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Measuring the maturity of risk management in large-scale construction projects

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ABSTRACT

The uncertainties and randomness in multi-dimensional risk management (RM) in large-scale construction projects should be effectively detected and measured through reliable managerial procedures to eliminate or reduce adverse consequences such as casualties and asset damages in advance. This paper aims at an innovative technical solution for project managers to better understand the level of RM practice by means of RM maturity measurement. Based on the theory of system science and previous research into project management in the maturity of RM, this paper describes the prototype of an RM Maturity System (RMMS) for large-scale construction projects. The system is underpinned by using the Analytic Network Process (ANP) method in order to measure the overall effectiveness of RM against major risk factors. The RMMS consists of three components to focus on capabilities, evaluation and evolution in RM. A case study is given at the end to verify the feasibility of the system.

1. Introduction

Large-scale construction projects such as skyscraper, hub airport and rail network involve complex interfaces, varieties of stakeholders and integration of materials and technologies, which incur uncertainties and associated risks. It has always been critically important and challenging for major participants such as clients and construction contractors with regard to effective RM in those projects. In this study, a methodology for measuring the maturity of risk management (RM) in large-scale construction projects is therefore developed based on identified major risk factors that generally lead to adverse impacts and costly consequences in project management.

With regard to the capability development in project RM, there are mainly two channels, including the spontaneous ascension and the capability induced ascension. Since the original use of maturity model in the ICT project management, it has been widely used as an effective approach to spontaneous ascension of capability development in various fields across sectors, and the RM, which is an essential component of project management, has also received more and more attention on specific maturity models [2–8]. All these pioneer studies have initiated theoretic development of RM maturity to facilitate project management towards better understanding of the status of organizations' capabilities in RM, and this helps organizations to take corresponding actions in both technical and managerial areas so as to improve the RM procedure in accordance with organization's strategy and objectives.

Although the value of RM maturity theory has been affirmed among scholars across the world, questions regarding how to build a RM maturity model and how to design the evaluation and improvement process are still under discussion. Based on the clients' general perspectives, this paper aims at a systematic approach to RM maturity in large-scale construction projects. In order to help the organizations to improve their RM capabilities, the new approach is described through the analysis of capabilities structure and the design of evaluation and evolution processes, which are underpinned by the theory of system engineering.

2. Literature review

2.1. RM procedure

The process of RM in project management has been widely studied in organizations and institutes across the world. For example, the Project Management Institute (PMI) [1], the former Office of Government Commerce (OGC) [8], the International Organization for Standardization (ISO) [9], the Institute of Risk Management (IRM) [10], and the HM Treasury [11] have all published their standards on RM process. According to the comparison on RM process among those standards (see Table 1), it has been found that there are similarities among those given processes, although proportions of essential RM processes in different standards are different. Based on the comparative study described in Table 1, common RM processes can be recognized to include RM planning, risk identification, risk analysis and assessment, risk response, risk monitoring, and RM reporting.

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Table 1
A comparative summary of general risk management processes.

RM process	Professional recognitions				
	PMI [1]	OGC [8]	ISO [9]	IRM [10]	HM treasury [11]
RM planning	✓		✓		
Risk identification	✓	✓	✓		✓
Risk analysis	✓		✓		
Risk assessment		✓	✓	✓	✓
Risk responses	✓	✓	✓	✓	
Risk monitoring	✓	✓	✓	✓	
Risk control	✓				✓
RM review and reporting			✓	✓	✓

In accordance to this summary, the general procedure of RM in large-scale construction projects was then identified based on the authors' long-term observations and experience in both academic research and professional practice, and Fig. 1 illustrates six processes and their relationships. Among these processes, RM planning is the starting point of the entire RM procedure; it is generally useful to regulate and promote four successive processes in the core RM cycle to roll forward with management system oriented self-improvement in the whole project development flow from project inception through design and construction to project competition. RM reporting is the finishing point of the entire RM procedure; it is generally useful to summarize the RM with regular outputs with regard to predefined risk control points, and helps organizations to understand current situations and take corresponding measures in their RM practice. The RM procedure summarized in Fig. 1 indicates a normal RM system, which can be led by RM planning and driven by RM reporting, with regard to not only obvious effectiveness but also significant improvement through its forward rolling process engine to implement a core RM circle at different stages of construction project development so as to gradually reduce uncertainties and adverse impacts.

The review into RM procedure in project management reveals a key question about the quality of RM based on those integrated processes with regard to general RM objectives, and accordingly it is important to use effective measurements such as the RM maturity to deal with the quality issue.

2.2. RM maturity

In the past decade, there has been an increasing research interest in the maturity of RM and applicable models for practice. It is generally regarded that RM maturity models can effectively help organizations to understand the level of current practice in terms of their capabilities in RM, as well as their strengths and weaknesses towards future RM practice, in order to take appropriate actions to improve their RM performances.

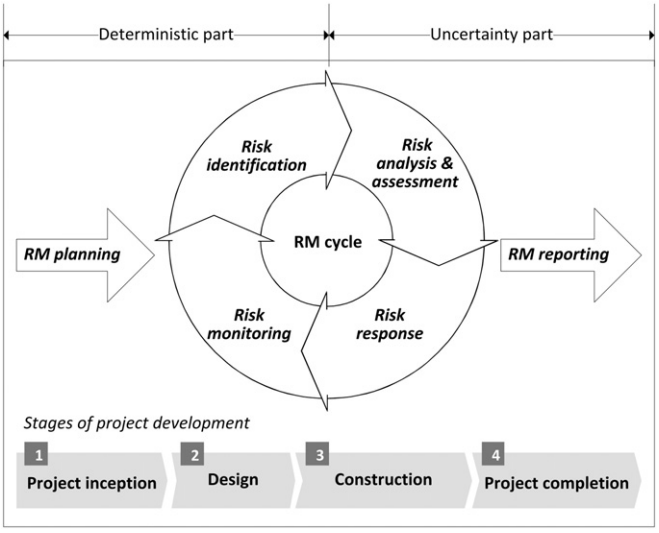

Fig. 1. A generic RM procedure for construction projects.

In terms of recent research and development in the area of RM maturity, Table 2 gives a summary of four representative RM maturity models, including the OGC's model [8] for generic RM practice across sectors, MMGRseg [2] for the ICT sector, RM-CMMI [4] for the manufacture sector, and RM3 [7] for the construction sector. The summary covers attributes used in setting up those models, and maturity levels which can be derived by using those models in RM practice. For example, for the maturity of RM in construction firms, Zou et al. [7] looked into eight RM maturity models in terms of related issues including system, process, human resources and culture; and they developed a RM capability maturity model which consists of five attributes towards four maturity levels (see Table 2) and was verified through an empirical study with professionals at various construction enterprises. The summary has revealed current research and practice in the area of RM maturity with a reliable reflection to construction projects.

However, there are two limitations in current research and development. The first one is about the methodology of RM. It has been found that although process oriented management method has been mostly adopted in those RM maturity models, there was no particular good example in terms of the use of system engineering method to deal with the complex situation of RM. For example, there was no RM maturity model for large-scale construction projects. The second one is about the contents of RM maturity. It has been found that although evaluation oriented RM maturity models were built up, there was a lack of in-depth description about risk problems by using a systematic structure with regard to RM capabilities, maturity factors, and maturity ascension, etc.; in addition, there was a lack of dynamic connections from RM to all other compatible clusters on cost, time and quality in construction project management, especially those large-scale construction

Table 2
A summary of recent RM maturity models.

RM maturity model	Attributes	Maturity level
OGC's model [8]	Organizational context Organizational objectives Stakeholder involvement Support structure Supportive culture Roles and responsibilities Early warning indicators MoR approach Overcoming barriers to MoR Reporting Review cycle Continual improvement	Initial Repeatable Defined Managed Optimized
MMGRseg [2]	Context definition Risk analysis/assessment Risk treatment Risk acceptance Risk communication Monitoring and critical risk analysis	Initial Known Standardized Managed Optimized
RM-CMMI [4]	Culture RSKM process Experience Application	Incomplete Performed Managed Defined Quantitatively managed
RM3 [7]	Management and leadership capabilities in relation to risks Organizational RM culture Ability to identify risks Ability to analyze risks Development and application of standardized RM process	Initial and ad hoc Repeatable Managed Optimized