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A gap analysis on the project risk management processes

SEYED MOHAMMAD SEYEDHOSEINI, SIAMAK NOORI AND MOHAMMAD ALI HATEFI

E-mails:Seyedhoseini@yahoo.com, Snoori@iust.ac.ir, Hatefima@yahoo.com
Industrial Engineering Department, Iran University of Science & Technology, Narmak, Tehran, Iran

ABSTRACT

Applying a suitable Risk Management Process (RMP) is a vital key to the success of any project. The main objective of this research study is to propose guidelines to clarify the proper roadmap for the future RMP research, especially in the project environment. For this purpose, a conceptual modeling approach has been developed to demonstrate and analyze the gap between conventional RMPs and a proposed modeling approach. The paper also looks carefully into the configuration analysis of a system and considers a four-part pattern i.e. organization, human, software and hardware. Based on the proposed modeling approach, a number of Critical Success Factors (CSF) has been identified with the help of recent literature reviews and experts opinions. It is hoped that the proposed approach can be a proper benchmark for RMP's researchers.

Keywords: Risk Management Process, Project Risk Management; Critical Success Factor.

INTRODUCTION

Risk is an entity that appears in all aspects of our life. From a project management view, based on PMBoK (PMI 2004), risk is defined as an uncertain event or condition that, if it occurs, has a positive or negative effect on a project objective. Therefore, to reach the project success we require managing risks related to our project.

The science of Risk Management (RM) was developed back in the sixteenth century during the Renaissance, a period of discovery, but regarding the subject of Risk Management Process (RMP), since 1990 there have been a number of authors proposing a range of processes. The purpose of project RM is to improve project performance by systematically identifying and assessing risks, developing strategies to reduce or avoid them and maximizing opportunities (Chapman & Ward 2003).

The main objective of this research study is to clarify the proper roadmap for the future RMP research, especially in the project environment. For this purpose, the paper analyzes the gap between the conventional RMPs and a conceptual framework. A gap is spoken of as "the space between where we are and where we want to be". Gap analysis is undertaken as a means of bridging that space. Therefore, in this paper, gap analysis is the study of the differences between conventional RMPs (i.e. current state) and the conceptual model (i.e. an improved state), for the purpose of determining the guidelines to get from the current state to the improved state.

All stages of the research approach presented in the paper are shown in Fig. 1. The next section looks at the literature on RMPs related to project context. The paper continues by addressing the Critical Success Factors (CSF) of RMP for project context and proposing a conceptual framework. The paper then analyzes the gap between conventional RMPs and the proposed modeling approach. Finally, some useful guidelines for the future RMP studies are discussed.

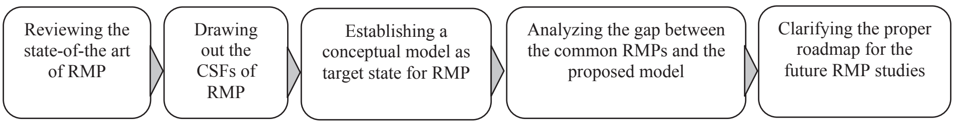

Fig. 1: Stages of the research approach presented in the paper

LITERATURE REVIEW OF RMPs

According to Martins Gomes & Perrelli (2003), RM is generally one of the main topics of interest for researchers in the area of project management. To cope with risks, many researchers have introduced several RMPs (Pipattanapiwong 2004). In Table 1, some typical RMPs are presented. Most of these RMPs have a similar framework with differences in the way of structuring the process, scopes, kind of planning, etc (Saari 2004). It should be noted that most of the proposed RMPs, that are applicable in the project environment, belong to one of the contexts shown in Fig. 2.

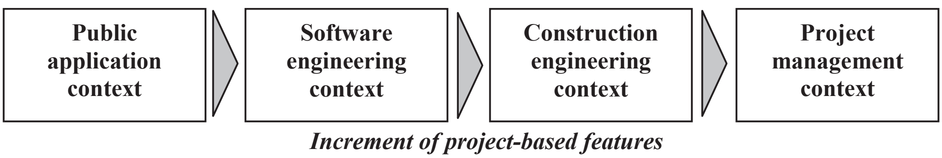

Fig. 2: The main contexts of RMP research subjects

Table 1: Typical RMPs in the literature

RMP name	Author	Context	Description
Department of Defense (DoD)	U.S. Department of Defense (DoD) 2000	Public Application	This RMP is a product of a joint effort by the Undersecretary of Defense (U.S. DoD 2000).
Risk Filtering, Ranking and Management (RFRM)	Haimes *et al*. 2002	Public Application	The RFRM identifies, prioritizes, assesses, and manages risks to complex, large-scale systems. It encapsulates the six questions of risk assessment and management, thereby adhering to a comprehensive risk analysis process.
Australian New Zealand Standard (AS/NZS 4360)	Cooper 2004	Public Application	This standard was developed to accommodate public sectors and private organizations on RM. Its RM approach is very generic and can be used in any projects.
Continuous Risk Management (CRM)	Rosenberg *et al*. 1999	Software Engineering	This methodology was developed in conjunction with the Software Engineering Institute (SEI) at Carnegie Mellon University and tailored to the NASA systems community.
Risk Kit (RISKIT)	Kontio 2001	Software Engineering	Based on a graphical modeling formalism, it supports multiple stakeholder views to risks by considering their potential utility losses. Kontio developed the concept of risk scenario within the RISKIT (Kontio 2001).
Construction Risk Management System (CRMS)	Al-Bahar & Crandall 1990	Construction Engineering	This RMP provides an effective and systematic framework for quantitatively identifying, evaluating, and responding to risk in construction projects.
Risk Analysis and Management for Projects (RAMP)	Institution of Civil Engineers *et al*. 1998	Construction Engineering	The RAMP is a logical process, designed to provide a useful and practical framework for the identification, analysis, mitigation and control of risks inherent in a complex activity. It specifically conceived for capital investment projects.
Project Uncertainty Management (PUMA)	Del Cano & De la Cruz 2002	Construction Engineering	The PUMA is a generic methodology that is proposed based on professional experience of the authors, an analysis of the previously published project RMP and interviews with professionals.
RISKMAN	Carter *et al*. 1996	Project Management	It has a practical approach to the management of risk. The purpose of the RISKMAN methodology is to provide a general framework for professional project RM, and guidance for its implementation.

RMP name	Author	Context	Description
Shape, Harness, And Manage Project Uncertainty (SHAMPU)	Chapman & Ward 2003	Project Management	The SHAMPU is a generic RMP consisting of nine steps, is explicitly defined to be iterative with the level of detail (Saari 2004), and is established based on risk efficiency concept (Chapman & Ward 2003)
Project Risk Analysis and Management (PRAM)	Association for Project Management (APM) 2004	Project Management	The PRAM is designed for the largest projects and the authors provide simplifications for specific cases. PRAM has a special importance because it was the first highly comprehensive process developed by a large number of persons, including a mix of practitioners and academics, with results of very high quality.
Project Management Body of Knowledge (PMBoK)	Project Management Institute (PMI) 2004	Project Management	It is a prime instance of literature that describes RM practice. The importance of the PMBoK lies in the relevance of the PMBoK as an ANSI (American National Standards Institute) and IEEE (USA institute of Electrical and Electronic Engineers) standard.

CSFs OF RMP

CSFs affect in RMP in variety of ways. Here, based on studying the state-of-the art of RM, expert's opinions and the author's experiences, a number of major CSFs are alphabetically listed and discussed.

Adaptability: The critical attributes will vary from project to project and must be identified locally by each project. Kontio (2001) defines adaptability as the versatility of a method to be applied into different situations and projects. This also means that a successful RMP should be well defined to user requirements (Mcslarrow 2003). In other words, RMP must be tailored to meet the requirements of the company in question (Saari 2004).

Agility: A user-friend RMP should essentially be agile. This means that the RMP should be easily used and learned, but should not time consuming. Managers prefer faster, better and cheaper RMPs that do not require large resources. If the RMP is too high a burden on the project staff, they will not use it effectively and may even evade the process at every opportunity.

Balance: The RMP should keep a good balance between effectiveness period, process complexity and process cost. These three elements are the same as three key elements of project management including schedule, quality and cost.

Behavior: RM researchers have stressed the inclusion of human behavioral aspects in RMP (Hillson 1998). Neglecting the human behavioral aspects results in RMP weakness.

Clarity: Clarity can be defined as carefully documented, consistently used and adequately shared information (Graham 2003). From the view of the present paper, a clarified RMP describes each work in each situation with clear definitions and sufficient guidelines.

Classification: The information which has been created within RMP needs to be classified. Structuring the information is the major key; for instance, Risk Breakdown Structure (RBS) is one of the methods to classify risks sources.

Communication: A successful RMP should have a close relationship with user, industry and other appropriate participants (Mcslarrow 2003). Experience has shown that managing a project's risks requires a close partnership between the project directors and the contractors (U.S. DoD 2000).

Connectivity: This factor is related to the inner integration in a RMP. The connection between RMP phases, stages and steps provides an error-tolerant environment to methodology implementation.

Coverage: The RMP should be conducted throughout the whole project lifecycle, from the initiation phase till the decommissioning of the project. Indeed, RMP has a dynamic concept which prepares a forward-looking process and has a thinking toward tomorrow (Higuera *et al*. 1994).

Creativity: RMP should be creative (Chapman & Ward 2003). Creativity is a vital property of persons that can accelerate the process way and increment the process quality.

Culture: One of the most significant CSF for effective RM is the level of an appropriate and mature risk culture. An organization with a risk adverse culture is less likely to realize improvements (Hillson 1998). This risk-immature organization's culture is hostile to RM and even sometimes to project management in general. Changing the organizational culture is perhaps the most difficult process in making RM successful (Hulett 2001). Cultural changes require time and repetition before they are firmly embedded into the organization.

Documentation: Documentation is properly recording the identification, analysis, and risk mitigation plans and results for each risk element which allows for lessons to be learned and actions to be taken if necessary (Walewski 2003). According to Martins Gomes & Perrelli (2003), the most important aspect of risk identification is the requirement of formal documentation.

Equilibrium: All phases of RMP are important in turn; thus RMP methodology should be valorized, fairly, for all related phases. The initial phases play a fundamental role, the tail end phases play a role throughout and the medium phases play a connective role between them. Focusing on one and ignoring another misleads RMP. Conrow (2003) states that "All RMP steps are equally important. If you do not do one or more steps, or you do them poorly, you will likely have an ineffective RMP".

Experience: This CSF emphasizes the importance of practical implications. Regarding this CSF, one major feature is learning from all experiences (Miler 2005).

Focus: This CSF indicates that the RM analysts should be focused on the most significant points. For instance, RMP should be concentrated on the risks affecting a whole industry or service i.e. systemic risks, as distinct from risks to the position of any individual organization (Hillson 1998). For another instance, the RM analysts should be focused on the points with certain characteristics such as new technology, multiple participants, unstable political situation, etc. (Walewski 2003).

Formalization: Formalization is defined as formally implementing RMP in the project organization. The need for a formal RMP arises from the nature of risk and the complexity of acquisition projects (U.S. DoD 2000). The most important illness of formalization is bureaucracy. So, it is emphasized that RMP should not be a bureaucratic or mechanistic process (Graham 2003).

Goal: It is very important to clarify the scope of RMP. This directs the kind of analysis such as cost-benefit analysis, cost effectiveness analysis, etc. Also, a successful RMP should have a defined set of success criteria for all schedule, quality and cost elements (Mcslarrow 2003).

Ideology: This important CSF states that the RM team should take a holistic view toward a project. In fact, RM should encompass all project management activities (Grey 1995). Ward & Chapman (2003) emphasize the concern with the understanding and managing all sources of project uncertainty. On the other hand, Hillson (2003) proposes the inclusion of opportunity within the definition of risk, ensuring that RMP covers both threats and opportunities. Also, we know that every project runs under various constraints from business, technology, time, etc. Thus, to minimize risks, we should not only consider reducing uncertainty but also consider eliminating constraints.

Impacts: One of the important areas on increasing the depth of analysis is the focusing on the impact measure of risks. Each risk may affect a project in more than one way (Kontio 2001); thus the goal is to consider all these types of impacts, and then to estimate the proper impacts.

Information: Hulett (2001) states that collecting data on risk is about 90% of the total risk analysis effort. The CSF of information stresses the accuracy of input data, information and knowledge entering RMP. Tools used to perform the analysis and the quality of the output is obviously driven by the quality of the input information.

Integration: RMP integration may be horizontal or vertical. In horizontal integration, risks should be considered in developing organization-wide policies, plans and priorities. Vertical integration signifies that functional units incorporate risk analysis into their programs and initiatives (Leysen & Nuffel 2005). A RMP has a strategic advantage if the process is integrated to other processes in its environment. A RMP should be integrated with other project management, engineering and support processes to ensure effectiveness and efficiency. Furthermore, it is important that RM should become fully integrated at both operational and strategic levels (Hillson 2003).

Leadership: Leadership is a key (Chadbourne Sanders 1999). It is recommended to demonstrate a visible and continuous senior leadership for RMP (Graham 2003).

Learning: Paying attention to the lessons learned from the evolution of the process implementation is important. This mechanism called experience factory is based on learning from experience (Kontio 2001). For this purpose, inside-outside benchmarking (Hulett 2001) and having advanced information technology capabilities to enable effective knowledge management and learning from experience (Hillson 2003) are emphasized.

Maturity: Examining the impact of RM over time allows the risk-mature organization to determine whether it is improving or stagnating (Hulett 2001). Thus, organizations may establish a mechanism to assess their current level of RM maturity, identify realistic targets for improvement, and produce plans for developing or enhancing their RM maturity level.

Mobilization: To guarantee the prosperity of RMP, the mobilization of the overall project organization is required. This means bringing together all the project systems and organizations responsible for setting targets, gathering information, affecting behavior or enforcing rules (Hillson 1998).

Modeling: This CSF stresses considering the risk measures such as risk probability, risk impact, risk detection, etc. to model risks. Regarding the response model, the same discussion applies. Undoubtedly, a more powerful RMP requires to a more complete modeling of risks and responses measures.

Motivation: Many projects have had good RMPs in place but still failed because the RM team was not committed to taking risk seriously. Thus, RM requires effort by most or all of the RM team, and this could be achieved by motivation.

Level: According to this CSF, the organizational level (Vision, Strategy, Program, Project and Task) on which the RMP is applied should be specified. A

RMP, in the view of hierarchy in organization, can be general or can belong to a specific level or some levels.

Optimality: The main scope of this CSF is allocating the optimal set of resources to RM. Increment of the assigned resources to RMP increases the cost of RM and decreases the cost of occurring risk events. Therefore, the RM analyst should search the optimum level of total cost (Leysen & Nuffel 2005).

Organization: RM must have a suitable position in the organizational chart of the project. Here, a major choice is whether to have a centralized or decentralized RM organization. The decentralized RM organization is the recommended approach (U.S. DoD 2000).

Output: This CSF emphasizes establishing formal mechanisms to measure the effectiveness of RM on achieving the organization's objectives (Graham 2003).

Outset: This means that RMP should start in a very early stage of the project process (Higuera *et al.* 1994). Naturally when RM is started early, it is more difficult but more useful (Saari 2004).

Patience: Implementation of the RMP requires patience and adequate time.

Perception: The RM team, project managers, project team and stockholders should have a valid and common perception of RM success. This CSF emphasizes the value of individual perception. Also, the company's boom may be a false perception of success and is not concerned about risks.

Perfection: All stages of RMP should be thoroughly implemented. For instance, in unperfected implementation, risk assessment may be performed but not turned into action (Hulett 2001).

Preemption: Problems should be anticipated before they materialize (Saari 2004). This CSF emphasizes that proactive action is the most effective (Miler 2005), because often, has the less cost than reactive action. Contrary to proactive process, reactive RM is often called crisis management and mainly consists of selecting suitable responses (Wideman 1992).

Professionalism: It means being committed to doing the right thing according to professional standards (Hulett 2001). One of the issues is bias. In a risk-immature organization, project management is notoriously biased when it comes to defending its own project. Another issue is commitment. Project leaderships must make a commitment to ensure that RM is not forgotten.

Reasonability: RMP should be feasible (Mcslarrow 2003). Feasibility is the ability to implement the handling technique and includes an evaluation of the potential impact of the technique.

Repetition: Repetitive and continuous improvement is critical to achieving longterm success in managing risk (Higuera *et al.* 1994). In other words, RMP revolutions have sequential alliance and any interruptions are not accepted between them.

Resource: Availability of adequate resources increases the use and effectiveness of RM tools. All projects must include sufficient resources in the project's planning activity to adequately provide for training in RMP.

Roles: All roles (responsibilities and authorities) should be explicitly clear. Five separate roles can be defined for performing projects RM (Hall 1998) including project risk manager, the RM team, project risk profile owners, project risk custodians and project team members.

Specialization: Expert's skills and accessing to a collective set of RM knowledge play a worthwhile role. Thus, an organizational focus for training is essential (Graham 2003). In addition, project manager must be willing to learn about and apply its principles in his daily decision-making.

Stability: A successful RMP should be stable (Mcslarrow 2003). One feature of this CSF is that the level of efforts through RMP rounds should not decrease. In another feature, it is expected that RMP and implementation must be robust enough to survive the machinery of government changes.

Structure: RMP should be a systematic process (Saari 2004). Systematic RM provides a valuable platform for achieving greater certainty in the delivery of projects.

Support: Once RMP is in place the project leaderships must support it. If there is no active support, the RM efforts will cease or become only window dressing.

Teamwork: Most of RM researchers believe that RM is essentially a team effort (Saari 2004, Leysen & Nuffel 2005, Miler 2005).

Tolerance: The human viewpoint can affect the process of making risk assessment (Leysen & Nuffel 2005). Research and experience both indicate that the attitude of individuals and organizations has a significant influence on whether the RMP delivers what it promises. These act as sources of bias, creating preferred risk attitudes which affect every aspect of RM.

Tools: Mature RM organizations use modern tools and are not disdainful of sophisticated and proven approaches (Hulett 2001). Researchers underline the utilization of techniques with deepest analysis capabilities (Hillson 2003). The Software Engineering Institute (SEI) also emphasizes the need for comprehensive software tool support within the entire RMP (Higuera *et al.* 1994).

Trust: Since RMP is a constructive process (Wideman 1992) which should be built on trust and confidence.

Universality: RMP should use comprehensive analysis ways which include subjective or objective analysis, qualitative or quantitative analysis, value-based or utility-based analysis, decision theory or management theory. Selection between these pairs is not an absolute matter. Indeed, project and organization conditions determine the best process.

THE PROPOSED CONCEPTUAL MODEL

According to Conrow (2003), there are two fundamental areas that must be satisfactorily addressed in order to have effective RM. They are process technical sophistication and implementation. We look carefully into the functional and configurational analysis of a system by Haimes (2004). He believes that the four elements within a system are organizational, human, software and hardware factors (Fig. 3). Based on the Haimes model, we propose a four-part pattern to establish a conceptual framework to reach the successful RMP. To establish this conceptual framework, we consider the above four system elements and refer them to RMP aspects as Fig. 4.

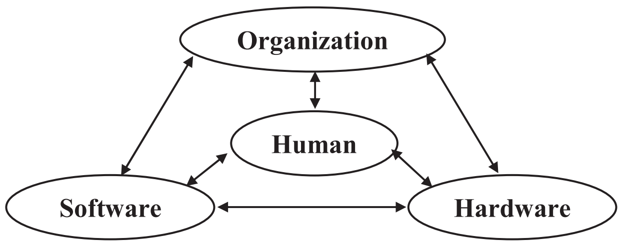

Fig. 3: System elements (Haimes 2004)

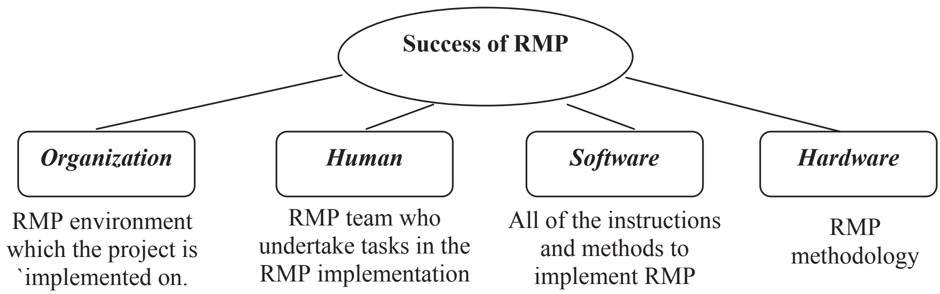

Fig. 4: The sources of the CSFs to reach the successful RMP

In Fig. 5, a conceptual framework for the successful RMP based on the CSFs is provided. In this model, CSFs described in the previous section have been structured in two dimensions: type and category. The dimension of type refers to system elements and the dimension of category includes seven items as shown in Table 2. Naturally, these classifications are fuzzy and have overlaps.

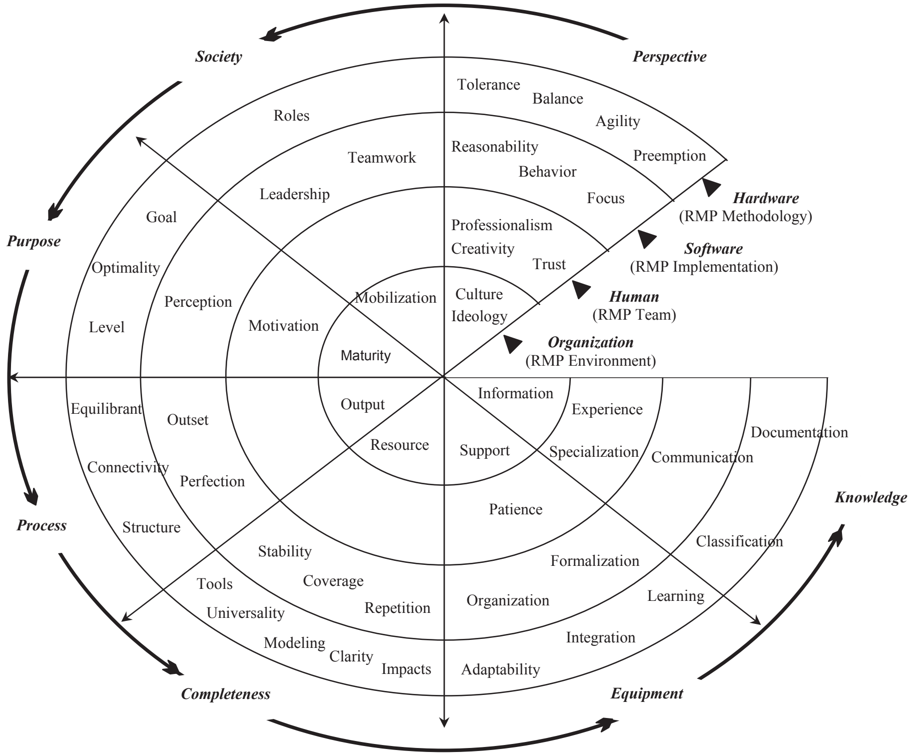

Fig. 5: CSF-based conceptual framework for the successful RMP

Note that in Fig. 5 all arrows represent decrease in the rudimentary aspects of CSFs. Also all lines are fuzzy borders.

Table 2: CSFs category in the conceptual model of Fig. 5

Category	Including CSFs associated with:
Perspective	Thinking, mentalities and views.
Society	Society-related matters.
Purpose	Statements, goals and directors.
Process	Components of the process, such as phases, stages and steps.
Completeness	Complementary aspects of RMP.
Equipment	Supportive equipments to reinforce RMP.
Knowledge	Knowledge, information and data.

GAP ANALYSIS

Conventional RMPs have considered analyzing the gap between these methodologies and the conceptual model of Fig. 5. A number of factors have been identified as the most important contexts for the future RMP studies. These factors are alphabetically described as follows:

Adaptability: Most RMPs have a rigid framework that may not adapt well to project conditions. For instance, tools and techniques for analyzing risk and making decisions under risk are many and must be chosen according to the project, its determining factors, and the type of analysis to carry out. Regarding this problem only a few efforts such as PUMA (Del Cano & De la Cruz 2002) have introduced a method that is preliminary case and should be extended to the whole parts of RMP.

Agility: According to Chadbourne Sanders (1999), many current RMPs are perceived as complex or too costly to use. However, the complexity of RMP results in a bureaucratic and tedious procedure.

Equilibrium: There has been some discussion about the relative importance of different phases of RMP. In the traditional view, the importance of risk assessment is primary and the importance of risk response is secondary because initial phases are more fundamental. For example, Elkjaer & Felding (1999) state that if risks are not identified, they cannot be managed thus giving greatest weigh to the risk identification phase. Contrary to the traditional view, the second view concentrates on the risk response phases of RMP, because they really lead process to final results. Hillson (1999) states that identification and assessment will be worthless unless responses can be developed and implemented which really make a difference in addressing identified risks. The traditional view has directed most RM researches toward risk assessment, resulting in a significant shortage in the risk response related research studies. Hillson (1999) states that risk response development is currently the weakest part of the risk process, and it is here that many organizations fail to gain the full benefits of project RM.

Goals and outputs: Establishing clear targets for RMP is a fundamental task that belongs to the RM planning phase. It is regrettable that RMP directors often overlook this major task. Hillson (1998) states that the current scope of RM is fairly limited, tending to concentrate on timescales and cost targets. While these factors are undeniably important, expansion of the scope of risk processes is to include program RM. Also according to Pipattanapiwong (2004), a fundamental limitation of RMPs is accurate interpretation of the RMPs outputs. Since output of conventional RMPs is normally presented as a dimensionless map, it does not represent how much the project is delayed. With this dimensionless representation, it is considered difficult to interpret the output and use it in communication. On the other hand, some RMPs are merely concerned with eliminating risks while researchers believe that RMPs should be focused on achieving the maximum benefits within budget and timescales rather than on attempting to eliminate all risks.

Integration: In the area of integration between RMP and other management systems such as Performance Management, Business Process Management, Earned Value Management, etc., researchers has been limited. Hillson (2003) believes that integration of RM with overall management and corporate culture is one of the areas where active development is needed.

Learning mechanism: Only a few RMPs such as RISKIT (Kontio 2001) are supported by a learning mechanism. Based on Hillson's (1998) recommendation, a related future development is the use of advanced information technology capabilities to proceduralize effective knowledge management and learning from experience, for example using artificial intelligence, expert systems or knowledge-based systems.

Perspective: Ward & Chapman (2003) suggest that the conventional project RM is based on an event-based perspective, which can result in a lack of attention to several important areas of project related uncertainty. On the other hand, the traditional view of risk is negative, representing loss, hazard, harm and adverse consequences. Most applications of the risk process still concentrate on managing threats, and approaches to opportunity management remain patchy and reactive (Hillson 2003). Furthermore, the tools and techniques available to practitioners seem to focus attention only on the negative side of risk. Another subject of interest is constraints elimination. In practice, few projects have the opportunity to reduce constraints, so most project managers focus on the reduction of uncertainty. Thus, project managers often ignore risks by abolishing constraints and reducing ambiguities. Consequently, in conventional RMPs, almost all tools and techniques are concentrated to encounter uncertainties.

Risk and response modeling: Conventional RMPs normally priorize risk by using probability and impact of risk event. This approach seems to be imperfect, because in the professional view, risk is a phenomenon that is under the influences of several additional factors such as risk detection, risk timeframe, risk predictability, risk manageability, risk proximity, etc. Considering this subject, RMPs are relatively limited. Response modeling suffers from the same problem even more seriously. To have a comprehensive modeling of risks, the above two-dimensional view should be changed. Some researchers have considered this field, yet there is not a comprehensive and well-structured model.

Risk impacts: The risk assessment process focuses on the uncertainty associated with a specific event occurring, with less attention given to the consequence of the event. This lowered attention includes both kinds of impacts and the depth of analysis related to impacts. One of the potential fields to future developments is considering the different consequences of the event occurring. Kontio (2001) states that most existing RMPs focus on schedule, quality and cost risks, yet their combinations or even other characteristics (such as company reputation) may be important factors that influence the real decision making process. In addition, according to Pipattanapiwong (2004), one often may not have enough necessary experience to properly deal with technical (quality) uncertainty because of insufficiency, inaccuracy and inapplicability of historical data, and bounded rationality of human subjective assessment. As a result, there is little established structuring and analysis procedure for technical issues.

Risk tolerance: A single, easily understood risk technique is available to determine and communicate a project's risk attitude. However for RMP to be carried out effectively, all of the steps need to be integrated consistently in line with the project objectives and risk attitudes of the organization and the stockholders.

Structure: In the state-of-the art, many researchers have discussed the weak structuring of conventional RMPs (Chadbourne Sanders 1999). This problem extends to practical applications (Hulett 2001). However, a properly structured risk identification, analysis and mitigation can moderate the risks associated with projects (Walewski 2003).

Tools and techniques: Most researchers agree that RMPs require developing new tools and techniques to increase the depth of analysis. This includes verifying the capability and applicability of the tools (Hillson 1998). According to U.S. DoD, (2000), several tools have been developed to support each component of RMP. However, although tool developers may claim otherwise, none of these tools are integrated to totally satisfy all needs of a project manager.

GUIDELINES FOR THE FUTURE RMP RESEARCH

Within the gap analysis carried out in the previous section, Table 3 summarizes some major areas that have potentials for the future RMP research.

Table 3: The most important subjects and recommendations for the future RMP research

Subject	Guidelines for the future RMP research
Adaptability	(a) Embedding organizational culture in RMP. (b) Bringing flexibility into project condition. (c) Using guideline mechanisms to select the proper path in every step of RMP; for instance, establishing advanced methods such as rule-based systems.
Agility	(a) Providing user-friendly, simple and effective RM methodologies. (b) Keeping balance between effectiveness period, process complexity and process cost.
Equilibrium	(a) Indispensable shifting of research perspectives to more "Equilibrant" RMPs, both for risk assessment and risk response. So, RM research should be concentrated on developing risk response aspects such as response information structuring, response assessment, response selection, etc.
Goals and outputs	(a) Providing mechanisms to consider RMP goals. (b) Developing techniques to interpret RMP outputs.
Integration	(a) Providing toolsets with online linking between RMP phases. (b) Providing a Total Integrated Project Management System (TIPMS) with embedded RMP. (c) Integrate RMP with other project management disciplines.
Learning mechanism	(a) Designing RMPs equipped by learning mechanisms (experience factory). (b) Using advanced information technology, quality management tools and Capability Maturity Models (CMM).
Perspective	(a) Going toward an uncertainty management rather than event-based RM. (b) Designing united frameworks to manage both threats and opportunities (c) Dealing with uncertainties together with constraints; for instance, linking RMP and Theory Of Constrains (TOC).
Risks and response modeling	Developing comprehensive and well-structured frameworks to consider all aspects of risks and responses such as risk manageability, risk proximity, response capacity, response urgency, etc.
Risk impacts	(a) Designing methodologies to consider different impacts of risks. (b) Establishing flexible frameworks to measure technical impacts.
Risk tolerances	(a) Applying of risk tolerances in all phases of RMP (planning, identification, assessment, etc). (b) More attention to utility theory techniques.
Structure	Developing more structured RMPs.
Tools and techniques	(a) Development of better techniques, with improved functionality, better attention to the user interface, and improved integration with other parts of the toolset. (b) Use of advanced information technology capabilities. (c) Development of existing techniques from other disciplines for application within the risk arena, for example from system dynamics, safety and hazard analysis, integrated logistic support, financial trading etc.

CONCLUSION

This paper is outlined to clarify the roadmap for the future RMP research. For this purpose, a conceptual modeling approach has been developed to investigate the present gaps. In the first phase, a number of CSFs has been established with the help of experts' opinion and the current state-of-the-art. It has been found that the proposed methodology provides a proper conceptual framework in the field of RMP. In the second phase, the gap between conventional RMPs and the proposed conceptual modeling approach is discussed. Finally, we have concluded that there is still a tremendous gap in RMP research. Therefore, careful, challengeable and in-depth investigations should be implemented for different areas of RMP.

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REFERENCES

Al-Bahar, J. & Crandall, K.C. 1990. Systematic risk management approach for construction projects. Journal of Construction Engineering and Management **116(3)**: 533-546.

AMP (Association for Project Management) 2004. Project Risk Analysis and Management (PRAM) Guide, 2nd Edition. APM Publishing Ltd, High Wycombe, UK.

Carter, B. Hancock, T., Marc Morin, J. & Robins, N. 1996. Introducing RISKMAN: the European Project Risk Management Methodology. Blackwell, Cambridge, MA, USA.

Chadbourne Sanders, B.C. 1999. To the Heart of Risk Management: Teaching Project Teams to Combat Risk. 30th Annual Project Management Institute, Philadelphia, PA, USA.

Chapman, C.B. & Ward, S.C. 2003. Project Risk Management: Processes, Techniques and Insights, 2$ˆ{nd}$ Edition. John Wiley, Chichester, UK.

Conrow, E.H. 2003. Effective Risk Management: Some Keys to Success. American Institute of Aeronautics and Astronautics, Reston, VA, USA.

Cooper, D.F. 2004. The Australian and New Zealand Standard on Risk Management. October, www.broadleaf.com.

Del Cano, A. & De la Cruz, M.P. 2002. Integrated methodology for project risk management. Journal of Construction Engineering and Management **128(6)**: 473-485.

Elkjaer, M. & Felding, F. 1999. Applied project risk management -- introducing the project risk management loop of control. Project Management **5(1)**: 16-25.

Graham, A. 2003. Risk Management: Moving the Framework to Implementation: Keys to a Successful Risk Management Implementation Strategy. A Report by the Conference Board of Canada, Kingston, Canada.

Grey, S. 1995. Practical Risk Assessment for Project Management. John Wiley, Chichester, UK.

Haimes, Y.Y., Kaplan, S. & Lambert, J.H. 2002. Risk filtering, ranking and management framework using hierarchical holographic modeling. Risk Analysis **22(2)**: 381-395.

Haimes, Y.Y. 2004. Risk Modeling, Assessment, and Management, 2nd Edition. Wiley, Hoboken, NJ, USA.

Hall, E.M. 1998. Managing Risk -- Methods for Software Systems Development. Addison-Wesley, Harlow, EX, UK.

Higuera, R.P., Gluch, D.P., Dorofee, A.J., Murphy, R.L., Walker, J.A. & Williams, R.C. 1994. An Introduction to Team Risk Management. Software Engineering Institute (SEI), Pittsburgh, PA, USA.

Hillson, D. 1998. Project risk management future developments. International Journal of Project and Business Risk Management **2(2)**: 181-195.

Hillson, D. 1999. Developing effective risk response. 30th Annual Project Management Institute, Seminars and Symposium. Philadelphia, PA, USA.

Hillson, D. 2003. Risk management: best practice and future developments. II Congreso Nacional de Gerencia de Proyectos Universidad Nacional de Ingieria, Lima, Peru.

Hulett, D.T. 2001. Key characteristics of a mature risk management process. Fourth European Project Management Conference, PMI Europe. London, UK.

Institution of Civil Engineers, Faculty of Actuaries & Institute of Actuaries, 1998. Risk Analysis and Management for Projects (RAMP). Thomas Telford, London, UK.

Kontio, J. 2001. Software Engineering Risk Management: A Method, Improvement Framework, and Empirical Evaluation. Ph.D. Thesis. Nokia Research Center, Helsinki University of Technology, Helsinki, Finland.

Leysen, J. & Nuffel, L.V. 2005. A framework for the evaluation of integrated risk and performance management. Department of Economics, Royal Military Academy, Brussels, Belgium.

Martins Gomes, G.C. & Perrelli, M.H. 2003. ISO, CMMI and PMBoK risk management: a comparative analysis. International Journal of Applied Management and Technology **1(1)**: 65-76.

Mcslarrow, K.E. 2003. Project Management Manual. The Deputy Secretary of Energy, Washington, DC, USA.

Miler, J. 2005. A Method of Software Project Risk Identification and Analysis. Ph.D. Thesis, Gdansk University of Technology, Faculty of Electronics Telecommunications and Informatics, Gdansk, Polish.

Pipattanapiwong, J. 2004. Development of Multi-party Risk and Uncertainty Management Process for an Infrastructure Project. Ph.D. Thesis, Kochi University of Technology, Kochi, Japan.

PMI (Project Management Institute) 2004. A Guide to the Project Management Body of Knowledge (PMBoK guide), 3rd Edition. Newtown Square, PA, USA.

Rosenberg, L., Gallo, A. & Parolek, F. 1999. Continuous Risk Management Structure of Functions at NASA. AIAA 99-4455. American Institute of Aeronautics and Astronautics, Reston, VA, USA.

Saari, H.L. 2004. Risk Management in Drug Development Projects. Technical Report, Helsinki University of Technology, Laboratory of Industrial Management, Helsinki, Finland.

U.S. DoD (Department of Defense) 2000. Risk Management Guide for DoD Acquisition. Defense Systems Management College Press, Fort Belvoir, VA, USA.

Walewski, G.J. 2003. International Project Risk Assessment: Methods, Procedures, and Critical Factors. A Report of the Center Construction Industry Studies, University of Texas at Austin, Austin, TX, USA.

Ward, S. & Chapman, C. 2003. Transforming project risk management into project uncertainty management. International Journal of Project Management **21**: 97-105.

Wideman, R.M. 1992. Project and Program Risk Management: A Guide to Managing Project Risks and Opportunities. Project Management Institute, Upper Darby, PA, USA.

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تحليل الفجوة في عمليات إدارة مخاطر المشاريع

سيد محمد سيد حسيني ، سياماك نوري و محمد علي حتيفي
قسم الهندسة الصناعية – جامعة إيران للعلوم والتكنولوجيا – نارماك
طهران 16844 – الجمهورية الإسلامية الإيرانية

خلاصة

إن تطبيق عملية إدارة مخاطر المشروع هي مفتاح مهم لإنجاح أي مشروع. إن الهدف الرئيسي لهذه الدراسة أن نقترح التعليمات لتوضيح الخارطة الصحيحة إلى البحوث المستقبلية من عملية إدارة المخاطر RMP، خاصة في بيئة المشروع. ولهذا الغرض فإن نموذج تصوري قد طور ليعرض ويحلل الفجوة بين RMP التقليدية وبين النموذج المقترح. وتنظر الورقة أيضاً بعناية، إلى تحليل ترتيب النظام وتأخذ في الاعتبار نمط ذو أربعة أجزاء أي بمعنى آخر، التنظيم، العامل الإنساني، برامج الحاسب الآلي وأجهزة الكمبيوتر. مستندة على النموذج المقترح. تم التعرف على عوامل النجاح الدقيقة (CSF) بمساعدة المراجع الحديثة وآراء الخبراء. ومن المؤكد أن النموذج المقترح قد يكون علامة مميزة لباحثي عملية إدارة المخاطر.