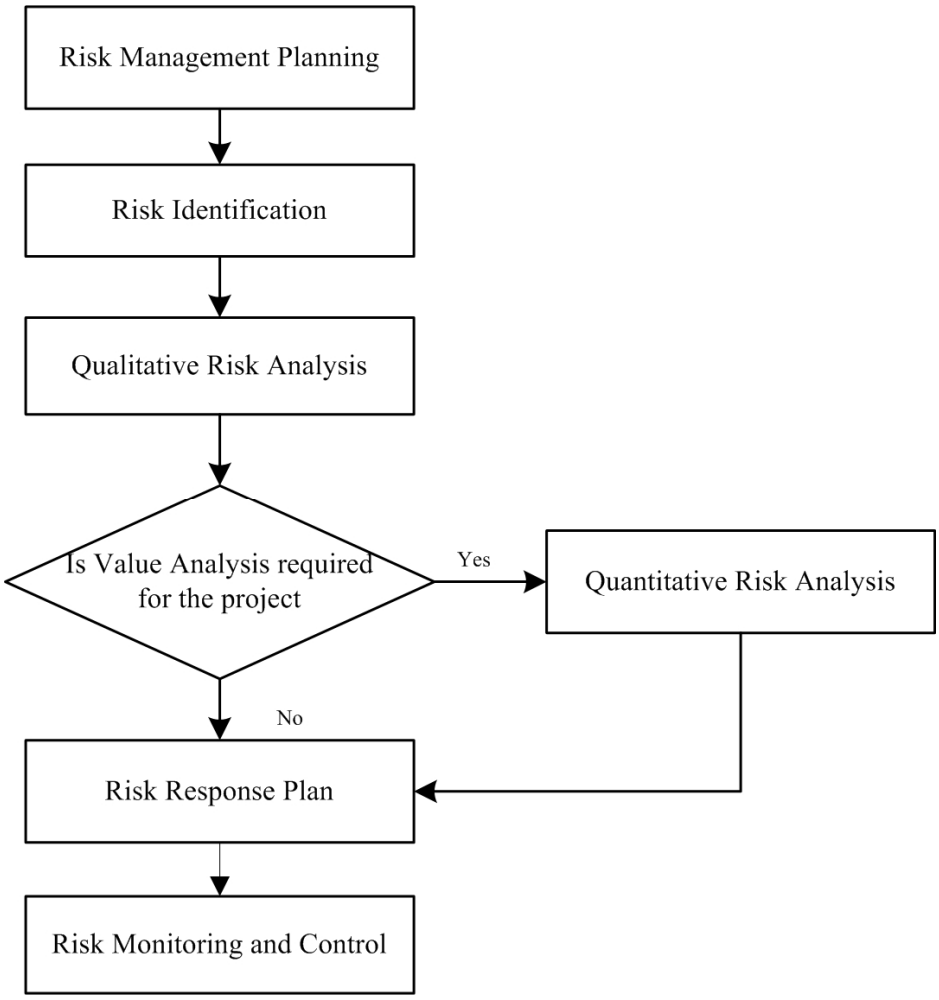

Figure 2.2 Flow Diagram of Risk Management Process (William, 2000)

The brief explanations for each stage as shown in Figure 2.2 are as follows.

1. Risk Management Planning is conducted to determine how to plan the risk management activities in the project.
2. Risk Identification is conducted to determine, which risks that might affect the project.

3. Qualitative risk Analysis is conducted to develop qualitative analysis for prioritizing the risks based on their effects to project objectives.
4. Quantitative risk Analysis is conducted to measure the likelihood and consequences of the risk include calculating the implications to project objectives.
5. Risk Response Planning is conducted to develop procedures and techniques for enhancing the opportunities and reduce threats to project objectives.
6. Risk Monitoring and Control is conducted to monitor the remaining risks, identifying new risks, implement a plan to response the risk, and evaluate their effect on the overall project time plan.

In the next sections, the stages of risk management processes are explained one by one.

2.4.3 Risk Management Planning

Risk management planning is an activity that continues to repeat and embrace the whole process of risk management that consist of identify, analyze, handle, monitor and well-organized the document of risks that associated with the project. Important outcome of the planning process is the risk management plan (RMP). Since all projects involve some degree of risk, a project risk management planning is necessary to define and document the procedures that will be used to manage risk throughout the life of the project. The procedure used to manage risks is defined in the planning stage, documented in the project risk management plan, and then executed through the life of the project.

In risk management planning, the program manager should specify who is responsible for managing the different areas of risk, how risks will be tracked