RISK MANAGEMENT INDEX

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ABSTRACT

Because of the complex nature, risk and uncertainty are more widespread in construction industry than many other industries. The risk management is an indispensable discipline for any organisation to achieve its objectives. Aiming to ensure that all project objectives are met, risk management is considered as a critical success factor for construction projects. The core components of risk management are now known and utilised by many organizations. Meanwhile, as declared by Project Management Institute (PMI), the ability to measure the effectiveness in managing risk is one of the most vital areas that risk management needs to be developed in. Created to evaluate the capability of a project or an organization in a particular area, a maturity model aids in determining strengths and weaknesses, and to target advance strategies accordingly. Several maturity models have been developed for the area of risk management and furthermore, an attempt to adapt a generic risk management maturity model to the construction industry was specified from the literature. Outstanding risk management maturity models were investigated, six of them were identified as being competent and further examined in terms of their usability and effectiveness. Based on the comparisons and evaluation made among the models, several advantageous and disadvantageous points were inferred. All in all, when examined, it was seen that most of these models outline the topics to be observed in a maturity assessment and provide guidance in terms of content. It was believed that a practical approach was needed and the diagnostic characteristics of these models should be improved.

ABSTRAK

Oleh kerana sifat kompleks , risiko dan ketidaktentuan yang lebih meluas dalam industri pembinaan daripada banyak industri-industri lain . Bertujuan untuk memastikan bahawa semua objektif projek dipenuhi, pengurusan risiko dianggap sebagai faktor kejayaan kritikal bagi projek-projek pembinaan. Teras-teras pengurusan risiko kini dikenali dan digunakan oleh banyak organisasi . Sebaliknya , seperti yang diisytiharkan oleh Institut Pengurusan Projek (PMI), kemampuan untuk mengukur keberkesanan dalam menguruskan risiko adalah salah satu kawasan yang paling penting bahawa pengurusan risiko perlu dibangunkan masuk Direka untuk menilai keupayaan projek atau organisasi di kawasan tertentu, yang alat bantuan model kematangan dalam menentukan kekuatan dan kelemahan , dan untuk sasaran strategi penambahbaikan sewajarnya. Beberapa model-model matang telah dibangunkan untuk bidang pengurusan risiko dan tambahan pula, usaha untuk menyesuaikan diri pengurusan risiko model kematangan generik dengan industri pembinaan telah dinyatakan dari penulisan. model-model matang pengurusan risiko yang cemerlang telah diperiksa , enam daripada mereka telah dikenal pasti sebagai cekap dan dikaji lebih lanjut dari segi kebolehgunaan dan keberkesanannya. Menurut perbandingan dibuat antara model , beberapa mata berfaedah dan merugikan telah disimpulkan . Semua sekali, apabila diteliti , ia dilihat bahawa kebanyakan model ini menggariskan topik yang akan disiasat dalam penilaian kematangan dan memberi bimbingan dari segi kandungan . Ianya dipercayai bahawa pendekatan yang praktikal yang diperlukan dan ciri-ciri diagnostik model ini harus ditingkatkan.

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LIST OF ABBREVIATIONS

CMM	Capability Maturity Model
PMI	Project Management Institute
RM	Risk Management
RMM	Risk Maturity Model
RMMM	Risk Management Maturity Model

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Construction project development is always shrouded by risks. Usually developers will try to control or absorb the risks but sometimes it has to be transferred to other parties, including end users and they are the ones to bear the costs. According to Flanagan and Norman (1993) begin the process of project (feasibility study) to the completion of the project took a long time. The construction industry is subject to more risk and uncertainty than many other industries. It involves many complex skills and involves more complex activities. According to Mills: "The construction industry is one of the most dynamic, risky, and challenging businesses" (2001, p.245).

According to Flanagan and Norman (1993) stated that, despite the existence of risks inherent in the development of this sector, it is surprising techniques that are used to identify, analyse and respond to risk just started to be used in the last decade. Many would agree that the risk significantly influence business decisions and have a significant impact on investment returns. Basically, the risk is attributed from uncertainty or due to the lack of information. Through effective information management, one is able to determine relevant information, up to date and accurate. Only this information alone can ensure that an organization can be collated and managed to achieve their business objectives effectively (Hollingworth, 1986) further intuition, skills and judgments are continually influencing one's decision-making.

Therefore, it is important for the effective control of project management, all significant risks and uncertainties are identified, classified, analysed, treated and monitored in a systematic response by the project management team to achieve the project objectives. The risk management index was designed to assess risk management performance. It provides a qualitative measure of management based on predefined

targets or benchmarks that risk management efforts should aim to achieve. The index estimates the performance of risk management in terms of risk identification, risk reduction, disaster management, governance and financial protection.

Due to its complex nature, risk and uncertainty are more widespread in construction industry than many other industries. Aiming to ensure that all project objectives are met, risk management is considered as a critical success factor for construction projects. The core elements of risk management are now known and used by many organizations. On the other hand, as declared by Project Management Institute (PMI), the ability to measure the effectiveness in managing risk is one of the most important areas that risk management needs to be developed in. Designed to assess the capability of a project or an organization in a particular area, a maturity model aids in determining strengths and weaknesses, and to target improvement strategies accordingly. Several maturity models will be developed for the area of risk management.

Being one of the nine knowledge areas of project management, risk management is now an accepted discipline within organization and individual projects, with its own language, techniques, procedures and tools (Project Management Institute, 2002). Risk management aims to ensure that all activities are fulfilled in order to achieve the project objectives (Flanagan and Norman, 1993). The value of risk management is increasingly being recognized by companies as they are searching for improvement steps to become more competitive in industry. As claimed by Project Management Institute (2002), although the core elements of project risk management are known and used by many organizations, risk management needs to be developed in a number of areas to build on the foundation that currently exists. Project Management Institute (2002) declares the ability to measure the effectiveness in managing risk as one of the most vital of these. According to Hilson (1997), an organization's current approach to risk, as well as a definition of the intended destination should be identified to define its goals, specify the process and manage the progress. Therefore, as Hilton (1997) continues, an accepted framework is needed to assess the current level of maturity and capability objectively, and assist in defining progress towards increased capability. From this point, "maturity" concept is introduced to the organizations, which is a term started to be used to describe

the state of an organization's effectiveness at performing certain tasks (Crawford, 2002). The maturity concept is utilized for benchmarking the current capability against best practices or against competitors, and by determining the strengths and weaknesses in a particular area, to devise improvement strategies. Risk management capability maturity is very important to the project and business performance (Ren and Yeo, 2002), they added such effort should be thoroughly undertaken by organizations for all project and throughout the overall project lifecycle. Some of the project risk maturity model have been established to help for the valuation of the organizational risk management capability for many type of industries. An effort was also differentiate from the literature to implement a basic risk management maturity model to the construction industry.

1.2 PROBLEM STATEMENT

Currently, the construction sector is one of the important activities that contribute to the economic growth. When compared with other manufacturing industries, this industry is known as high fragmentation, low productivity, cost and time overruns, conflicts and disputes characterize the construction industry (Vrijhoef and Koskela. 2000; Love, Irani and Edwards. 2004). Risk and uncertainty are more widespread in the construction industry than any other industries. This is due to the nature of construction business activities, which include processes, environment and organization (Akintoye and MacLeod, 1997). From the beginning to the end, the construction process is complex and characterized by many uncertainties (Al Bahar and Crandall, 1990). Therefore, as pointed out by several authors (Hayes, Perry, Thompson and Willmer, 1986; Flanagan and Norman, 1993; Raftery, 1994; Chapman and Ward, 1997), a risk driven approach is a critical success factor for construction projects. Effective risk management brings about tighter margins and less contingency, making use of opportunities rather than rejecting works as too risky, as well as avoiding unforeseen disasters (Chapman and Ward, 1997). Moreover, the Malaysian construction industry was deliberated, the compatibility and directness of these models for the Malaysian construction companies were in issue. The results of this study this study will provide useful information to construction companies in order to reduce risk effectively in construction.

1.3 RESEARCH OBJECTIVE

This study aim to provide construction risk management maturity models. The following objectives need to be accomplished in order to achieve this aim:

1. To provide a picture of the previously developed maturity models in the area of risk management
2. To determine advantageous and disadvantageous aspects of maturity models by comparing and evaluating them in terms of their usability and effectiveness.

1.4 RESEARCH QUESTION

The questions of this study are:

1. How are the former developed maturity models in the area of risk management?
2. What are the advantageous and disadvantageous aspects of the existed maturity model in terms of their usability and effectiveness?

1.5 OPERATIONAL DEFINITION

Construction industry

Sector of national economy engaged in preparation of land and construction, alteration, and repair of buildings, structures, and other real property (Business Dictionary, n.d).

Project Risk Management

The process of conducting risk management planning, identification, analysis, response planning, and monitoring and control project to increase the probability and impact of positive events, and decrease the probability and impact of negative events in the project (PMBOK,2004)

Maturity Model

A service mark that provides a model for understanding the capability maturity of an organisations business processes. A maturity model is specifically used when evaluating the capability to implement data management strategies and the level at which that company could be at risk from said strategies. (Wikipedia, n.d)

1.6 SCOPE OF THE STUDY

The scope of this research was focus on providing a picture of the existed maturity models by comparing and evaluating their usability and effectiveness in the area of construction risk management. There are some researched has assumed that the maturity model needed for an organization in order to benchmark its current maturity and capability in managing risk, and this maturity should also assist in defining progress towards increased maturity. Thus, the components of a construction specific risk management maturity model have been investigated through literature review. By using a risk maturity model, value can be added to a company's operations by improving its performance and enhancing its own future.

1.7 ORGANIZATION OF RESEARCH

This report contains of four chapters, which is this is the first chapter. The second chapter review the literature on risk management, risk management processes, maturity, models of risk management maturity and construction supply chain, views from risk and risk management and finalize them with a discussion on the inferences portrayed from the literature review. The third chapter describes the research method and material, including information on the sample, data collection procedure, and data analysis.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is consisting of the issues found from the literature, which are organized under four main sections. First section comprises the various definition of risk, risk management and related topics, and also explores risk management practices inside the construction companies, it advantages and integration. In the second section discussed the processes of risk management, while the third section is devoted to the maturity concept with an insight to maturity models and risk management maturity.

2.2 CONCEPT OF RISK AND RISK MANAGEMENT

In this section, first of all, the matters of risk and uncertainty, sources of risk and management of risk are clarified with various definitions. Then, in pursuit of a concise look to the history and research of risk management in construction, advantages of risk management are discovered. In conclusion, the integration of risk management with other management roles is briefly explained.

2.3 RISK AND UNCERTAINTY

Risk and uncertainty exist in all construction projects, regardless of its size (Hayes, et al., 1986). Similarly, Chapman and Ward(1997) state that a non-risky project is not worth pursuing, which mean that every project contain some degree of risk. High degree of risk in construction is attributed to the nature of construction business activities, processes, environment and organization (Akintoye and MacLeod, 1997). Risk can be transferred, managed, minimized or shared, but cannot be ignored (Latham, 1994).

Al-Bahar and Crandall(1990) define risk as “the exposure to the chance of occurrences of event adversely or favourably affecting project objectives as a consequence of uncertainty”. According to Al-Bahar and Crandall (1990) also, no uniform or consistent usage of the word “risk” exist in the literature. As Al-Bahar and Crandall (1990) continue in their claim. Most definitions are concerned with the downside of risk, indicating losses and damages, but the upside and opportunities such as profits or gains are often disregarded. Consequently, risk definitions in literature show variety in a way that results of it are always negative, can be positive or negative, or neither is mention and highlighting on the project objectives is being affected. Royal Society (1991) gives definition of risk as “probability that an adverse event occurs during stated period of time”.

Burtonshaw -Gunn (2009) define risk as “the threat or possibility that an action or event will adversely or beneficially affect an organization’s ability to achieve its objectives”. Wharton (1992) states that the word “risk” is simply describing any unintended or unexpected outcome, good or bad, of a decision or course of action. Loosemore, Raftery, Reilly and Higgon (2006), defines risk as a complex phenomenon that has physical, monetory, cultural and social dimensions and is defined as being concerned with the unpredictable events that might occur in the future whose exact likelihood and outcome is uncertain but could potentially affect the interest and objectives of an organization in some way. Project risk may influence one or more of the project objectives. However, a few authors (Akintoye and McLeod, 1997; Smith, Merna and Jobling, 2006; Burtonshaw-Gunn, 2009) give cost, time and quality for the affected project objectives, Mills (2001) adds productivity and performance as subject to risk and uncertainty in construction projects.

Though the terms risk and uncertainty can be used interchangeably, as Merna and Al Thani (2005) make it clearer, their meaning differ in a way that risk refer to statistically predictable occurences whereas uncertainty refer to an unknown of generally unpredictable variability. If a decision maker can assess, either intuitively or rationally, the probability of a particular event occurring, then that decision is made

under risk (Flanagan and Norman, 1993). To draw the relationship between risk and uncertainty, Raftery (1994) established a "risk uncertainty continuum" as in table 2.1.

Table 2. 1 Risk –uncertainty continuum (source : Merna and Al Thani, 2005)

RISK		UNCERTAINTY
Quantifiable	→	Non quantifiable
Statistical Assessment	→	Subjective Probability
Hard Data	→	Informed Opinion

Flanagan and Norman (1993) claims that if there is no historic data or previous history related to the situation being considered by the decision maker, then there is uncertainty. As Flanagan and Norman (1993) add in their claim, the term risk is more relevant for the construction industry than the term uncertainty, as there is always some information to be based on, and by using that information, a company has to convert the uncertainty to risk.

As stated by Allen (1995), risk is composed of four essential parameters. These are likelihood of occurrence, severity of impact, susceptibility to change and degree of interdependency with other factors of risks. As said by Loosemore, et al. (2006), there are risk events and their potential impacts and consequences. In the same way, Kerzner (2005) states that a risk is noted by having a cause and if it occurs, it has a consequences. According to Loosemore, et al. (2006), the probability and consequence terms are used to express and assess risks, and this can be given as : Risk = Probability of event times magnitude of loss/gain.

2.4 SOURCES OF RISK

A company must assess many sources of risks before a decision is decided. The sources of risk occur at different times over an investment (Merna and Al –Thani, 2005). An extensive list of risk sources produced by Merna and Smith (1996) and

reproduced by Merna and Al Thani (2005) is show in Table 2.2 as being a complete outline.

Headline	Change and uncertainty in or due to :
Political	Government law, public authority, change in ideology, dogma, legislation, disorder such as war, riot, terrorism etc.
Planning	Permission requirements, public opinion, land use, policy and practice, socio economic impacts,
Environment	Contaminated land or pollution liability, permissions, nuisance, internal policy, environmental law or regulations or practice.
Market	Demand, competition, obsolesces, fashion, style, customer satisfaction
Economic	Taxation, treasury policy, cost inflation, interest rates, exchange rates
Financial	Bankruptcy, margins, insurance, risk share
Project	Procurement strategy, definition, standards, leadership, performance requirements, organization (maturity, commitment, competence and experience), quality control and planning, labour and resources, communication and culture.
Natural	Unforeseen ground conditions, weather, earthquake, fire or explosion, archaeological discovery.
Regulatory	Changes by regulator
Technical	Design adequacy, operational efficiency, reliability.
Human	Error, incompetence, ignorance, tiredness,

	communication ability, culture, work in the dark at night.
Criminal	Lack of security, theft, fraud, corruption, vandalism.
Safety	Health and safety at work, hazardous substances, collisions, collapse, flooding, explosion and fire.
Legal	Changes in legislation

Table 2.2 Typical sources of risk to business from projects (Source: Merna and Al-Thani, 2005)

The relationship between the source of risk, risk event and its effect is shown by Flanagan and Norman (1993) as in Figure 2.1.

Figure 2.3 Source-event-effect relationships for risk **(**Flanagan and Norman, 1993)

Standard risk sources on a construction project are quoted from Flanagan and Norman (1993) as follows :

- 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 labour force
- Unexpected price rises for labour 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 (earth quake, flood, 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.

The consequences of risks are quoted from Flanagan and Norman (1993) as:

- Failure to keep within the cost budget/forecast/estimate/tender
- Failure to keep within the time stipulated for the approvals, design, construction and occupancy
- Failure to meet the required technical standards for quality, function, fitness for purpose, safety and environment preservation.

2.5 RISK MANAGEMENT

Risk management is labelled as one of the nine knowledge areas of Project Management Body of Knowledge (PMBoK) by PMI. As stated by several authors (Akintoye and McLeod, 1997; Raz and Michael, 2001; Burtonshaw-Gunn, 2009), risk management is a continuous activity and covers the whole project life cycle, from inception through its planning, execution, control, up to its closure. Systematic risk management aims the project to be completed on time, within budget, to the required quality and with proper provision for safety and environmental issues (Mills, 2001). According to Merna and Al-Thani (2005), throughout the life cycle of a project, risk management aims to obtain the optimum or acceptable degree of risk elimination or control.

As stated by Merna and Smith (1996), risk management can be defined as any set of actions taken by individuals or corporations in an effort to alter the risk arising from their business. According to PMI (1996) project risk management is the systematic process of identifying, analysing and responding to project risk. On the contrary,

Crawford (2002) states that risk management aims to identify, analyse, respond and control risk factors throughout the life of a project. Dikmen, Birgonul, Anac, Tah and Aouad (2008) define risk management as a four-step procedure composed of : risk identification, in which the sources of uncertainty are defined. Risk analysis, in which the consequences of uncertain events are evaluated. Risk response, in which appropriate strategies according to the expected outcomes are set forth. Finally, repeating the steps continuously throughout the lifecycle of a project in consideration of the feedback received on actual outcomes and risks emerged, to achieve the project objectives.

Flanagan and Norman (1993) claims that risk management should involve common sense, analysis, judgement, intuition, experience, gut feel and willingness to operate a disciplined approach. Merna and Al-Thani (2005), claims that overcoming risk often have positive impact if managed in the correct way, therefore risk management should consider the opportunities (possible gains) as well as the threats (possible losses).

2.6 RISK MANAGEMENT IN CONSTRUCTION

Risk has become an issue of business literature during the last two decades of the twentieth century (Loosemore, et al., 2006). As Flanagan and Norman (1993) claims, risk management in construction has perhaps a greater significance at 1990s than any other time since the 1970s. Flanagan and Norman (1993) add, this is because of the increased integration between financial and real sectors of the economy and major capital commitments in the building industry. As stated by Merna and Al-Thani (2005), for forward –thinking companies, risk management has become an important issue by the increasing pace of change, customer demands and market globalization. As Merna and Al Thani (2005) continue, the failure of projects to meet their budgets, completion dates, quality and performance or generate sufficient revenues to service the principal and interest payments generate sufficient revenues to service the principal and interest payments generated the need of risk management. The activities of many industries like construction have come into question, putting forward new challenges for managers (Loosemore, et al., 2006). As Loosemore, et al. (2006) continues while traditionally companies were relying on insurance as a mechanism for managing their

risks. Lately, many organizations are conscious and aware that risk management cannot be done merely by passing it on to insurance and finance companies. Risk management is now a important necessity for every construction company.

Flanagan and Norman (1993) claims that construction projects have a large number of risks, contractors cope with it and owners pay for it. As Flanagan and Norman (1993) further state, the complex nature of construction industry comes from the time-consuming design and production processes that a construction project possesses. The route and processes to taking a project from the initial investment evaluation to accomplishment involves a wide range of people with different skills, concerns, and interest, and quite different but interconnected tasks.

The process of taking a project from the initial investment appraisal to completion requires a wide range of people with different skills and interests, and quite different but interrelated activities. The external, unmanageable factors are into the bargain. In spite of all these, managerial methods used to identify, analyse and respond to risk have been implemented in the industry only during the last decade.

On the same way, Mills (2001) points out the very poor reputation for managing risk in the construction industry, although it is one of the most dynamic, risky and challenging businesses. According to several authors(Tah 2005; Kumar and Viswanadham, 2007) a high level of coordianation is needed among various stakeholders who have conflicting interest. As stated by O'brien (1999), construction process has a fragmented nature, often associated with poor productivity. Deadlines and cost targets are failed to be met by many major projects (Mills, 2001). Smith, et al., (2006) extent this claim, with quality, as another frequently missed target in construction projects. As claimed by Al- Bahar and Crandall (1990), the conractors develop rules of thumb based on experience and judgement to deal with risk. According to Mills (2001), Ignorance of risks or simply adding a 10 percent contingency onto the estimated project cost is common. In terms of risk management research, four main areas can be identified from literature that risk management studies are concentrated on (Dikmen, Birgonul and Arikan, 2004).

(1) Development of conceptual frameworks and process model for systematic risk management,
(2) Investigation of risks, risk management trends and perceptions,
(3) Application of risk identification and analysis techniques in specific projects, and
(4) Development of risk management support tools.

2.7 THE IMPORTANCE OF RISK MANAGEMENT

There is clearly an intimate link between effective risk management and the success of projects, since risks are measured by their potential impact on achievement of project objectives. Similarly, Loosemore, et al. (2006), claim that rather than avoiding risk, it is important to take calculated risks by recognizing and managing them effectively. As Loosemore, et al. (2006) continues, the more confident a company is in its risk management systems, the more likely it is able to turn these risks into opportunities to make profits. As claimed by several authors (Kerzner, 2000; Chapman and Ward, 2003), in ensuring successful project management, the single most important factor of function is managing risk. The chances of meeting or even surpassing the predefined project objectives increased by means of comprehensive approach to dealing with risk (Ren and Yeo, 2009). As claimed by Chapman and Ward (2003), organization which have an established risk management capability as a process, obtain an important advantage over competitors.

There are a few sources in the literature that focus on benefits of risk management. A common one is shown in Table 2.3, which is customized from Newland (1992) and Simister (1994) by Merna and Al Thani (2005), sorting the possible benefits of risk management in two types : hard benefits and soft benefits. Loosemore et al. (2006) list important benefits provided by effective risk management as : a better basis for decision making at strategic, tactical and operational levels, better corporate reporting, better use of human resource expertise, increased engagement wit stakeholders, less adverse publicity, a better basis for negotiations, reduced finance costs, increase reliability and quality of services and products, lessons and feedback to

improve future business activities, reduces claim and legal cost, better change management, enhance morale, reduces level of conflict and stress, and enhanced competitive advantage. Another imperative benefit of risk management given by Merna and Al Thani (2005), as it helps to make the stakeholders aware of the risks, both negative and positive, and to manage them effectively. Burtonshaw-Gunn (2009) looks through the effects of ignoring risks and risk management tools, and states that it will cause unfavourable effects on projects, such as cost overruns, schedule delays and inability to achieve desired project technical objectives. Other significant effects are retold as: project de-scoping, loss of credibility, project cancellation and unhappy clients, personal or organizational liability and fines.

Hard benefits	**Soft benefits**
1. Enable better informed and more believable plans, schedules and budgets 2. Increases th likelihood of a project adhering to its plans 3. Leads to use of the most suitable type of contract 4. Allows a more meaningful assessment of contingencies 5. Discourages the acceptance of financially unsound projects 6. Contributes to the build-up of statistical information to assist in better management of future projects 7. Enable a more objective comparisons of alternatives 8. Identifies, and allocates responsibility to, the best risk owner	1. Improves corporate experience and general communication 2. Leads to a common understanding and improved team spirit 3. Assists in the distinction between good luck/good management and bad luck/ bad management 4. Helps develop the ability to staff to assess risks 5. Focuses project management attention on the real and most important issues 6. Facilitates greater risk taking thus increasing the benefits gained 7. Demonstrates a responsible approach to customers 8. Provides a fresh view of the personnel issues in a project

Table 2.4 The hard and soft benefits of risk management

Source: Merna and Al-Thani, 2005

2.8 INTEGRATION OF RISK MANAGEMENT

Risk management processes interact with each other and also with the processes in the other project management knowledge areas as well (PMI, 2004). As PMI (2004) further claim that poor project management activities and lack of integrated management systems contribute to project risk. Similarly argued by Heldman (2005), there is a high integration between risk management and other project management processes. As also claimed by Ren and Yeo (2009), that all other project management knowledge areas such as cost, time, quality, scope, resources (human and procurement), communication and integration are covered by risk management. Ren and Yeo (2009) continues that business objectives of value creation and profitability are also among the objectives of risk management, as well as project or system level objectives, and issues of safety, health and environment. Integration of risk management with other project management areas is presented by Burtonshaw-Gunn as in Figure 2.5 which was copied from PMI (1992).

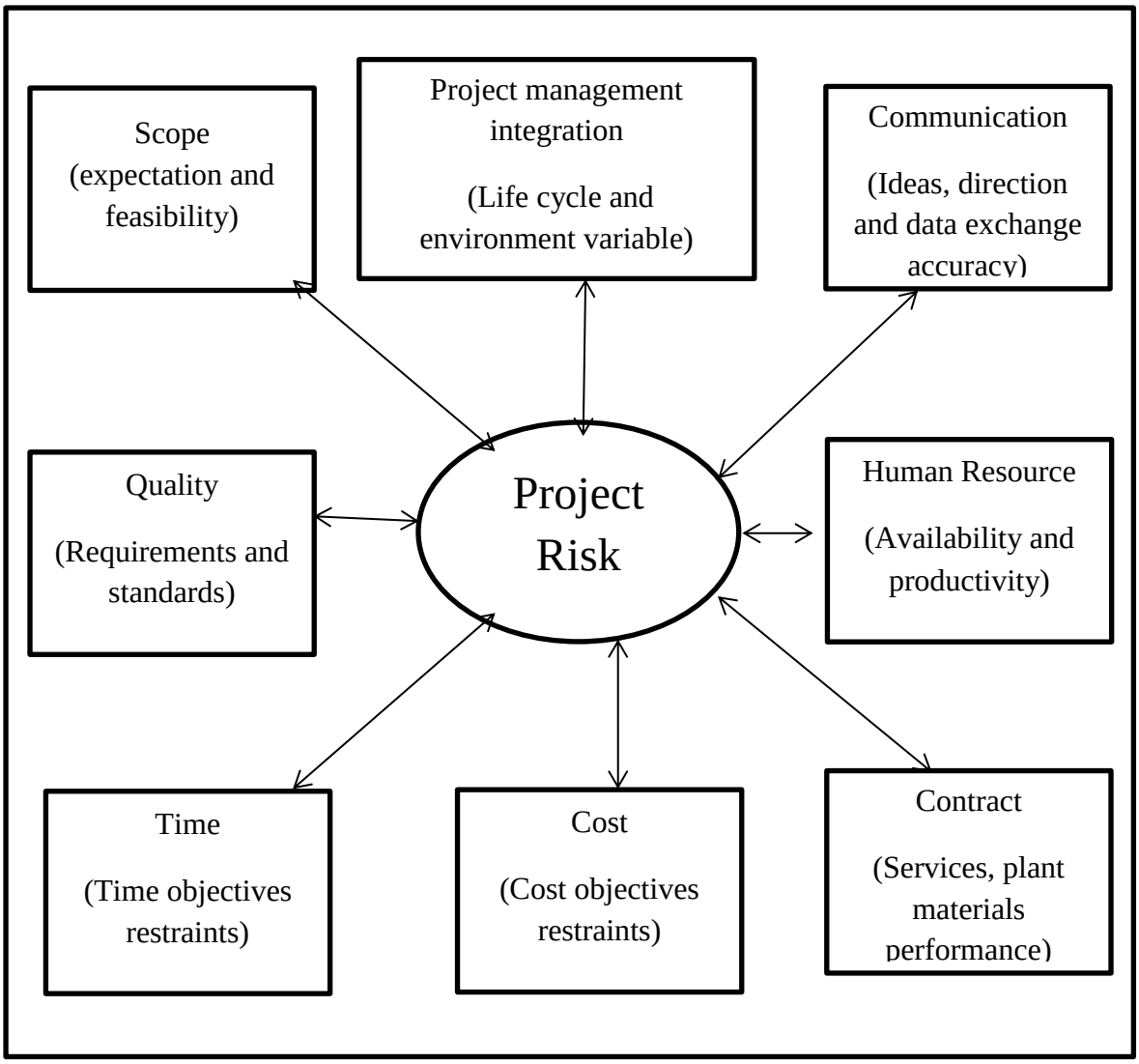

Figure 2.5 Integrating risk management with other project management functions
Source: Burtonshaw Gunn, 2009

According to Burtonshaw-Gunn (2009), risk management has an impact on many facets of the project. On the word of the traditional view, risk management is a part of project management and appreciated by the project manager and delegated team member. Another view is risk driven project management, since there is not necessary for project management if none of the risks in a project. Consequently, all facets of the project should be taking into account in risk management and whole project life cycle should be involved.

2.9 PROCESS OF RISK MANAGEMENT

There are numerous classifications of risk management processes exist in the literature. According to Raz and Michael (2001), these variations depend on the level of detail and assignment of activities to steps and phases, but the content of the whole cycle does not change. A diagram outlining the continuous steps of risk management is given in Figure 2.6.

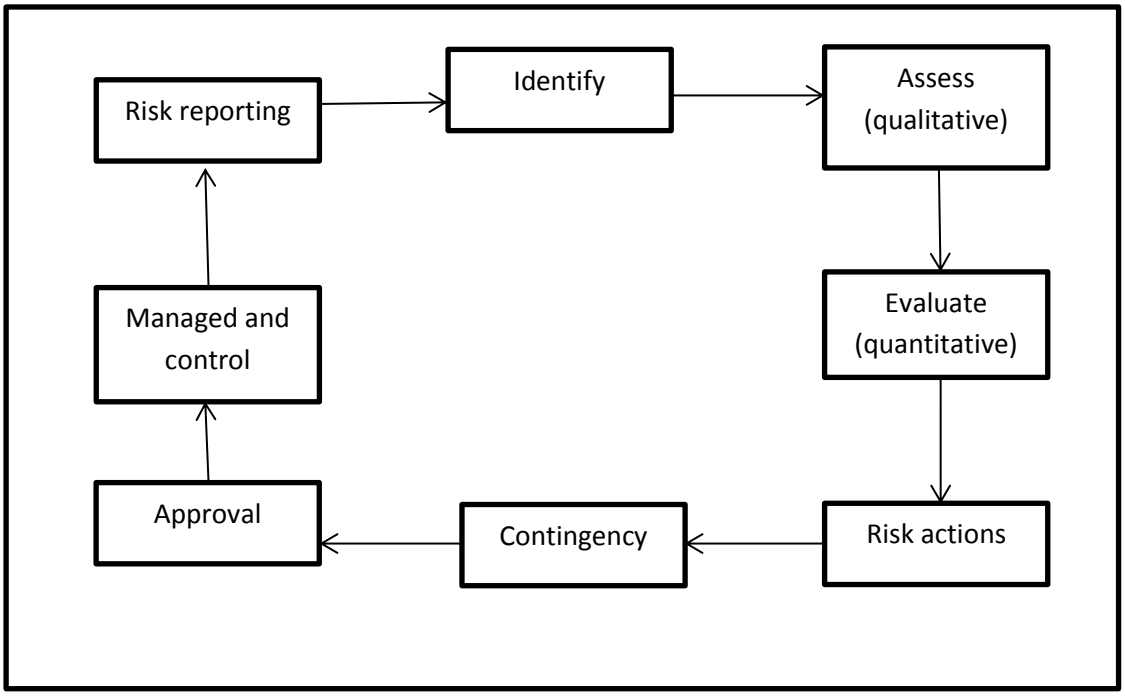

Figure 2.6 Risk management processes

Source: Burtonshaw Gunn, 2009

2.10 DESCRIPTION ON THE TERM MATURITY

Maturity means fully developed or perfected, in general usage (Cooke-Davis, 2005). Andersen and Jessen (2003), argue that if the concept of maturity is adapted to an organization, then it might denote an organization being in a perfect state of condition to achieve its objectives. Crawford (2002), claim that today this maturity

concept is being utilized increasingly to map out logical ways to improve an organization's services. It is used in "Best Practice" benchmarks, indicating increasing levels of sophistication and other features (PMI, 2002). Maturity refers to the degree that an organization consistently carries out processes that are documented, managed, measured, controlled and continually improved (CMMI Product Team, 2002). According to Andersen and Jessen (2003), maturity can best be described for the business community through a combination of three different dimensions: action (ability to act and decide), attitude (willingness to be involved) and knowledge (understanding of the impact of willingness and action).

2.11 THE NEED FOR MATURITY RESEARCH

The purpose of benchmarking is to assess current capability, diagnosing strengths and weaknesses critical to process and performance improvement, and identifying gaps where improvement is required, within a particular domain (Hillson, 2003; Ren and Yeo, 2009). As argued by several authors (Hillson, 2001; Foti, 2002), by means of the assessment framework, an organization becomes able to compare its project delivery with best practice or against its competitors. After an objective assessment, process improvement strategies can be defined (Hillson, 2001; Crawford, 2002; Foti, 2002; Ren and Yeo, 2009). To follow a logical and realistic route in order to reach higher standards, an organization should aim at achieving objectives at the next highest level (Hopkinson, 2000). By repeating the assessment over a period of time, comparisons can be made to prior assessments, impact of the changes made can be identified and future improvements can be guided (Ibbs and Kwak, 2000). Being one of the most famous and most commonly used maturity model, Capability Maturity Model (CMM) is clarified herein to lay the foundation for the subsequently developed models. CMM was created by the Software Engineering Institute (SEI) at Carnegie-Mellon University, with wide, government funded research into how to evolve and measure an organization's effectiveness at developing software (SEI, 2013). As Kerzner (2005) states, the tool aims to provide a structured and objective means for measuring a software organization's development processes and comparing these measures against optimum practices. Kerzner (2005) further claims that to become more competitive in the industry,

CMM helped software developers identify specific improvements. To paraphrase Hillson (1997), the model defines five levels of increasing capability and maturity, termed Initial (Level 1), Repeatable (Level 2), Defined (Level 3), Managed (Level 4) and Optimizing (Level 5).

According to Crawford (2002) , the CMM has gained widespread acceptance, and it has become a standard for process modeling and assessing an organization's maturity in several process areas. In the same way, Kerzner (2005) states that project management measures and standards have been applied to CMM to utilize it in other industries. But as Hillson (1997) argue that CMM's application is limited to organizations involved in software development processes and attempts to broaden the scope of the model to other types of project have not gained widespread currency. According to Hillson (1997), as being the most common maturity model, there has been an attempt to modify the CMM to apply to risk, but it was for software development organizations and was not further developed. Hillson (1997) continues that CMM is a general model of capability, maturity and business excellence, but it does not provide specific assistance for risk management. Although the superseded version of CMM, Capability Maturity Model Integration (CMMI), is becoming well established, its application is limited by its overall invasiveness (PMI ,2002). As PMI (2002) continues, to fully apply the CMMI model (which contains a risk management maturity model) requires significant amounts of resources and integration within the overall Systems Engineering process. Cooke-Davis (2005), claim that capability maturity models are composed of process areas and capability levels, and by assessing the capability level of each process area separately, the overall maturity level of an organization is attained at the end. Andersen and Jessen (2003) define the maturity concept with the notion of a ladder of stages, and express that certain steps or stages assist maturity. As stated by Hopkinson (2000), the levels of a maturity model are designed to aid assessment and set objectives. For a process to mature, it should develop from being unstable to stable and by that means, gain improved capability (Cooke-Davis, 2005).

Cooke-Davis (2004), states that the growing number of maturity models that assist for the assessment of organizational maturity. Ren and Yeo (2004) claim that maturity models have been proposed for many activities like: quality management,

software development, supplier relationships, research and development (R&D) effectiveness, product development, innovation, product design, product development collaboration and product reliability.

2.12 MATURITY RESEARCH IN CONSTRUCTION INDUSTRY

The lack of project predictability and under achievement of the UK construction industry were the major concerns of various studies and reports (Latham, 1994; Love and Li, 1998; Egan, 1998; Santos and Powell, 2001; Koskela, Ballard and Howell, 2003). In the mid-1990s, there was a call for more systematic and industry-wide efforts to increase productivity and improve quality in the UK construction industry, with the reports by Latham (1994) and Egan (1998). It was suggested that to overcome the performance related problems, lessons should be learned from other industries and capabilities should be developed to successfully execute business processes. With these reports, the industry was urged to focus in particular on construction processes (Sarshar, et al., 2000). As stated by several authors (Hobday, 1998; Brady, Davies and Hobday, 2003), developing organizational capabilities is a vital issue for achieving competitive advantage of construction industry or organizations.

In response to such calls from the industry's critics, there was an attempt to apply the maturity concept to construction organizations through a research project titled SPICE (Standardized Process Improvement for Construction Enterprises), conducted at Salford University, beginning in 1998. The argument is given by Sarshar, et al. (2000) as that the construction organizations has no methodological mechanism to systematically assess the construction process, prioritize process improvements, direct resources accordingly, and benchmark their performance relative to other organizations. The objective of SPICE was to investigate how CMM's basic concepts and framework can be applied to the construction industry and by that means, tailor the successful CMM from software industry to a construction specific model to create an evolutionary framework for process improvement and also an assessment tool for organizational maturity (Sarshar, Finnemore, Haigh and Goulding, 1999). As Sarshar, et al. (1999) further claim, research findings reveal that the basic process concepts of CMM are generic and applicable to the construction industry, but the major concern was related

with complex supply chain arrangements in construction projects. It was decided that the framework must adopt the project supply chain for adaption to the construction industry. The model uses five maturity levels and a number of processes connected with each level. Also, process enablers (i.e. commitment, ability, verification, evaluation and activities) are established to support for the evaluation procedure and ensure that the processes are properly performed.

Fengyong and Renhui (2007) applied the generic principles of the Project Management Maturity Model (PM3) created by Remy (1997) to the construction industry and developed a Construction Project Management Maturity Model (CPM3), which aims to evaluate construction project management maturity and support improvement. similarly, Guangshe, Li, Jianguo, Shuisen and Jin (2008) investigated the applicability of Organizational Project Management Maturity Model (OPM3), developed by PMI (2003), to construction industry in China. The findings of the study exposed that it is not suitable to directly apply the OPM3 to the construction projects and obstacles were identified against the application. In the area of risk management, an attempt to adapt a generic risk management maturity framework to construction was taken by Loosemore, et al. (2006), which is explained in detail, as Model 6.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter presents the research design and methodology that will be used to conduct the study. These two elements will explain though secondary data analysis an qualitative analysis methods that will be used for analysing data, and limitation of the research.

3.2 METHODOLOGY

The research methodology is an important stage to conclude the successfulness of achieving the aims and objectives of a project. The research methodology is based on the concepts and principles of the knowledge areas which associated to the research topic were discovered by conducting comprehensive literature review. Current industry practices and available application were studied during literature review. There is some risk maturity model exist and practice by construction companies. The existing models will be reviewed and evaluate, as well as construction specific attributes and construction supply chain issues. By using risk maturity model, it is intentionally for construction companies to be able to appraise their strengths and weaknesses in the area of risk management.

3.3 TECHNIQUE

Data collection is the most critical stage in the planning an implementation of the study. Mistaken data collection can affect the result of the study and in the end will lead to invalid results. To achieve the objectives of the research, the initial was start with conducting a comprehensive literature review. The data collected through

qualitative methodology. The researcher gather information using the past journal research. A clear benefit of using secondary data is that much of the background work needed has already been carried out, such as literature reviews, and case studies might have been carried out, published texts and statistics could have been already used. The wealth of background work means that secondary data generally have a pre-established degree of validity and reliability which need not be re-examined by the researcher who is re-using such data. Since the research is to provide the previously developed risk maturity models, it is important during the initial stage of the research to go to past journal research that related to the maturity model dealing with risk

After a thorough investigation on past research, six maturity models dealing with risk management is identified and several advantageous and disadvantageous points were identified, both in terms of content and in terms of usability. The findings are presented separately for each maturity models. Brief descriptions of the models are presented for each model

3.4 LIMITATION OF THE RESEARCH DESIGN

The study will be conducted using secondary data analysis to gather six previously develop maturity models dealing with risk management. Since it qualitative study Rigor is more difficult to maintain, assess, and demonstrate. Interpretation is time consuming. Findings can be more difficult and time consuming to characterize in a visual way. and It is sometimes not as well understood

CHAPTER 4

RESEARCH FINDINGS

4.1 INTRODUCTION

This chapter presents the quantitative findings of the finding of the study. The main objective of this study is to investigate the components of a construction specific risk management maturity model through literature review in construction industry in Kuantan, Pahang. This chapter comprised of three sections. In the first section showing the results of the questionnaire survey consist of the statistical analysis tests conducted on the compiled data the results given together with the inferences about the companies and commentaries related with the model. Finally, the revision of the model is explained, which was derived from the inpection of data.

4.2 RISK MANAGEMENT MATURITY MODELS

As Hopkinson (2000) argues, by using a risk-based approach, value can be added to a company's operations by improving its performance and enhancing its own future. To quote Hillson (1997), "In order to define the goals, specify the process and manage progress, it is necessary to have a clear view of the enterprise's current approach to risk, as well as a definition of the intended destination." Hillson (1997) continues that a generally accepted framework is needed for an organization in order to benchmark its current maturity and capability in managing risk, and this framework should also assist in defining progress towards increased maturity. Being an assessment tool, a risk maturity model is designed to measure risk management capability and to

provide objectives for improvement (Hopkinson, 2000). Several tools have been designed for diagnosing risk management maturity of a project or an organization. To be further studied in this research, six outstanding risk management maturity models were identified. These models are explained in detail in the following sub sections.

4.2.1 MODEL 1 : RISK MATURITY MODEL

Hillson (1997)'s Risk Maturity Model (RMM) is the first notable attempt to develop a framework for a risk maturity model. It serves as a foundation for many of the subsequent maturity models such as Risk Management Maturity Model (RMMM), RMMM Adapted to the Construction Industry, IACCM Business Risk Management Maturity Model and Risk Management Capability Maturity Model for Complex Product Systems Projects.

Hillson (1997) claims, Risk Maturity Model (RMM) serves for the organizations wishing to implement a formal approach to risk management or to improve their existing approach. The major objective of the model is to provide a framework against which current risk management practice can be benchmarked. The benchmarking is done in terms of maturity. The model assists organizations to assess their current level of risk management capability maturity, identify targets for improvement, and to devise strategies for developing or enhancing their risk management capability maturity level. It also suggests strategies to move to the next level of maturity. The RMM has four levels of capability maturity, each linked to specific attributes. These are: Level 1: Naive, Level 2: Novice, Level 3: Normalised and Level 4: Natural. Each\RMM level is briefly described in Table 4.1. According to Hillson (1997), to achieve a more detailed diagnostic tool required for objective and consistent assessment of risk management process maturity, four attribute headings are integrated to the system: Culture, Process, Experience and Application. With this breakout, clear criteria that had been accepted by numerous risk management organizations were attempted to be utilized in the assessment. The obstacles faced by organizations when attempting to progress to the next level of maturity were also given by the author and some strategies were suggested for overcoming them.

DEFINITION	Naive	• Unaware of the need for management of risk. • No structured approach to dealing with uncertainty. • Repetitive and reactive management processes. • Little or no attempt to learn from past or to prepare for future
	Novice	• Experimenting with risk management (RM) through a small number of individuals. • No generic structured approach in place. • Aware of potential benefits of managing risk, but ineffective implementation, not gaining • full benefits.
	Normalised	• Management of risk built into routine business processes. • RM implemented on most or all projects. • Formalized generic risk process. • Benefits understood at all levels of the organization, although not always consistently • achieved.
	Natural	• Risk-aware culture, with proactive approach to RM in all aspects of the business. • Active use of risk information to improve business processes and gain competitive • advantage. • Emphasis on opportunity management (“positive risk”).
CULTURE	Naïve	• No risk awareness. • Resistant/reluctant to change. • Tendency to continue with existing processes.
	Novice	• Risk process may be viewed as additional overhead with variable benefits. • RM used only on selected projects.

	Normalised	• Accepted policy for RM. • Benefits recognized and expected. • Prepared to commit resources in order to reap gains.
	Natural	• Top-down commitment to RM, with leadership by example. • Proactive RM encouraged and rewarded
PROCESS	Naïve	• No formal processes
	Novice	• No generic formal processes, although some specific formal methods may be in use. • Process effectiveness depends heavily on the skills of the in-house risk team and • availability of external support.
	Normalised	• Generic processes applied to most projects. • Formal processes, incorporated into quality system. • Active allocation and management of risk budgets at all levels. • Limited need for external support
	Natural	• Risk-based business processes. • "Total Risk Management" permeating entire business. • Regular refreshing and updating of processes. • Routine risk metrics with constant feedback for improvement.
EXPERIENCE	Naïve	• No understanding of risk principles or language.
	Novice	• Limited to individuals who may have had little or no formal training.
	Normalised	• In-house core of expertise, formally trained in basic skills. • Development of specific processes and tools.

	Natural	• All staff risk-aware and using basic skills. • Learning from experience as part of the process. • Regular external training to enhance skills
APPLICATION	Naïve	• No structured application, no dedicated resources and risk tools.
	Novice	• Inconsistent application. • Variable availability of staff. • Ad-hoc collection of tools and methods.
	Normalised	• Routine and consistent application to all projects. • Committed resources and integrated set of tools and methods.
	Natural	• Second-nature, applied to all activities. • Risk-based reporting and decision-making. • State-of-the-art tools and methods.

Table 4.1. Risk Maturity Model (RMM) framework
Source: Hillson, 1997

4.2.2 MODEL 2: PROJECT MANAGEMENT MATURITY MODEL BY PROJECT MANAGEMENT SOLUTIONS

Project Management Maturity Model (PMMM) by Project Management Solutions is intended for diagnosing the maturity of the project management processes of an organization. Its focused view on the processes constitutes the main difference of the model from the other investigated models. Crawford (2002) claims, this model was developed to assist organizations in improving their project management processes by providing a conceptual framework. As Crawford (2002) further claims, it has become the industry standard in measuring project management maturity. Furthermore, it serves

for improvement by mapping out a logical path and to track progress. The PMBoK Guide's nine knowledge areas and the Software Engineering Institute's five levels of maturity were used in this model. The knowledge areas are: Project Integration Management, Scope Management, Time Management, Cost Management, Quality Management, Project Human Resource Management, Communications Management, Risk Management and Procurement/Vendor Management. Five levels of maturity are; Level 1: Initial Process, Level 2: Structured Process and Standards, Level 3: Organizational Standards and Institutionalized Process, Level 4: Managed Process and Level 5: Optimizing Process.

Each knowledge area is defined at each level of maturity. These knowledge areas are broken down into their specific components to offer the most comprehensive definition. The model defines five components for risk management: Risk Identification, Risk Quantification, Risk Response Development, Risk Control and Risk Documentation. For each maturity level, along with a brief general description of the characteristics, more detailed explaination are provided for each component at each maturity level. By the use of the descriptions in risk management knowledge area, a matrix of maturity levels and components was constructed accordingly. Refer to Table 4.2.

PROJECT RISK MANAGEMENT		
RISK IDENTIFICATION	Level 1	• Risks are not identified as a standard activity • There is reaction to risks when the risk is already a current problem versus a future possibility
	Level 2	• Organization has a documented process for identifying project risks, but it is used only for • large, highly visible projects • A conscious effort to identify total project risks • Input from key stakeholders is also considered in discussions • To help identify the risks; scope statement, WBS, a more detailed project schedule and cost estimate are used • Procurement and staff management plans are also examined • Top-level risks are included in project plan • Expert judgment and known industry lessons are used
	Level 3	• A documented, repeatable process exists • Documentation exists on all processes and standards • Expanded with checklists, automated forms, etc. • Risk triggers are also identified • Interrelationships among related projects are also considered • Input from past, similar projects, lessons learned, key stakeholders are all consolidated and integrated
	Level 4	• Integrated with the cost management and time management processes and the project office • Made within individual project, within programs and between projects and programs

	Level 5	• An improvement process is in place • Lessons learned are being captured • Includes a method to identify an organizational priority for the project
RISK QUANTIFICATION	Level 1	• The impact of the somehow identified risks on the project is speculated without any analysis, • forethought, standard approach/process
	Level 2	• A more structured approach to quantifying risks • A standard methodology to consistently assess the risk items • May include; low-medium-high ratings or expected monetary value of risks using simple probability and value calculations • Employ more objective approaches to quantify the probability and impact of the risks • Evaluation still on a project-by-project basis • Risks are prioritized based on a single factor
	Level 3	• More advanced procedures to quantify risks • Multiple criteria to prioritize risk items • The entire process is fully documented and repeatable • Range predictions, optimal calculations using simulation tools and decision trees, weighted average calculations • Risks are prioritized based on multiple factors like EMV, criticality, timing, risk type

	Level 4	• Integrated with cost management, time management, finance/accounting, strategic planning • processes and project office • The risks on other projects and other parts of the organization are also considered • Risks are evaluated on an organizational basis • Performance indices can be used (to calculate the impact of risk on a project)
	Level 5	• An improvement process is in place • Cost and schedule impacts are adequately captured • Lessons learned are being captured • Management uses the quantified risks to make decisions regarding the project
RISK RESPONSE DEVELOPMENT	Level 1	• Risks are considered as they arise • Determination of mitigation strategies or contingency plans for future is seldom
	Level 2	• Informal gatherings on the strategies to deal with the risk events • A risk management (RM) plan that documents the procedures to manage risk • Contingency plans for near-term risks and mitigation strategies for large projects
	Level 3	• Templates are used • Contingency plans and mitigation strategies are identified for each risk item
	Level 4	• Integrated with cost management, time management, finance/accounting, strategic planning • processes and project office
	Level 5	• Lessons learned are being captured • A process for tracking the use of project reserves is in place

RISK CONTROL	Level 1	• Day-to-day problem solving if a new risk event arises • No RM plan or additional risk response strategies
	Level 2	• Apply their own approach to manage and control risks • Assign responsibility for each risk item as it occurs • Discussion of the risks in staff meetings • Risk status of large projects is tracked • There is a process to report risk status to key stakeholders • A risk log, periodic meetings • Tracking changes and incorporating into the project schedule
	Level 3	• Fully developed process, project risks are actively, routinely tracked • Corrective actions are taken, RM plan is updated and metrics are used
	Level 4	• Integrated with organization's control systems, monitoring programs, cost and time management
	Level 5	• Risk assessments and the current risk status are utilized for management decisions
RISK DOCUMENTATION	Level 1	• No historical database on typical risks encountered and related experiences • Individuals rely upon their own past experiences and discussions with other team members
	Level 2	• Some historical information about general tendencies in risk may have been collected • No typical and centralized method to collect historical information
	Level 3	• A historical database of information such as common risk items and risk triggers
	Level 4	• Historical database is expanded to include inter-dependency risks between projects

	Level 5	• An improvement process is in place • Post-project assessments • Lessons learned are being captured

Table 4.2 Component-maturity level matrix

Source : Crawford (2002)

4.2.3 MODEL 3: RISK MANAGEMENT MATURITY MODEL

As PMI (2002) argues, this model is an elaboration of the initial work accomplished by Hillson (1997), which is presented as Model 1, to improve its diagnostic elements and to further aid in identification of the current level at which an organization is operating. As mentioned by PMI (2002), this is a simplified maturity model designed to quickly target weaknesses and is applicable to all types of projects and all types of organizations in any industry, government or commercial sector. The naming of the levels has been changed but the basic structure remained the same with the Hillson (1997)'s model. The maturity levels of Risk Management Maturity Model (RMMM) are: Level 1: Ad-Hoc, Level 2: Initial, Level 3: Repeatable and Level 4: Managed. Also the four attribute headings were taken from the Hillson (1997)'s model, therefore the headings remained the same as; Culture, Process, Experience and Application. Framework of RMMM is constructed as in Table 4.3. There are some elaborations made upon RMM, on the descriptions of the maturity levels and on the suggested strategies for moving to the next level.

DEFINITION	Level 1- Ad hoc	• Unaware of the need for management of uncertainties (risk). • No structured approach to dealing with uncertainty. • Repetitive and reactive management processes. • Little or no attempt to learn from past projects or prepare for future projects.
	Level 2- Initial	• Experimenting with risk management (RM) through a small number of individuals. • No structured approach in place. • Aware of potential benefits of managing risk, but ineffective implementation.
	Level 3 - Repeatable	• Management of uncertainty built into all organizational processes. • RM implemented on most or all projects. • Formalized generic risk process. • Benefits understood at all organizational levels, although not always consistently achieved.
	Level 4 - Managed	• Risk-aware culture with proactive approach to RM in all aspects of the organization. • Active use of risk information to improve organizational processes and gain competitive advantage.
CULTURE	Level 1- Ad hoc	• No risk awareness. • No upper management involvement. • Resistant/reluctance to change. • Tendency to continue with existing processes even in the face of project failures. • Shoot the messenger.

	Level 2- Initial	• Risk process may be viewed as additional overhead with variable benefits. • Upper management encourages, but does not require, use of RM. • RM used only on selected projects.
	Level 3 - Repeatable	• Accepted policy for RM. • Benefits recognized and expected. • Upper management requires risk reporting. • Dedicated resources for RM. • "Bad news" risk information is accepted.
	Level 4 - Managed	• Top-down commitment to RM, with leadership by example. • Upper management uses risk information in decision-making. • Proactive RM encouraged and rewarded. • Organizational philosophy accepts idea that people make mistakes.
PROCESS	Level 1- Ad hoc	• No formal process. • No RM plan or documented process exists. • None or sporadic attempts to apply RM principles. • Attempts to apply RM process only when required by customer.
	Level 2- Initial	• No generic formal processes, although some specific formal methods may be in use. • Process effectiveness depends heavily on the skills of the project risk team and the availability of external support. • All risk personnel located under project.

	Level 3 - Repeatable	• Generic processes applied to most projects. • Formal processes incorporated into quality system. • Active allocation and management of risk budgets at all levels. • Limited need for external support. • Risk metrics collected. • Key suppliers participate in RM process. • Informal communication channel to organization management.
	Level 4 - Managed	• Risk-based organizational processes and RM culture permeating the entire organization. • Regular evaluation and refining of process. • Routine risk metrics used with consistent feedback for improvement. • Key suppliers and customers participate in RM process. • Direct formal communication channel to organization management.
EXPERIENCE	Level 1- Ad hoc	• No understanding of risk principles or language. • No understanding or experience in accomplishing risk procedures.
	Level 2- Initial	• Limited to individuals who may have had little or no formal training.
	Level 3 - Repeatable	• In-house core of expertise, formally trained in basic RM skills. • Development and use of specific processes and tools.
	Level 4 - Managed	• All staff risk aware and capable of using basic risk skills. • Learning from experience as part of the process. • Regular training for personnel to enhance skills.

APPLICATION	Level 1- Ad hoc	• No structured application. • No dedicated resources. • No RM tools in use. • No risk analysis performed.
	Level 2- Initial	• Inconsistent application of resources. • Qualitative risk analysis methodology used exclusively.
	Level 3 - Repeatable	• Routine and consistent application to all projects. • Dedicated project resources. • Integrated set of tools and methods. • Both qualitative and quantitative risk analysis methodologies used.
	Level 4 - Managed	• Risk ideas applied to all activities. • Risk-based reporting and decision-making. • State-of-the-art tools and methods. • Both qualitative and quantitative risk analysis methodologies used with great stress on having valid and reliable historical data sources. • Dedicated organizational resources.

Table 4.3 RMMM Risk Management Maturity Model
Source: PMI, 2002

4.2.4 MODEL 4: IACCM BUSINESS RISK MANAGEMENT MATURITY MODEL

The IACCM Business Risk Management Working Group (2003) designed a tool for the organizations to evaluate their level of maturity in the area of business risk management. IACCM Business Risk Management Maturity Model (BRMMM) aims to

assist an organization to assess whether its approach to risk management is adequate or not, to compare its approach with best practice or against its competitors and create an accepted benchmark for organizational risk management. The developer of RMM (Model 1) took part in this project and provided a framework to be utilized in this model. Accordingly, the basic structure of the framework is not so different from RMM and RMMM. Four levels of organizational business risk management maturity were utilized (i.e. Level 1: Novice, Level 2: Competent, Level 3: Proficient, Level 4: Expert) against four key attributes (i.e. Culture, Process, Experience, Application).

The model provides the maturity characteristics by a maturity level - attribute matrix which is presented in Table 4.4. However, instead of this general framework, a detailed questionnaire is provided as a set of tables, each row containing one characteristic within an attribute. For the culture section there are ten rows of characteristics. Similarly, it is eight for the process, six for the experience and seven for the application sections. Each characteristic is scored according to the maturity levels (1, 2, 3 or 4) and at the end, total attribute scores and maturity score of the organization are achieved. The variation in the characteristic and attribute scores reflects the strengths and weaknesses of the organization. Thus, along with serving for the assessment of the maturity level of the organization, the questionnaire can also be used to set realistic targets for improvement, on the basis of the identified strengths and weaknesses.

	LEVEL OF MATURITY				
ATTRIBUTE		Novice	Competent	proficient	Expert
	Culture	-Risk averse -Lacking awareness/ understanding -Lacking strategy -Lacking	-Patchy, inconsistent -Some understanding/ awareness -Cautious approach, reactive	-Prepared to take appropriate risks -Good understanding of benefits across most of organization -Strategy mapped	-Proactive -Intuitive understanding -Belief, full commitment to be the best

		commitment		into process implementation	
	Process	-Where present tend to be inefficient, informal, ad-hoc	-Inconsistent -No learning from experience -Standard approach/ generic	-Consistent approach but scalable -Tailored to specific needs	-Adaptive -Proactively developed -Fit for purpose -Best of breed
	Experience	-None; nothing relevant	-Basic competence	-Proficient -Formal qualifications	-Extensive experience -Leading qualifications -Externally recognized high competence
	Application	-Not applicable	-Inconsistent-major projects only -Process driven -Inadequately resourced	-Consistently applied -Adequately resourced	-Proactively resourced Across entire business -Flexible -Measured for improvement

Table 4.4 Maturity level – attribute matrix of Model 4

Source: IACCM Business Risk Management Working Group, 2003

4.2.4 MODEL 5: RISK MANAGEMENT CAPABILITY MATURIT MODEL FOR COMPLEX PRODUCT SYSTEMS PROJECTS

This model offers a framework for complex product systems projects to benchmark the current approach in risk management against five standard levels of maturity. The tool allows for the evaluation of the current level of the organization, identify realistic targets for improvement and develop action plans for improving its risk management maturity. The model uses the maturity levels of capability maturity model (CMM), which are; Level 1: Initial, Level 2: Repeatable, Level 3: Defined, Level 4: Managed and Level 5: Optimizing. As claimed by Ren and Yeo (2004), for the improvement of risk management maturity, the organization must develop its capabilities in organizational culture (context), risk management process (process) and risk management knowledge/techniques (content) simultaneously. Consequently, the tool defines three key capability areas, Organization Culture, Risk Management Process and Risk Management Knowledge and Technology. For each maturity level, the model defines major organization culture characteristics, risk management process characteristics and knowledge characteristics, and a theoretical framework is obtained as in Table 4.5.

	Major Organization Characteristics	Major RM Process Characteristic	Major Knowledge Characteristic
Level 5	-Strong risk-awareness culture with proactive approach to risk management (RM) in the CoPS network -Active use of risk information to gain competitive advantage -Risk-based organization that isdynamic and energetic, and flexible -Develop and sustain goodwill and long term relations with lead customers and clients	-RM processes are continuously improved -Develop a system of coalition and partnering with vendors and contractors -Project risk management process integrated into other project management processes	-Excellence in RM knowledge management -Continuous RM learning -Centre of excellence in RM -RM knowledge shared and transferred
Level 4	-Strong teamwork, even with external partners. -Continuous formal RM training for project teams. -Strong risk-based organization process. -Strong senior support to RM	-Consistent and systematic RM for project portfolios. -RM processes are integrated internally and with external partners. -RM processes data are quantitatively analysed, measured, and stored continuously.	-Strong RM learning capability. -RM information management system -Integrated sets of tools and methods. -All staff risk aware and capable of using basic risk skills.

Level 3	-Dedicated resources to RM. -Formal training of RM skills and practices. -Risk awareness at the organizational level. -Recognition of risk. ownership and allocation of risk and responsibility.	-Formal project planning and control systems are established and -Applied RM system and procedures are used to identify, confront and mitigate risks continuously. -Ensure real time monitoring of budgets and schedules.	-Full understanding of RM principles. -Mastering basic RM tools and techniques. -The personnel in charge of RM has high level of RM competence. -Formal RM databases are maintained.
Level 2	-Partial acceptance of RM. -Initial assignment of responsibility and accountability for risks. -Informal training of RM skills and practices.	-Informal RM processes are defined. -RM problems are seldom systematically identified and analysed. -Fragmented RM data are collected	-Partial knowledge on RM principle and language. -Historical risk data are used in assessing future projects -RM tools are used in some activities.
Level 1	-No senior management support and involvement. -Shoot the messenger, risk-fear culture. -Unaware of the need for RM.	-No formed RM processes or practices are available. -No RM data are consistently collected or analysed.	-No understanding of RM.principles or language - No RM tools in use. -No historical risk data collected and maintained.

Table 4.5 Framework of Model 5

Source: Ren and Yeo, 2004

4.2.6 MODEL 6: PMI'S RISK MANAGEMENT MATURITY MODEL ADAPTED TO THE CONSTRUCTION INDUSTRY

Loosemore, et al. (2006) built their work upon the Risk Management Maturity Model (RMMM) designed by the PMI (2002), which is presented as Model 3. While valuable, the RMMM was assessed by the authors as being quite narrow in its description of what characterizes each level of maturity. According to Loosemore, et al. (2006), it needs refining to suit the particularities of different industries such as construction. Using the integration of work by Mitroff and Pearson (1993) and Loosemore (2000), PMI's work was adapted and expanded for the construction industry by Loosemore, et al. (2006), and a more robust model was obtained.

This new model lists the typical attributes of an organization at each level of maturity under the headings of: Awareness, Culture, Processes, Skills/Experience, Image, Application, Confidence and Resources. Other than the attributes maintained from RMMM, awareness, image, confidence and resources are the extra attribute headings integrated to the structure. The final model utilizes the mentioned headings against four levels of maturity; which are; Level 1: Ad-Hoc, Level 2: Established, Level 3: Managed and Level 4: Integrated, as depicted in Table 4.6. As claimed by Loosemore, et al. (2006), an organization may belong to different levels of maturity for different attributes and may be operating at different levels of maturity for different types of risk. As Loosemore, et al. (2006) continues in their claim, to achieve a consistent level of maturity across all risk categories and across all attributes is the challenge for any organization.

CULTURE	Level 1 - Ad Hoc	• No risk awareness, RM seen as a nuisance and peripheral activity with no relevance or value to core business objectives. • No upper management involvement or support. • Resistance and reluctance to adopt risk management (RM). • Tendency to continue with existing processes even in the face of project failure. • Managers do not want to hear about problems. Many undiscussable problems. • People are punished for communicating bad news. • Secretive inward looking - no stakeholder communication.
	Level 2 - Established	• Risk processes are viewed as a compliance requirement and an additional overhead with variable practical benefits. • Scepticism of ability of RM to add value to organization. • Focus on downside of risk. • RM system is primarily for public relations purposes but not implemented. • Upper management encourages but does not require RM. • Little communication with stakeholders
	Level 3 - Managed	• Benefits of RM recognized, accepted and proven. Focus on upside and downside of risk. • Upper management requires risk reporting. • Bad news risk information is accepted. • Informal communication channels to top management. • Effective communication with stakeholders.

	Level 4 - Integrated	• RM widely seen as a core business function. • Risk is an instinctive and automatic way of thinking for all employees at all levels of organization. • Open flows of information and trusting relationships with business partners along entire supply chain. • Collective responsibility for risks and opportunities along supply chain. • No blame culture – acceptance of mistakes. • Formal communication channels to top management. • External stakeholders actively encouraged through formal mechanisms to participate in business decisions.
PROCESS	Level 1 - Ad Hoc	• No structured and documented approach to deal with risk. • No formal processes. No RM plan. Reactive management of risks. • Over reliance on insurance as a substitute for effective RM. • A policy of risk transfer to weaker parties through contractual mechanisms. Internal business processes actively create risks.

	Level 2 - Established	• Project-based RM systems with little inter-relationships. • No generic risk processes and no RM planning across projects. • RM processes inconsistent across different management systems. • No attention to reducing risk exposure created by internal business processes.
	Level 3 - Managed	• Generic RM processes widely communicated and implemented on most projects and common across different management systems. • Risks metrics collected to support basic quantitative analysis. • A policy of risk fairness in contracts rather than risk transfer. • Steps activity taken to reduce risk in products, services, business and production processes. • Use of external experts and services in RM.

	Level 4 - Integrated	• Risk-based organizational processes at all levels and functions of organization. • Well-developed, tested and refines RM procedures. • Regular monitoring, evaluation, auditing and improvement of processes. • Management of risk built into all organizational processes and consistent across all management systems. • Wide range of reliable risk metrics covering whole risk portfolio collected and analysed systematically. • Processes reflect good principles of RM/transfer – re; pricing, capability, resources must be appropriate to risk. • Diversification and portfolio strategies in place. • Computerized inventories of plant, employees, products and capabilities. • Business continuity planning, crisis management and emergency systems in place and regularly tested – backed up by technical redundancy. • Regular legal and financial audits of threats and opportunities undertaken. • Dedicated research on hidden opportunities and threats. • Critical follow up and learning from incidents.
AWARE	Level 1 - Ad Hoc	• Unaware of the need for RM. • Little or no attempt to learn from past projects

	Level 2 - Established	• Experimenting with RM through a small number of enthusiastic individuals. • Aware of potential benefits of managing risk but no effective implementation. • Staff tends to react to risks as and when they arise .
	Level 3 - Managed	• Benefits of RM understood at all organizational levels and along supply chain, although not consistently. • Key internal stakeholders and suppliers can participate in RM process. • Proactive approach to risk when making decisions .
	Level 4 - Integrated	• Risk awareness applied proactively in making all decisions. • Risk awareness instilled throughout all organizational levels and along entire supply chain. • Active use of risk feedback to improve organizational processes and gain competitive advantage. • Collective responsibility for risk along entire supply chain. Key suppliers, external and internal stakeholders and customers participate in RM process.
SKIL	Level 1 - Ad Hoc	• No understanding of RM language or principles.

	Level 2 - Established	• Basic understanding of RM language or principles in organizational pockets. • Limited to individuals who have had little or no formal training. • No analysis capability apart from some basic qualitative analysis by individual managers.
	Level 3 - Managed	• Widespread understanding of RM language or principles. • Qualitative analysis is widely practiced and some basic quantitative analysis.
	Level 4 - Integrated	• Intimate and developing understanding of RM language or principles and how it applies to organization's business. • Where appropriate, complex quantitative analysis is possible using sophisticated probabilistic and simulation techniques. • State of the art tools and methods in use. • Evolving corporate memory of and learning about past risks and opportunities.
IMAGE	Level 1 - Ad Hoc	• Reputation for poor RM associated with cost overruns, delays, poor safety, poor quality on projects.
	Level 2 - Established	• Perception of competence but unreliability associated with variable performance and well publicised problems on contracts spreading between clients.
	Level 3 - Managed	• Reputation for effective RM consistency of service, and product quality based on well publicised and widely implemented RM system.

	Level 4 - Integrated	• Reputation for excellent RM acquired from successful completion of high-risk projects. • Company attracts educated clients which are sophisticated in RM and expect same standards. • Customers have confidence that organization can take on higher risks than competitors. • Added value to customers often added by emphasis on upside as well as down side of risk. • Major efforts in public relations and stakeholder management.
APPLICATION	Level 1 - Ad Hoc	• No or very few managers practice RM.
	Level 2 - Established	• RM applied inconsistently in response to customer demands and practiced on selected projects depending on knowledge of managers on those projects.
	Level 3 - Managed	• RM applied consistently across systems and levels but needs continuous support and leadership to maintain. • RM focused on operational risks. • RM training.
	Level 4 - Integrated	• RM consistently and systematically implemented on all projects and across all management systems. • Enthusiasm for value of system develops its own momentum for continuous improvement. • RM applied to broad range of risks – political, reputational, strategic, commercial and operational. • Regular RM training to all staff.
CONFIDENC	Level 1 - Ad Hoc	• Fear of RM. • No experience in implementing risk procedures. • No confidence in identifying, analysing and controlling risks.

	Level 2 - Established	• Fear of RM remains in pockets. • Risk analysis beyond most people – better risk identification processes are a major step forward.
	Level 3 - Managed	• Perceptions of fear have been broken. • People work confidently at own ability level and actively seek further information to help manage risks. • Support system in place to help people with RM activities.
	Level 4 - Integrated	• Overt confidence in managing risks communicated to customers and clients. • Enthusiasm to learn about RM and develop skills. Staff see RM as their core skill. • Interactive and intelligent support system available to staff which enables learning across different functions. • RM system develops a life of its own – driven forward and developed by staff. • Risk leadership provided by staff. • Staff externally communicate RM capabilities as a competitive advantage
RESOURCES	Level 1 - Ad Hoc	• No dedicated resources for RM.
	Level 2 - Established	• All risk personnel located under project. • No central support. • Risk financed under project cost centres

	Level 3 - Managed	• Top management commitment to RM. • Active allocation and management of risk budgets. • In-house core of expertise, formally trained in basic RM skills. • Development and use of specific dedicated processes and tools for business. • Training of key people in organization who administer and involved in RM system.
	Level 4 - Integrated	• Dedicated budget/resources for RM. • Top-down implementation of system led by strong management leadership. • Dedicated RM unit or team. • Centralised RM expertise and resources and support for everyone in the organization. • Human resources management support RM activities through incentives, training, rewards, etc. Resources to support, train supply chain in RM. • Psychological support for employees, stress management.

Table 4.6 Framework of Model 6
Source: Loosemore, et al., 2006

4.3 ADVANTAGEOUS AND DISADVANTAGEOUS ASPECTS OF MATURITY MODELS

Through the literature review it was observed that even if construction process improvement and project management capabilities of construction organizations are concentrated in numerous studies, there is deficiency in maturity research specifically carried out in the area of construction risk management. The inferences drawn from the

review of the risk management maturity models are explained in advance. After a deep examination of the reviewed six maturity models dealing with risk management, some advantageous and disadvantageous points were discovered, both in terms of effectiveness and in terms of usability. Table 4.1 was constructed in accordance with the specific features of the models, defining the evaluation and comparison. The evaluation criteria were listed as attributes, levels of maturity, content, specificity to the construction industry and assessment system. Accordingly, the appraisal of each criteria is conveyed herein, based on Table 4.7 simplifying easy to follow up.

	Model 1	Model 2	Model 3
Attributes	Simple and reasonable attributes	Risk management processes are taken as attributes	Reasonable attribute headings taken from model 1
Maturity levels	Four levels of capability maturity	Fives levels of capability maturity	Four levels of capability maturity
Content	The model is composed of brief descriptions of the levels according to the defined attributes.	The model focuses on the risk management processes of the project. Therefore, its effectiveness is restricted with the process attribute, when the aim is to measure the risk management maturity of an organization. Being effective only on a specific part, the model provides detailed characteristics of the	When compared with model 1, it is seen that some parts of the frameworks are expanded in terms of content. Some entries are added to the framework to provide a more detailed approach

		processes at each maturity level.	
Construction-specificity	X	X	X
Assessment system	No defined assessment system, as it only involves general descriptions.	No defined evaluation system. Assessment are carried out via benchmarking against brief descriptions of groupings.	No defined assessment system. Listing of entries instead of systematic approach
Comments	Although constructing a strong basis, the practicality of the model is restricted. As also claimed by Hillson (1997), its diagnostic elements should be enhanced and a self-assessment questionnaire is needed	Like model 1 , this model also does not provide a systematic assessment approach. In a similar vein, it is solely composed of descriptions for each attribute at each maturity level, which does not provide sufficient usability as a diagnostic tool.	The problematic point related with practicality in model 1 remains the same. Enhancement of its diagnostic elements is still needed, as also pointed out by its developers (PMI, 2002)

	Model 4	Model 5	Model 6
Attributes	Same attributes heading with the model 1 and model 3	Three key attributes as culture, process and knowledge/ techniques.	Extra attribute headings are integrated to the Model 3 framework.
Maturity levels	Four level of capability of maturity	Five levels of capability maturity	Four levels of Capability maturity
Content	The content is parallel to model 1 and model 3. However, unlike the previous models, the model considers the integration of risk management with other management processes, although in a very brief manner. Diagnostic characteristics are given for each attribute and each characteristic is described for each level of maturity.	The model elaborates its process section under the headings of risk identification, risk analysis and risk mitigation. This is a positive approach in terms of the effectiveness of the model. The model also includes the integration of risk management with other processes in its process part as another improvement.	Considering the construction industry, Model 3 is expanded with some entries and the notable ones are regarding the supply chain in construction. Integration of risk management with other management processes is taken into consideration.
Construction-specificity	X	X	✓

Assessment system	The assessment system is defined and clear which increases the usability of the model.	The evaluation system is based on a five-point likert scale, by means of scoring each statement on a degree of agreement.	No defined assessment system.
Comments	Provides not only a framework but also a detailed and systematic questionnaire. As mentioned, each attribute characteristic is given for each level of maturity so no gaps are left in the structure.	It has a different structuring than the mentioned models that are built upon Hillson (1997)'s model. Not only a framework, but also a more detailed outline composed of statements is developed by the authors. But the comprehensibility of the statements in terms of serving for a self-assessment is in question.	In terms of usability, same arguments are valid as for Model 3. As claimed by Loosemore, *et al.* (2006), the model guides for the assessment of RM maturity by denoting the types of questions to be asked, instead of constructing the actual questionnaire.

Table 4.7 Evaluation and comparison of the existing risk management maturity models

4.3.1 ATTRIBUTES

Simple and practical attributes are specified by Model 1 as culture, process, experience and application. Under culture attribute the model considers risk awareness, top management commitment and approach towards risk management. Process attribute examines the existence of formal processes, risk budget and organizational learning from risks. Under experience attribute the model concern with, staff dealing with risk management, training and use of tools. And finally, under application attribute, the existence of a structured application of risk management, dedicated tools and resources are examined. Also, developed upon Model 1, Models 3 and 4 use the same attribute headings with Model 1. In contrast, having a intensive view on the processes, Model 2 takes risk management processes (in which it is called components) as attributes. In a different approach, Model 5 uses three main attributes as culture, process and knowledge/techniques. In Model 6, additional attribute headings are assimilated to the RMM framework – awareness, image, confidence and
resources. Taking grasp of the descriptions of the term "organizational culture" in the literature, it was realized that the scope of culture attribute covers awareness, so creating an additional heading may be unnecessary. Similarly, it was assumed that confidence and image headings do not improve the model and the content of the confidence heading can be immersed under the experience heading. To create a resources attribute heading was believed reasonable in terms of comprehensiveness, because this subject is immersed under the application heading of Model 1 and Model 3.

4.3.2 LEVELS OF MATURITY

As pointed out by Hillson (1997), having four standard levels of maturity provides clarity and simplicity, reduces fuzziness in determination of the maturity level of the organization. Likewise, PMI (2002) states that having more than four levels of maturity would increase ambiguity in the assessment without giving any additional refinement to the model. With five levels, the variations between the levels become minimal and to differentiate the current level of the organization for each attribute turns

into a tedious task. Consequently, having four levels of maturity was assessed to be advantageous when compared with five levels.

4.3.3 CONTENT

In terms of content, company culture is one dimension to evaluate, because it reflects the attitude of the organization on risk management. As claimed by Hillson (2000), the risk management efforts can be built up or blocked by the organization's attitude and culture. As Hillson (2000) continues, undertaking risk management successfully and effectiveness of a risk process are strongly connected with the idea and attitude of the team, since a strong belief in the process is a key component for a good implementation, as well as people and money resources and leadership. Therefore, this attribute was evaluated to be reasonable and to the point. In all of the reviewed models, organizational culture is evaluated under its respective attribute, except Model 2, in which only risk management processes are assesed rather than organizational aspects. Assessment of risk management processes is vital, as it creates the backbone of risk management. As thoroughly depicted in literature review, risk management is a stepwise method composed of several processes, and these processes should be continuously repeatitive throughout the project lifecycle. Though playing a essential role, it was observed that this section needs more elaboration in most of the reviewed models. Generalized entries do not give any clue about the risk management processes, hence insufficient to serve for an assessment. It was determined that detailed diagnostic descriptions should be specified for each risk management process. In this respect, with its focused scope on the processes, Model 2 compensates this insufficiency. Except Model 2, the only model with an explained process section is Model 5, using the headings of risk identification, risk analysis and risk mitigation. This is a positive approach in terms of the effectiveness of the model. Considered in Models 4, 5 and 6, integration of risk management with other management tasks is another critical dimension for effective application of risk management and should not be ignored. In the literature, lack of integration of risk management system with the rest of the management activities, in other words, carrying out risk management irregularly as a separate activity independent from other project purposes is considered as one of the main factors that cause the risk management system to fail in particular projects.

Another factor that causeo the failure of the risk management system is given in the literature as the lack of a shared understanding of risks between the parties. Smith, et al. (2006) argue that the effectiveness of risk management is improved if all parties have the same appreciation of the identified risks. In a similar vein, Hendrickson and Au (1989) take "organizational relationships" in their risk classification as one of the major groups of risk, although they seem to be unnecessary. Under this heading, Hendrickson and Au (1989) iterate contractual relations, attitudes of participants and communication. Accordingly, effective communication of risk information within the supply chain is important to consider, since there is multi-firm collaboration in construction, as elaborated in literature. Thus, to provide a model specific to the construction industry requires the cognizance of supply chain issues. The only construction-specific model is Model 6, which includes issues related with supply chain and considers effective communication with stakeholders. Moreover, models except Model 1 take into account the participation of key stakeholders in risk management process. A relative issue is argued by Merna and Al-Thani (2005) that a clear and mutual understanding of the threats and opportunities associated with the project should be improved within the organization. Consequently, effective communication of risk information within the project team and within the company should also be asked. Model 4 and Model 5 take open communication to risk and uncertainty as one of the aspects to consider under culture attribute. Model 6 considers the existence of formal communication channels to top management, also under its culture attribute.

Pointing out to the importance of risk management resources, Burtonshaw-Gunn (2009) states that for achieving effective risk management, an organization should have willingness to allocate budget or other resources to risk actions at each stage of the project. Similarly, all of the reviewed models except Model 2 view the existence of organizational resources for risk management. Furthermore, this feature is dedicated a respective attribute in Model 6 and this approach was believed as advantageous in terms of comprehensiveness.

4.3.4 SPECIFICITY TO THE CONSTRUCTION

In models except Model 5 and Model 6, the definitions are general, without specificity for a specific industry. On the other hand, Model 5 is particularly designed for complex product systems projects. As mentioned before, the only model that reflects the construction-specific attributes is Model 6, as an adaptation of Model 3 to the construction industry with some explanations on the content of it, generally related with the issues on construction supply chain.

4.3.5 ASSESSMENT SYSTEM

Most of the models examined in this study (i.e. Models 1, 2, 3 and 6) are in the form of an attribute-maturity level matrix. These models provide common descriptions of the attributes at each maturity level, but do not provide a logical assessment approach. Not each description entry has a correspondence in each of the maturity levels. As claimed by Hillson (1997) for Model 1, the diagnostic elements of the model should be enhanced. A self-assessment questionnaire is needed to better serve for the identification of the current risk management maturity level and provide adequate usability as a diagnostic tool. As also pointed out by Loosemore, et al. (2006) for Model 6, these models are in the form of a guidance indicating the types of questions to ask for a maturity assessment. Models 4 and 5 are one step forward in this matter, by providing more detailed questionnaires with defined assessment systems. After all, the questionnaire of Model 5 consists of very brief statements, which are hard to understand and lead for an evaluation at once. Furthermore, to assess these statements on a 1 to 5 Likert scale also creates vagueness, in which guidance in advance is needed. The approach of Model 4 was assessed to be more practical and clarify in this respect when compared to Model 5, as each of the features in an attribute is defined at each maturity level.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

The overall research contribution is a set of assessment that can be used to develop risk maturity model in construction industry. The researcher can use these assessments to create a better construction risk maturity model in the future. This chapter provides the conclusion to the study. In this chapter is first presented a summary of the study, through a brief explanation of its aim and the principal stages including research objectives, discussion on limitation and recommendation for future development related to the research topic.

5.2 RESEARCH SUMMARY

With its value and advantages being increasingly acknowledged by the construction companies, risk management usages are rapidly growing in the construction industry. Risk management is recognized as the main agent in ensuring effective project management and as a significant success factor for the construction companies, targeting at proper execution of the projects and thus, organizations. There is an increasing amount of research on risk management, though some areas are still open to progress. There is not much research conducted on “maturity” in construction risk management, although various generic maturity models and models specific to other industries in the area of risk management have been developed. Maturity models are aimed to assess the current capability maturity of an organization in a particular area, aid in the determination of strengths and weaknesses, and by that means, assist in the development of targeted improvement strategies for companies. Improved risk management maturity would mean enhanced risk management practices, a mature

organizational culture with risk awareness and advanced communication within the company and among project parties, better use of organizational resources for risk management and all in all, a stronger structure in terms of risk management. From this point, this study was intended to investigate risk management maturity with respect to construction.

5.2.1 Research Objective 1: To provide previously developed maturity models in the area of risk management

Initially, previously developed risk management maturity models were investigated with a thorough literature review. Six outstanding risk management maturity models were identified.

The first model identified is Risk Maturity Model (RMM) which is the first notable attempt to develop a framework for a risk maturity model. It serves as a foundation for many of the subsequent maturity models such as Risk Management Maturity Model (RMMM), RMMM Adapted to the Construction Industry, IACCM Business Risk Management Maturity Model and Risk Management Capability Maturity Model for Complex Product Systems Projects.

The second model is, Project Management Maturity Model (PMMM) developed by Project Management Solutions. It is intended for diagnosing the maturity of the project management processes of an organization. Its focused view on the processes constitutes the main difference of the model from the other investigated models.

The third model is Risk Management Maturity Model, developed by Project Management Institute (PMI). This model is an elaboration of the initial work accomplished which is presented as Model 1, to improve its diagnostic elements and to further aid in identification of the current level at which an organization is operating.

The fourth model is IACCM Business Risk Management Maturity Model, designed by IACCM Business Risk Management Working Group as a tool to evaluate their level of maturity in the area of business risk management.

The fifth model is Risk Management Capability Maturity Model for Complex Product Systems Projects. It is designed to allow for the evaluation of the current level of the organization, identify realistic targets for improvement and develop action plans for improving its risk management maturity.

And the last model is PMI's Risk Management Maturity Model. it is the advancement from the third model. It was narrow in its description of what characterizes each level of maturity. It was robust and was expanded for the construction industry.

Risk-based approach can help the construction company to add to a company's operations by improving its performance and enhancing its own future.

5.2.2 Research Objective 2: To determine advantageous and disadvantageous aspects of maturity models by comparing and evaluating them in terms of their usability and effectiveness.

All six of the maturity models were identified as being competent and further examined in terms of their usability and effectiveness. According to the comparisons made among the models, several advantageous and disadvantageous points were inferred. The main determination was that most of these models were in the form of a framework intended to indicate the topics to be examined for a maturity assessment.

After a deep examination of the reviewed six maturity models dealing with risk management, some advantageous and disadvantageous points were discovered, both in terms of effectiveness and in terms of usability. It was evaluated in accordance with the specific features of the models, defining the evaluation and comparison. The evaluation criteria were listed as attributes, levels of maturity, content, specificity to the construction industry and assessment system.

5.3 LIMITATION

There were some limitations to this study, with respect to the restricted time to go through all the journals. The researcher need to filter what is needed to fulfil the research questions. Sometimes, not all the information collected is matched to what the researcher needs. It took time to extract the right information from the journals and long time to get the data into the form needed for analysis.

If the data that researcher have gathered is unreliable, insufficient or flawed, the data analysis will be incorrect and the decision that be made upon it will be unsustained and may lead to bad conclusion. The limitation also related to the credibility of the source who has published the information and the small nuances that may not fit into research objectives. Since the researcher did not collect the data, the researcher not familiar with the data.

Some of the journals and books on the internet need to be bought. It is expensive and sometimes not meets the quality the researcher expected. The researcher has no control over the quality of the information and the researcher do not know how authentic the measures used for data collection have been The information also may be outdated

5.4 RECOMMENDATION FOR FUTURE RESEARCH

There are some of the recommendations for the future research in this study. For future studies, this study provides a compilation of the research that has been carried out on risk management maturity. Further work might be to construct a framework and questionnaire to develop a new maturity model based on six maturity models that identified in this research.

Actually, this research duration is not enough to do the questionnaire and propose a new maturity model because it takes a long time to test applicability of the questionnaire via case studies. Hence, the future researches are suggested to extend the

current study to develop a new risk maturity model for construction to provide a picture of the current risk management maturity in the construction sector.

Furthermore, the future study should not be limited just to use a single method in instrument. Since data collected using secondary data can be uncontrollable, unreliable and insufficient, it is suggested for the future study to use variety of method such as questionnaire and interview so that the more accurate result can be collected.

5.5 CONCLUSION

Project management is a relatively new area of business management studies; it is still struggling to establish its acceptability and importance within business community such as construction industry. The struggle has been strengthened by the efforts to establish standards by professional associations such as PMI, and by increasing level of project management research that has been carried by researchers.

The major purpose of this study is to investigate the previously developed maturity models in the area of risk management and determine advantageous and disadvantageous aspects of the maturity models by comparing and evaluating them in terms of their usability and effectiveness. Previously developed risk management maturity models were investigated with a thorough literature review. As a result, six of them were identified as being competent and further examined in terms of their usability and effectiveness. According to the comparisons made among the models, several advantageous and disadvantageous points were inferred. The main determination was that most of these models were in the form of a framework intended to indicate the topics to be examined for a maturity assessment.

The maturity models that are provided can be used by construction organizations wishing to enhance their risk management approach. They also can use the data in this study to construct a new maturity model that suit their company. This study also can aid the future researchers to develop more maturity models that are updated and suitable for current situation and future improvements can be guided. The model can also help in developing risk management awareness and familiarity with the concept by presenting

the perspective, practices, use of resources and processes that a construction organization should possess to have an advanced capability in risk management.

Being an assessment tool, a risk maturity model is designed to measure risk management capability and to provide objectives for improvement. It is an advance approach that required a solid foundation on project management discipline. However, by using assessment tool to evaluate the organization's current status, project managers and employees who involved in construction industry can better evaluate their capability and identify their gaps towards risk management approach. They also better have a clear view of the organization's current approach to risk, as well as a definition of the intended destination.

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APPENDIX A

	Task Name	Duration	Start	Finish	Predecessors	Res
1	**FINAL YEAR PROJECT 1 (FYP 1)**	**63 days?**	**Mon 18/2/13**	**Wed 15/5/13**		
2	prepare chapter 1 (introduction)	11 days	Mon 18/2/13	Mon 4/3/13		
3	prepare chapter 2 (literature review)	24 days	Tue 5/3/13	Fri 5/4/13	2	
4	prepare chapter 3 (methodology)	21 days	Mon 8/4/13	Mon 6/5/13	3	
5	submit draft FYP 1	3 days	Tue 7/5/13	Thu 9/5/13	4	
6	revised proposal FYP 1	3 days	Fri 10/5/13	Tue 14/5/13	5	
7	proposal submission	1 day?	Wed 15/5/13	Wed 15/5/13	6	
8	FYP 1 completed!	0 days	Wed 15/5/13	Wed 15/5/13	7	
9	**FINAL YEAR PROJECT 2 (FYP 2)**	**177 days**	**Thu 16/5/13**	**Fri 17/1/14**		
10	collecting data	46 days	Thu 16/5/13	Thu 18/7/13	8	
11	data gathering and analysis	46 days	Fri 19/7/13	Fri 20/9/13	10	
12	prepare chapter 4 (Data Analysis)	14 days	Mon 23/9/13	Thu 10/10/13	11	
13	supervisor consultation	3 days	Fri 11/10/13	Tue 15/10/13	12	
14	revised chapter 4	7 days	Wed 16/10/13	Thu 24/10/13	13	
15	prepare chapter 5 (conclusion and recomm	26 days	Fri 25/10/13	Fri 29/11/13	14	
16	submit draft FYP 2	1 day	Mon 2/12/13	Mon 2/12/13	15	
17	revised FYP 2	12 days	Tue 3/12/13	Wed 18/12/13	16	
18	FYP 2 submission	1 day	Thu 19/12/13	Thu 19/12/13	17	
19	FYP 2 presentation preparation	20 days	Fri 20/12/13	Thu 16/1/14	18	
20	FYP 2 presentation	1 day	Fri 17/1/14	Fri 17/1/14	19	
21	FYP 2 completed!	0 days	Fri 17/1/14	Fri 17/1/14	20