PROJECT RISK MANAGEMENT FOR NEW PRODUCT DEVELOPMENT

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Abstract

Project risk management provides a guideline for decision making in managing new product development project, reduce its uncertainty and increase success rate. In contrast the acceptance of formal risk management process in industry, especially for new product development projects still in question. The initial study in one of biggest food manufacturers in Thailand found that only 48% of their organization involved risk management in their product development projects and only 4% of them use a systematic approach for managing risk. This paper aims to conducts a literature review of risk management theory in new product development (NPD) literature. Scope of the literature includes international standard for risk management and project management (i.e. ISO31000, ISO21500), publication for project management body of knowledge by professional association (PMBOK), and academic research publication on project risk management. The review of academic research used a systematic literature review that clearly formulate the searching strategy and method for paper screening from the three research domain for project management, risk management and new product development. Total of 182 academic papers published between 2002 to August 2012 have been selected for full text review. Finding from literature review are concluded in five topics which are classification of research method, project type and industrial segment, distribution of articles by regions, tools & techniques for risk management and risk factors in projects. The review shows the alignment of risk management approach and provides a better understanding of project risk management theory which identify research gap in this area and can lead to the development of an appropriate model for project risk management in NPD project. Variety of standard tools and techniques for project risk management are presented. Some specific needs of risk management model and tools for industry are identified. Opportunity for future research was also discussed in this paper.

Keywords: Project Management, Project risk management, New product development, Risk factor

1. INTRODUCTION

The project management are widely use in several industry for various type of projects from construction, information technology (IT), manufacturing, engineering, marketing, military, including new product development (NPD). The increasing acceptance and more implementation of project management in several industries indicate that the application of

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appropriate knowledge, processes, skills, tools, and techniques can have a significant impact on project success (PMI 2008).

From several knowledge areas in project management, risk management is the one of most importance part as major contributor for project success. According to the several studies in this field (Chapman and Ward 2004, and Aloini et al. 2012) risk management can lead to a range of benefits for project and organizational such as provide guidance for decision making about alternative option in project, increased confidence in project success and outcome and reduced unexpected events that caused project delay or over budget.

To support importance of risk management for NPD, The study from Cooper (2003) conclude that the successful new product development requires effective strategies for reducing risk and knowledge management systems have the potential to aid in risk reduction. Also we can see many studies in last decade have been focused on determinants of new product success and failure (Keizer et al. 2005). This stream of research about new product successes and failures identified various group of important factors related to managerial issues in NPD such as factors related to product performance, factors related to market and marketing issues, factors related to organization & synergy and factors related to project management which also include risk management.

Beside the importance of risk management which support by research, the NPD related standard such as BS7000-1: Guide to management innovation (BSI, 2008) also recommend organization to perform risk assessment for their innovation project (include NPD). Moreover, risk assessment should be performed for decision making in every step from idea generation and feasibility study to project implementation.

As one of the important success factor; industry required more research which focus on project management and risk management in NPD which seem to be more complex and have different issues, compare to other type of project (Pinto and Covin 1989). Several studies also try to point out the unique characteristics and particular requirement of project management in NPD process (Milosevic and Patanakul 2005, Thal et al. 2007, Pons 2008). However those studies still did not explain all problems in risk management for NPD.

The management of risks in projects is a growing area of concern (Maytorena et al., 2007) but the risk management in NPD project for industry seems to have very low attention, and systematic risk management process was not usually included in NPD activities by organization. Recent studies by Ahlemann et al. (2009, 2012) indicated that PM method suffer from low adoption and individual acceptance rates because there is a lack of universal applicability as well as a lack of consideration of the usage environment (contextual factors) and antecedents of successful application of PM methods. Hence, this study attempts to understand more detail in the problem of low utilization for risk management in NPD by explore the standard, literature and academic papers in the last decade to identify the problem, research gap and requirement for tools and technique that will lead to development of new

conceptual model and tools for risk management. This paper is divided in to five sections, (1) risk management standard (2) objective, scope and inclusion criteria (3) systematic literature review method (4) finding of the study and (5) discussion and conclusion.

2. RISK MANAGEMENT STANDARD

PMBOK (PMI 2008) defines risk as an uncertain event or condition that, if it occurs, has an effect on at least one project objective. Similarly, risk management standard ISO31000 (2009) and AS/NZS 4360 (2004) define risk as the chance that something happening that will have an impact on an objective. Traditionally risk was perceived negatively but new but recent standards suggest the impact of risk could be either negative or positive.

The recent study by Jafari et al.(2011) which reviewed four well-known approaches to risk management: PMBOK (PMI, 2004), project risk analysis and management (PRAM) (Simon et al., 1997; Association for Project Management, 2004), management of risk (MOR) (Office of Government Commerce, 2002) and the standard AS/NZS4360 (Standards Australia/Standards New Zealand, 2004) indicated that there were no significant difference for risk management process among them. This study expand further review to additional standard for ISO31000 (ISO,2009), ISO1006 (ISO,2003) and ISO21500 (ISO, 2012), including and new released PMBOK 5th Edition (PMI, 2013)

All standards that were included in this review connect to project risk management in different perspective. AS/NZS4360 and ISO31000 cover risk management for all organization activities (included project) while the ISO10006, ISO21500 and PMBOK limit the scope for project activities only and risk management is one important process (or knowledge area) in their project activities. The relation to project management and risk management process for this fours standard and PMBOK are explain in Table 1

Table 1: Summary of standard and PMBOK related to project risk management

Standard	Relation to Project Management	Risk Management Process
AS/NZS 4360:2004 Risk Management	Included but not specific to project risks	Defines risk management process as 1) Communicate and consult 2) Establish the context 3) Identify risks 4) Analyse risks 5) Evaluate risks 6) Treat risks 7) Monitor and review
ISO 31000 :2009 Risk management	Included but not specific to project risks	Defines risk management process as 1) Communication and consultation 2) Establishing the context 3) Risk assessment 4) Risk treatment 5) Monitoring and review

ISO10006 :2003 Guidelines for quality management in projects	Defines project management to 7 process grouping for 1) Inter dependency-related processes, 2) scope-related processes, 3) time-related processes, 4) cost-related processes, 5) communication-related processes, 6) risk-related processes and 7) purchasing-related processes	Defines risk-related processes group as 4 processes 1) Risk identification 2) Risk assessment 3) Risk treatment 4) Risk control
ISO 21500 :2012 Guidance on project management	Defines project management to 10 subject groups for 1) integration, 2) stakeholder, 3) scope, 4) resource, 5) time, 6) cost , 7) risk , 8) quality, 9) procurement and 10) communication.	Defines risk subject group into 4 processes 1) Identify risks 2) Assess risk 3) Treat risk 4) Control risks
PMBOK 5th Edition (PMI, 2013)	Defines project management to 10 knowledge area for 1) Project integration management, 2) Project scope management, 3) Project time management, 4) Project cost management, 5) Project quality management, 6) Project human resource management , 7) Project communication management , 8) Project risk management, 9) Project procurement management and 10) Project stakeholder management.	Defines risk management process as 6 processes as following 1) Plan risk management 2) Identify risks 3) Perform qualitative risk analysis 4) Perform quantitative risk analysis 5) Plan risk responses 6) Control risks

Comparison of process step for risk management in related standard and PMBOK are illustrated in figure 1

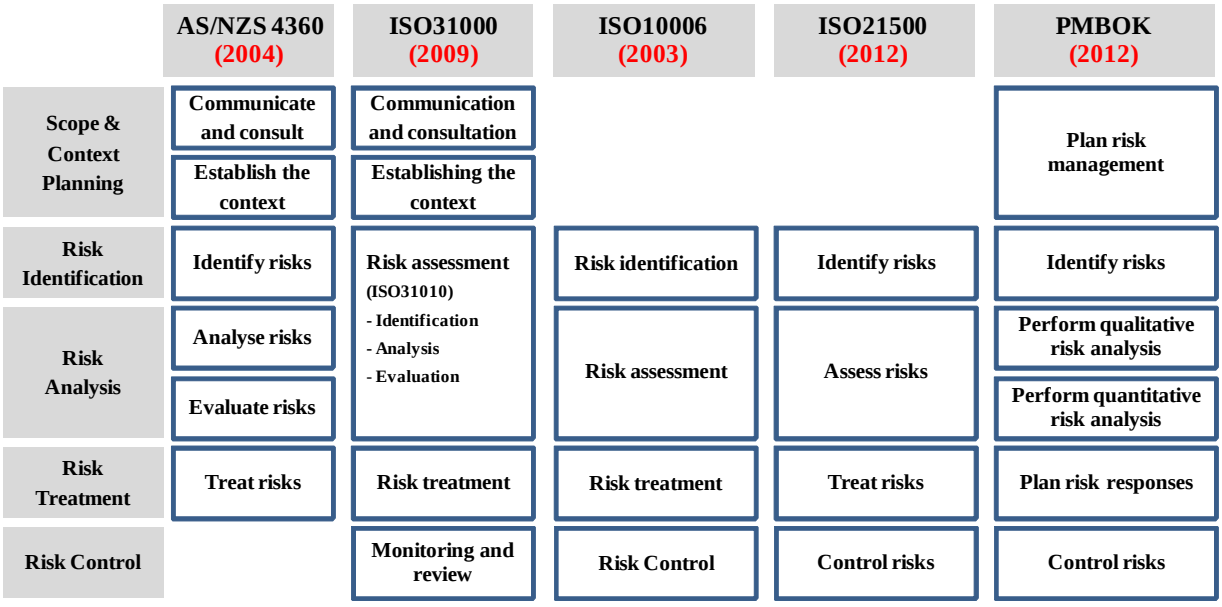

Figure 1: Comparison of risk management process in standard and PMBOK

From comparison of four standard and PMBOK, all of them provide similar approach and process steps for risk management started from establishing or planning for scope of risk management, followed by identification of risks in project and perform analysis or evaluation to prioritize risk before create risk treatment or respond plan for major risk. Finally, risk management process ends by monitor and control risk until project completion. In conclusion, we can summarise key steps of project risk management as 1) scope and context planning, 2) risk identification, 3) risk analysis, 4) risk treatment, and 5) risk control.

3. OBJECTIVE, SCOPE AND INCLUSION CRITERIA

Research question to be answer by this study is whether the process step in international standard and PMBOK related to project risk management has good alignment and can be effectively use for academic research and real business case from industry. The study reviewed academic paper published between 2002 to August 2012 by do not specific for particular journal but selected the database that have large number of related articles from initial search before apply systematic literature review methodology as will be explained later in next section.

There were five main objectives for this study (1) to classify the research method related to project risk management (2) to explore article by project type and industrial segment. (3) to find out the distribution of research by regions (4) to explore tools and technique use for risk management in research (5) to identify risk factor by project type

The inclusion criteria for article selection in this study are:

1. The articles were selected from overlap area of three main knowledge domains, for project management, risk management and new product development.
2. The paper aim to study risk management for NPD project but the search criteria do not limit to paper for NPD project only due to risk management model and methodology that were used in other types of project might be help for better understanding of different requirement in each project type and some tools and technique which successfully used in other type of project might be benefit for using in NPD project too.
3. Selected article were peer reviewed only. Book chapter, non-peer reviewed publication, and newspaper article were not included in this study
4. The articles must be published between January 2002 to August 2012. And some articles which did not have access to full paper might be exclude from full text review.

4. SYSTEMATIC LITERATURE REVIEW METHOD

The systematic literature is a review of articles that clearly formulate the searching strategy and method for screening. This methodology can limit the bias by random select or

non systematic search.

For selection of document collection, authors decided not to be specific on any Journal due to risk management and product development are the interdisciplinary subject which can be published in many journal of different research areas. However we also assured the inclusion of main journal on Project Management such as Project Management Journal and International Journal of Project Management to be included in document collection. The initial search have been conducted to see the number of paper about project management and risk management in each database that we have access by university network then selected 4 major databases that initial search found highest number of publication about risk management and project management. 4 selected databases are (1) ProQuest; (2) EBSCO host; (3) Elsevier Science Direct; and (4) Emerald.

The search criteria for Literature Review are.

1. Journal article with peer review only. However, some proceeding with content strongly related to the topics also included.
2. The search start from record of paper published in January 2002 until August 8, 2012. The paper published after the search period were not available on that time.
3. The search term were used to search title, abstract and keywords of paper in database
4. Single search terms in each research area for risk management, project management or new production development were not used due to broad description results excessive number of paper in each domain.
5. Some search term does not directly relate to “Risk” but relate to product development and project management also include in search term.
6. The search term consist of following
   - (Project Risk) AND (Product Development)
   - (Project Risk) AND (Project Management)
   - (Risk Analysis) AND (Product Development)
   - (Risk Analysis) AND (Project Management)
   - (Risk Assessment) AND (Product Development)
   - (Risk Assessment) AND (Project Management)
   - (Risk Management) AND (Product Development)
   - (Risk Management) AND (Project Management)
   - (Product Development) AND (Project Management)

We found 2,271 papers from search criteria, 427 papers from ProQuest database; 1507 papers from EBSCOhost database; 248 papers from Elsevier Science Direct database; and 89 papers from Emerald database. After remove duplication and papers type that out of scope, including items that we did not have access to full paper, total number of paper reduced to 1278 papers and passed to next step for screening process.

Papers were selected by screening criteria. They will be selected in following condition.

1. Discuss on definition, framework, and methodology about project risk.
2. Discuss about problem, success factor and risk factor of project from project management perspective.
3. Case study or empirical study relate to project risk.
4. Discuss about development of tools and technique and application of risk management
5. Some paper which were not found from search criteria but related to some important topics or used as important reference in selected paper has been added in to collection of review papers.

The remain papers were screen by title to 541 papers before download the full paper for abstract screen to 326 paper and final full text screen until 182 papers remain at final step as details in Table 2

Table 2: Number of papers by database and screening process

	ProQuest	EBSCOhost	ScienceDirect	Emerald
Total Search results	427	1507	248	89
Exclude duplication from search term	293	701	204	80
Screen by title	190	125	151	75
Screen by abstract	326			
Full text screening	182			

Then the information from selected 182 articles were collected by using an excel database as shown in Figure 2. The columns of the database was designed by title, author, year, focus of the study, research methodology, type of project, area of application (Industry segment), theory/tools used, contribution in risk management, type of risk and citation.

No.	Title	Authors	Year	Research Methodology	Theory/Tools Used	Contribution in Risk Management	Type of Risks
13	Project Management Process Maturity PM2 Model	Kwak & Ibbs	2002	Literature Review and discussion	PMI-PMBOK Guide	This paper presents the project management process maturity (PM)2 model that determines and positions an organization's relative project management level with other organizations. The comprehensive model follows a systematic approach to establish an organization's current project management level. Each maturity level consists of major project management characteristics, factors, and processes. This paper describes the 5-level (PM)2 model to better understand an organization's levels of PM sophistication.	Overall Project Risk

Figure 2: Excel database for summary of contribution in risk management

5. FINDING OF THE STUDY

From selected 182 papers related to project risk management from four databases during 2002- October 2012. We can conclude our finding in five topics (1) Classification of research method; (2) Project type and industry segment; (3) Distribution by regions; (4) Tools and technique for risk management; (5) Risk factor by project type.

5.1 Classification of Research Method

The research methods have been classified to four groups according to Hendry and Nonthaleerak (2005), which are descriptive, empirical, conceptual and literature review. The definitions for each group has been modified for classification of research method for project risk management as explained in Table 3 and distribution are illustrated in Figure 3

Table 3: Research method and description

Research Method	Description	No. of paper
Descriptive	Describe various expect, theory and tools for risk assessment and risk management	48
Empirical	Survey, interview, case study, experimental, exploratory based on empirical use and industrial case	68
Conceptual	Propose conceptual frame work, model and technique for risk management	51
Literature Review	Reviewing of research paper and past study	15

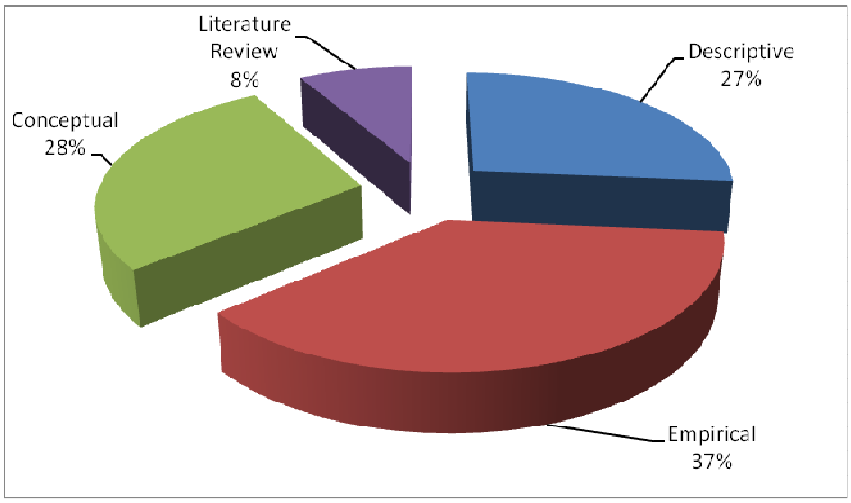

Figure 3: Distribution of papers by research method

5.2 Project Type and Industrial Segment

Our main focus for this study is the risk management in New Product Development (NPD) process. However, there are many research study in other type of projects that use the same concept and methodology which can be applied in risk management for NPD. Our study also included other main type of project such as construction, information technology, engineering and industrial project. The distributions of selected articles by project type are shown in Figure 4.

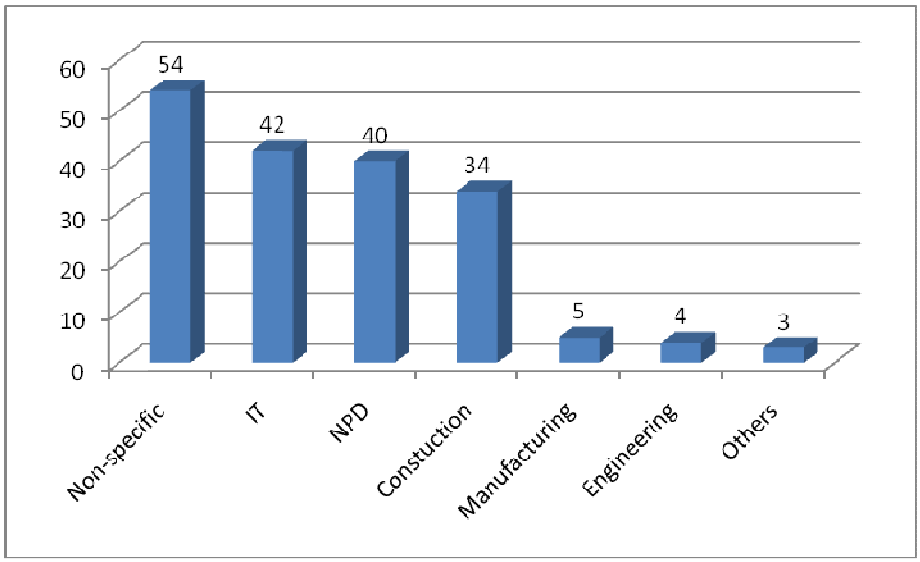

Figure 4: Distribution of articles by project types

From 182 selected articles, 29 articles indicated the context of their study in specific industry segment and the rest did not specify industrial segment or perform study in more than one industry. The distribution of papers by segment can be seen in Figure5

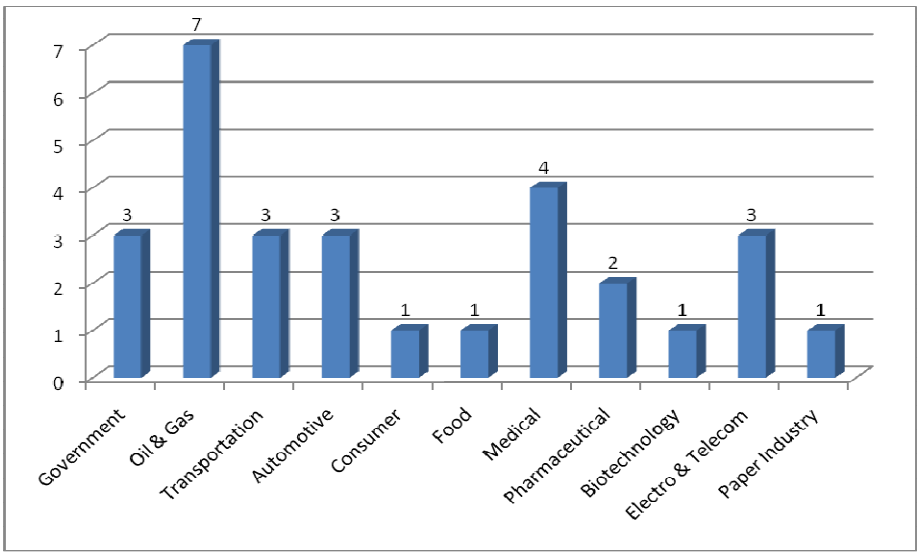

Figure 5: Distribution of articles by industrial segment

5.3 Distribution of Articles by Regions

This study also identified a location of research or location of author(s) of 182 selected articles for project risk management. Figure 6 shows the distribution of article by region.

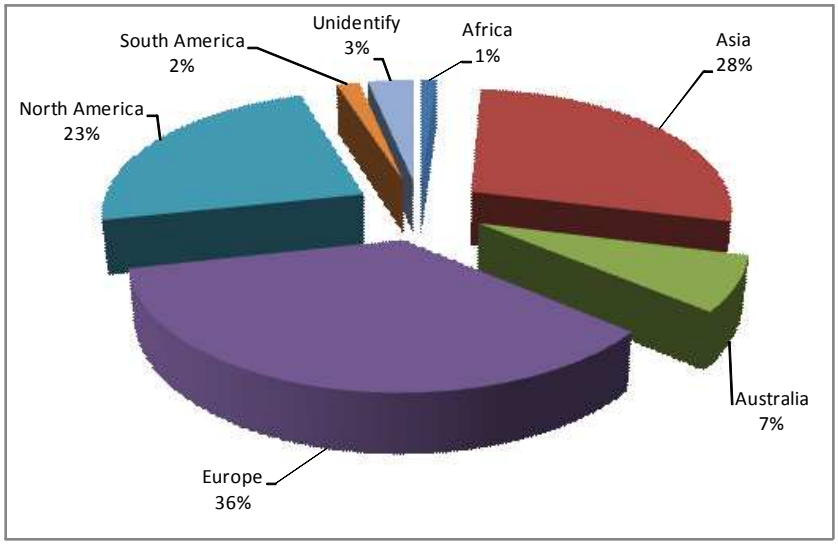

Figure 6: Distribution of articles by region

The highest percentage of study for project risk management were conducted in Europe for 36% , followed by Asia and North America at 28% and 23% respectively. The major contributor for country in Europe was UK with Korea as the major contributor in Asia. The rest of the world contributed only 13% in total for research in this topic.

5.4 Tools and Techniques for Risk Management

From literature review, tools have been used in two major areas in risk management process for risk identification step and risk analysis step. The level of complexity of tools start from basic tools such as risk breakdown structure by common risk category, risk matrix, until more complex tools using probability and mathematic model for risk analysis.

The most frequently used tools that has been found in project risk management research are Failure Mode and Effect Analysis (FMEA), Analytic Hierarchy Process(AHP), Bayesian network (BN), Fuzzy set and Monte Carlo Simulation with few paper used less popular tools such as Bubble Diagrams (Abrahamsen & Aven,2011) and Control Charts (Salah Eldin,2009).

Another approach of the risk management study consider the project risk as the network and used network design to facilitate the evaluation of projects by determining the project execution risk. The example of research by this approach can be found by paper from Chin et al. (2009). And summary of tools and methodologies used for risk management are displayed in Table 4.

Table 4: Tools and methodology used in project risk management research

Tools & Methodologies for risk management	**Reference Articles**
Analytic Hierarchy Process (AHP)	Badri et al 2012, Dey 2002, Jaskowski and Biruk 2011, Kayis et al.2006, Kayis et al 2007, Dey 2010, Nieto-Morote and Ruz-Vila 2011
Bayesian network (BN)	Al-Rousan et al.2009, Lee et al. 2009, Chin et al. 2009, Fen and Yu 2004 and Hu et al.2012
FMEA	Carbone and Tippett 2004, Segismundo and Miguel 2008, Zeng et al. 2010, Zhang and Chu 2011
Fuzzy set	Abdelgawad and Fayek 2010, Choi and Ahn 2010, Tüysüz and Kahraman,2006, Zeng and Smith 2007, Ismail et al. 2008, Zou and Li 2010, Wei and Chang 2011
Expected utility theory	Kutsch and Hall 2005, Miles 2004
Game theory	Zhao and Jiang 2009
Monte Carlo Simulation	Liou et al.2012, Sharma and Suri 2011, Turgut and Baykoc 2007 and Vanhoucke 2012
Bubble Diagrams	Abrahamsen and Aven 2011
Control Charts	Hamza 2009

5.5 Risk Factor by Project Type

From selected 182 papers in full text review, 18 papers has focused or mentioned about risk factor in their research. Those risk factors can be summarized by project type in four groups consist of: (1) NPD project (2) IT project (3) Construction project; and (4) Non-Specific type of project. Table 5 shows list of risk factor for each type of project.

Table 5: Risk factors in risk management research

		NPD							IT				Construction					General	
	Risk Factors	Kayis et al., 2007	Tang et al., 2011	Keizer & Halman, 2007	Sicotte et al., 2006	Chin et al.,2009	Mu et al., 2009	Park, 2010	Kumar Day, 2010	Liu et al., 2010	Han & Huang, 2007	Hu et al., 2012	Zou & Li, 2010	Nielsen, 2006	Zeng et al., 2010	Diraby & Gill, 2006	Lee et al., 2009	Chia, 2006	McConnell, 1996
1	Schedule Risk	●																	
2	Technical Risk	●		●	●		●	●	●	●				●			●	●	
3	External Risk	●		●															
4	Organizational Risk	●		●			●	●		●	●								
5	Communication Risk	●																	
6	Location Risk	●																	
7	Resource Risk	●			●					●	●							●	
8	Financial Risk	●							●				●	●		●	●		
9	Quality Risk														●				
10	Customer/User Risk		●	●						●	●	●						●	
11	Product Positioning Risk			●															
12	Manufacturing Technology Risk			●															
13	Intellectual Property Risk			●															
14	SC and Sourcing Risk			●		●		●											
15	Competitors Risk			●															
16	Commercial Viability Risk			●	●														
17	Screening and Appraisal Risk			●															
18	Product Reliability Risk					●													
19	Production Risk					●													
20	Planning Risk									●	●		●						
21	Contractual Risk												●	●					
22	Design Risk					●							●						
23	Geological Risk												●						
24	Construction Risk												●			●			
25	Market Risk						●	●	●	●						●			
26	Economical Risk								●					●		●	●		
27	Environmental Risk								●					●	●	●			
28	Safety Risk														●				
29	Social Risk								●					●			●		
30	Political Risk				●				●					●		●	●		
31	Natural Risk																●		
32	Legal Risk												●				●		
33	Dependencies Risk																		●
34	Requirement Risk									●	●	●							●
35	Management Risk				●												●	●	●
36	Lack of Knowledge Risk																		●
37	Delivery/Operation Risk							●						●		●			
38	Procurement/Contract Risk											●		●				●	
39	Project Complexity Risk										●								
	Average number = 5.7	8	1	11	5	4	3	5	7	7	6	3	7	8	3	7	8	5	4

Each type of project seems to focus on different areas of risk. NPD project more focused on internal process within organization, while construction project will also consider much more factors from other stakeholder outside project or outside organization and IT project seem to have good balance of risk assessment for internal and external factors. The definition of risk factors can be found in appendix.

6. DISCUSSION AND CONCLUSION

The study of international standard and PMBOK related to project risk show well established theory and alignment of project management and risk management. Those standards provide process step, including suggestion for tools and technique that can be applied in various type of project. However those standard and guideline did not address the different characteristics of project type and also not consider specific requirement for each type of application. This can be opportunities for more details research for project management and risk management in a specific area or context.

However, the literature review of research papers in this area show that majority of researchers also understand this requirement and try to address this contextual issues. The main stream of research papers focus on empirical study of risk management in projects by using survey, interview, case study or experimental to explore problems, issues and effectiveness on empirical use of risk management method and tools for business cases in specific area or specific project application. This finding emphasizes the need of industry that required more data and knowledge to support risk management process in project execution rather than development of new theory for risk management.

If consider characteristic of NPD in term of complexity and success rate (usually only 60% of NPD projects survive from the fuzzy front end to commercialization) (Stevens & Burley, 2003), this type of project requires high attention for risk management. From literature review, we can see good distribution in the number of research relates to risk in NPD compare to other project type. Nevertheless, those research papers did not focus on the problem of low acceptance and low utilization of systematic risk management for NPD. Hence, this provides an opportunity for future research work.

The other part of finding in this study relates to tools and techniques used in project risk management. There are various standard tools and technique used for different propose in each step of risk management process. However the study by Pons (2008) examines the intersection of the project management body of knowledge with new product development and concluded that the project management method, with its structured task definition and software tools, is generally useful for managing NPD projects. However, in some areas, project management incompletely meets the needs of NPD and has opportunity for improvement.

More recent study about problem in risk planning by Zwikael and Ahn (2011) identified problem of existing tools that are “too complicate” for users. In addition, when the size and complexity of projects increase, the effort required for effective risk planning exponentially rises, making those tools difficult to use. The other study about risk management tools development for NPD project by Kayis et al.(2007) also indicated the gap in commercial-off-the-shelf software that lacked capabilities to support project risk identification, analysis and mitigation of risks during life cycle of the project because those software are

mainly designed for risk analysis and assessment. Actually both the identification and analysis phases of the risk management process are considered the most important (Maytorena et al., 2007) but more study are focus on risk analysis and leave the risk identification phase to be handled by NPD team or project manager which some time may deny, ignore or underestimate the risk (Kutsch 2008, Kutsch and Hall 2010).

This study reveals three importance gaps for future research. Firstly, there were only few study in overlap area of three research areas for project management, risk management and new product development, some paper may discuss project management and risk management issue without study specific requirement of NPD, some paper may explore the risk in NPD project but did not use project management approach to address risk in project. Secondly, majority of the study for project risk management cover total process of risk management start from identification, analysis until risk response and control. In addition, some study focused on specific process for risk analysis, but very few study focused on risk identification process, which will be critical starting point for risk management, especially for NPD project and Lastly, the development of tools for risk management are focus on one objective such as risk analysis but very few research intent to help NPD team by developing the integrated tools that can be used to navigate project team to follow proper process for risk management.

APPENDIX

Risk Factors	Definitions
Commercial Viability Risk	Risk related to long-term market potential, reliability of volume estimates, including realistic sales perspective.
Communication Risk	Risk related to the ability to effectively convey ideas and information within the company and externally to suppliers and customers, may concern language barriers, cultural differences and communication channels.
Competitors Risk	Risk related to competition in market, ability to enabling creation of potential barriers for competitors.
Construction Risk	Risk related to construction activities in project. May relate to safety, health and environment issue in construction.
Contractual Risk	Risk related to agreement and contract such as legislation change, contract dispute, contract negotiation, contractual progress payment.
Customer/User Risk	Risk related to the understanding of user needs and ensuring the new product meets target consumers' needs.
Delivery/Operation Risk	Risk related to delivering and operating the project as conceived. This involves issues or concerns associated with actual engineering, procurement, construction execution, and operation of the project, including nontraditional approaches such as a public owner's use of design-build contracts.
Dependencies Risk	Risk related to dependencies within project such as intercomponent dependencies within software, intergroup dependencies across functions, the availability of people to perform task functions at the needed time.
Design Risk	Risk related to uncertainty that cause product specifications cannot be fulfilled within the expected schedule, including design problem such as inadequate design specification and documentation, design mistakes, design variations and issue relate to product standards.
Economical Risk	Risk related to ability to overcome the economic impact in project, involves issues or concerns associated with the macroeconomic impact of the project to the community and region within which it is to be located.
Environmental Risk	Risk related to the environmental problems, concerns, and activities confronting the project during the project execution and the project operation.
External Risk	Risk related to any issues with regards to any parties outside of the organisation.
Financial Risk	Risk related to monetary receipts and expenditure, including currency exchange rates, inflation, budget and costs. Sometime refer to ability to overcome the financial risk of the project through to final completion and operation.
Geological Risk	Risk related to unclear geological conditions, complex and adverse geological conditions and geological barriers.
Intellectual Property Risk	Risk related to knowledge of relevant patent issues, patent-sharing potential, availability of required external licenses and dependency on third-party development.
Lack of Knowledge Risk	Risk from poor understanding of methods, tools, and techniques cause by inadequate training, inadequate application domain experience or project members who are not subject matter experts.
Legal Risk	Risk from changing in rules and regulations relate to product or project specification
Location Risk	Risk related to the physical distance/barrier between two respective parties, including their geographic location, proximity to each other, location selection, number of sites.
Management Risk	Risk related to poor project management or unclear project ownership and decision making processes, unrealistic commitments which lead to unrealistic expectations.
Manufacturing Technology Risk	Risk related to technological issues for manufacturing, may included quality and safety requirements of production system.

Risk Factors	**Definitions**
Market Risk	Risk from changing in market condition such as competitive situation, power of supplier and users, product substitution.
Natural Risk	Risk of natural disaster such as Typhoon, flood, earthquake and other uncontrollable events happen.
Organizational Risk	Risk related to the management or administration personnel of the business, defined by the organisational structure, ownership, stakeholders, leadership and the organisation's culture.
Planning Risk	Risk related to process to establish scope of project and define the course of actions to execute the project.
Political Risk	Risk related to local, state, and national political opposition and code and regulatory impediments. Including issues or concerns associated with the local, regional, and national political and regulatory situation confronting the project.
Procurement/Contract Risk	Risk associated with the procurement of, or contracting for, the execution and operation of the project.
Product Positioning Risk	Risk related to project portfolio and ensuring product format meets functional requirements.
Product Reliability Risk	Risk related to ability to maintain stable production process and an expected product performance in its service lifetime.
Production Risk	Risk related to uncertainties that cause production requirements cannot be met within the expected schedule.
Project Complexity Risk	Risk of project involving the use of new technology, high level of technical complexity, use of technology that has not been used in prior projects.
Quality Risk	Risk related to quality requirement of products.
Requirement Risk	Risk related to understanding and agreement on project requirement, including prioritization and change management process in project.
Resource Risk	Risk related to the available capabilities to supplies or support project, including materials, labour, equipment and facility specific issues.
Safety Risk	Risk of accidents and dangerous events on OHS.
Schedule Risk	Risk related to plan of procedures, task in project, sequence of operations, milestones.
Screening and Appraisal Risk	Risk related to evaluation and screening of alternative options in project.
Social Risk	Risk related to social and cultural impacts of the project to the community and region within which it is to be located.
Supply Chain and Sourcing Risk	Risk related to supply chain network, supplier's readiness, quality of supply, contract arrangements and contingency option.
Technical Risk	Risk related to the ability to overcome the technological issues or concerns of the project, technological know-how, innovation and technical support.

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