

Risk management and risk management performance measurement in the construction projects of Finland

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ABSTRACT

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Distinguishing and diminishing risks in today's projects are crucial for project success. Almost every project is facing several risks throughout the project timeline. Construction projects in Finland are also facing project risks due to the complexity of the project. To minimize the impact of risks, an effective risk management approach must be incorporated into every project which also includes the effectiveness and measurement of its performance. Managing the risks is an important job but measuring the RM performance is crucial. Thus, the objective of this study is to analyze the risk management (RM) and risk management performance measurement (RMPM) through an in-depth empirical analysis of two complex construction projects of Finland. To achieve the objective, a qualitative case study is followed by the authors of this article to identify the RM processes, major and minor risks of the projects, RM strategies to mitigate them and RM performance measurement strategies. Overall, this article provides a comparative analysis of RM and RMPM for construction projects and it can be used as a basis for further research into RM perspective in complex construction projects.

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1. Introduction

The concept of "Risk" is not new. Assessing risk before making decisions was offered by the Athenians a long ago (Bernstein, 1996). However, the concept of "Risk Management" (RM) is comparatively new, about 40-50 years ago (Aven, 2016). In recent years, intense research has been conducted on RM in the field of project management (PM) (Pekkinen & Aaltonen, 2015). Every business function comes with risks and these risks can affect the business (Acharyya, 2008). Voetsch et al. (2004) also stated in his article that there is a significant relationship between the RM approach and project's success. Such organizations often fail to create value added project RM practices because they end up executing tick-the-box exercise only (Kutsch et al., 2014; Lehtiranta, 2014; Oehmen et al., 2014). Construction projects are no different than that; in fact, construction projects are more unique in a way that they have too many stakeholders, lots of capital investment and complexity. For such constrains, success in construction project is dependent on the quality of preparations and processes. Risk management is such type of process which help project managers and owners to identify, assess and minimize the project risks (Firmenich, 2017). Risk management strat-

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egy can obviously improve the project's success, but it is equally important to maintain the measurements of the RM's performance on regular basis. There are many criteria to measure the performance of organization and measure the efficiency and effectiveness of the activities (Shahbaz et al., 2018). It is said "If you can't measure it, you can't improve it" (Gunasekaran & Kobu, 2007). Not able to measure the RM's effectiveness during progress of the project may cause project failure (Basova & Mitselsky, 2011). Without proper evaluation of RM, an organization is unable to track the progress of the risk mitigation; which leads to project failure. Thus, it is very crucial to identify the risks, a proper way to manage them and finally, measure the risk management performance properly. Therefore, the purpose of this article is to focus on the risk management processes and risk management performance measurement evaluation of two large construction projects of Finland. The empirical basis of this article's findings was qualitative interviews and were analyzed and collected through multi-method study. The project managers and owners were interviewed, and two project's risk management and risk management performance measurement practices were analyzed. Further, we analyzed how their practice supports the current RM and RMPM mechanisms.

The article is structured in the following way: Section 2 addresses the insights of RM, risk categories, RM steps and RMPM, Section 3 describes the research method and context. The next section presents our result from the empirical study where we assessed the risk management processes and performance measurement of two construction companies of Finland. Finally, in Section 5 we discuss the implications of the result in managerial field and in section 6, we will discuss for further research as well.

2. Theoretical background

2.1 Definition of RM

There are many literatures on risk management (RM) where authors defined RM as uncertainty management in a way that risk itself an uncertain thing (Carbone & Tippett, 2004). The most two popular definitions of RM are published by Project Management Institute (PMI) and Association for Project Management (APM):

"The systematic process of identifying, analyzing and responding to project risk. It includes maximizing the probability and consequences of positive events and minimizing the probability and consequences of adverse events to project objectives" (PMI, 2016).

"A process whereby decisions are made to accept known or assessed risk and/or implementation of actions to reduce the consequences or probability of occurrence" (APM, 2012).

Both organizations defined RM similarly but the major differences between these definitions concerns PMI's consideration of risk as being positive sometimes. According to Jaafari (2001) and Perminova et al. (2008), positive risks, although causing uncertainty, can also maximize success or profit, and should therefore be considered in RM strategies, alongside negative risk (Ward and Chapman, 2003). Many previous publications concur that project failure is closely associated with ineffectual RM in failing projects and some notable project failures due to RM are Yucca Mountain (Swift, 2015), Panama Canal (Alarcón, 2011; Alhojailan, 2012), Millennium Dome (Peter, 2000), Airbus A380 (Shore, 2008). Different scholars have defined RM from different aspects. Table 1 represents some generally accepted aspects of RM.

Table 1
Perspective of RM by different researchers

Study	RM definition
Stranks (1994)	Defines RM in terms of identification, evaluation and control of exposure to each risk that hinders project success.
Chong and Brown (2000)	Risk is a fundamental aspect of RM; the main aim is to minimize or maintain risk at a level that is acceptable for an enterprise.
Stephenson et al. (2011)	Describes RM in two dependent variables: risk identification and risk analysis.
Loader (2011)	Risk Management is very important for any business, but it doesn't ensure the ultimate success of a project.
Loch et al. (2011)	RM is kind of a tool that assists enterprises to confront change.

2.2 Risk Categories

Project risks are categorized as cost, schedule and performance risk, and also other type of risks such as governance, strategic, operational, market, legal and external hazard risks (Project Management, 2017; Jaber, 2019). Different scholars describe project risk types in different ways depending on the source of nature. Ward and Chapman (2003) found in their article five types of risk sources that cause uncertainty. Miller and Lessard (2001) developed a list of examples of some common risks faced by different project types, according to the nature (social acceptability risk, market risk, social risk, institutional risk, technical risk). A study by IMEC analyzed 60 complex projects where project managers were interviewed and asked to name and rank the risks they faced during the projects. The risks are demand, supply and financial risks (41.7% of risks); technical, construction and operational risks (37.8% of risks); regulatory, social acceptability and sovereign risks (20.5% of risks) (Miller and Lessard, 2001). At the same time Jafaari (2001) identified several risks (political, promotional, technical, financing, operating, schedule, environmental, cost and organizational risks) categories that a project may encounter. Later, Rolst adas et al. (2011) added a new category to this list; called contextual risk. Meanwhile, Arto et al. (2011) divided risks into four types: pure risk, business risk, financial risk and area-specific risk. Krane et al. (2010) and Thamhain H.J. (2013) also categorized risk into operation, short term strategic, long term strategic and category I – category IV respectively. Fountaine (2015) also divided risks during projects into project risks and technical risks.

2.3 RM Steps

In order to handle the complexities and uncertainties of projects there are several steps to be followed in the context of RM. There are many process models of RM described in the literature and there is a strong consensus regarding RM approach (PMBOK). Fone & Young (2005) stated that the process should include another extra step. According to them, the steps are: RM mission identification, Risk and uncertainty assessment, Risk control, Risk financing and Program administration. Chapman and Ward (2003) expressed a generic framework named “SHAMPU” which contains nine steps: define, focus, identify, structure, ownership, estimate, evaluate, plan and manage. D. van Well-Stam et al. (2004) also described the RM steps in a similar way by splitting the RM process into nine steps. D. Van emphasized that after performing risk analysis, the following evaluation and control phase should continue on a regular basis. Another popular framework named Active threats opportunity management (ATOM) by Hillson and Simon (2007), where he mentioned that threats and opportunities can be controlled by identifying and assessing risk during two-day workshops. Kahkonen and Arto (2008) also developed a holistic RM process model where they divided RM steps into core and accessory steps. This process focuses on continuous risk registry updates and environment scanning (Kahkonen & Arto, 2008).

2.4 Risk Management Performance Measurement

Performance measurement is a process of quantifying the efficiency and effectiveness of past actions (Neely et al., 2007). Moullin (2002) stated in his research that performance measurement is a process in which the management of the organization and the customer valuation are evaluated. Goh (2012) stated that the main aim of performance measurement is to make the organization more efficient while improving its performance. Measurement must start immediately once the criteria have been selected and should continue throughout the project (Bradley et al., 2010). Performance management has four main components: duty, strategy goal, performance goal and performance index (Seon-Gyoo kim, 2010). Among them, the four most used and popular RM performance measurement methods for large construction projects are: BSC, EVMS, KPI and RMI (Brandon, 2005). Balance Score Card (BSC) was introduced by Kaplan and Norton (1991). Though it is a strategic management method, it is also suitable for analyzing traditional finance and accounting performance. According to Kaplan and Norton, BSC has four perspectives and the goals and

measure changes with the perspectives. Earn value management system (EVMS) is the most extensively used performance measurement method. According to Fleming and Koppelman (2005), and PMI (2005), EVMS has three main variables: planned value (PV) budgeted value for the project, actual cost (AC) of the work done, earned value (EV) of work completed (EVM, 2017). There are also four types of variance analysis for EVMS (Fernando Acebes et al., 2013) that is shown in Table 2.

Table 2
EVMS variance analysis (PMI, 2011)

Cost Variance (CV) CV= EV-AC	Schedule variance (SV) SV= EV-PV	Cost performance Index (CPI) CPI= EV/AC	Schedule Performance Index (SPI) SPI=(EV/PV)
CV= 0; project is on budget, CV= (-)ve; project is over budget, CV= (+)ve; project is under budget	SV= 0; project is on schedule, SV= (-)ve; project is over schedule, SV= (+)ve; project is under schedule	CPI=>1; project is favorable condition, CPI<1; project is in unfavorable condition	SPI=>1; project is favorable condition, SPI<1; project is in unfavorable condition

Key performance Index (KPI) is mainly used to measure the performance of construction business, but Carreño et al. (2007) stated in his article that it can also be used to measure the RM system performance and success. When developing a KPI for project's performance, four characteristics must be taken into consideration: tangibility, flexibility, standardization and objective focus (KPI, 2017). Risk Management Index (RMI) is another method which is based on four indicators and those are: risk identification (RMIRI), risk reduction index (RMIRR), disaster management index (RMIDM), government and financial protection index (RMIFP) (Carreno et al., 2007). RMI is the average of these four indicators:

$$RMI = (RMIRI + RMIRR + RMIDM + RMIFP) / 4$$

The performance of each indicator can be ranked as low, incipient, significant, outstanding or optimal; numbered from 1 (low) to 5 (optimal) (Carreño et., 2007).

3. Methodology

Research Methodology acts as a glue which holds research together in a perfect rigid shape, providing a framework to carry out the research in its entity (Herbst & Coldwell, 2004). This study focuses on analyzing the RM approaches and their RMPM in two large construction projects. A qualitative approach is followed in pursuing this research as qualitative research is a systematic approach which illustrates life experience and related situation provide its meaning (Burns and Grove, 2003). The rationale behind selecting a qualitative approach for this research is that this research focuses on case studies with different risk identification strategies. As their impact and performance management plans are analyzed, the data regarding the risk identification and how they were tackled in the projects is most appropriately collected through verbal and questionnaire means. Data was collected through face-to-face interviews with two construction projects: The Tampere Rantatunneli Project (TRP) and Tampere Tramway Project (TTP). In TRP, an underground tunnel was built excavating rock in the middle of the Tampere city. TTP is a 24 km long tramway that's currently under construction in Tampere city. Data for TTP case study was collected through face-to-face interviews which were semi-structured as a list of questions. The interviews were recorded through audio tape and was later transcribed for data analysis. Data for TTP was collected through a questionnaire and it was very helpful as in this form, the participant has their own freedom and time to give answers according to their own pace. The data that was recorded and transcribed from the interview and questionnaires, was analyzed through a thematic content analysis method. This involves organizing the data into different categories based on the relevant themes and features (Alholjalín, 2012). At first the data from interviews was first categorized based on the qualitative data given by the interviews, then categorized into RM steps, risk identification, major and minor risks and performance measurement of those risks. Finally,

based on the categorized data, project complexity was validated, a RM process was drawn up, the impact of major and minor risks was calculated, and a risk matrix was drawn. Thus, the categorized data helped us with the interpretation of collected data.

4. Results

4.1 Project Risk Management (PRM)

In both projects, the alliances followed RM process in two phases: development phase and implementation phase. Risk identification, risk analysis, risk distribution and risk action were followed in both phases as a cont. process throughout the TRP project. Meanwhile in the TTP, the RM was planned for development phase only. In the development phase, the RM team used a Monte Carlo Simulation Model with a view to calculate the risk value and risk level. Figure 1 shows the RM process of two individual projects.

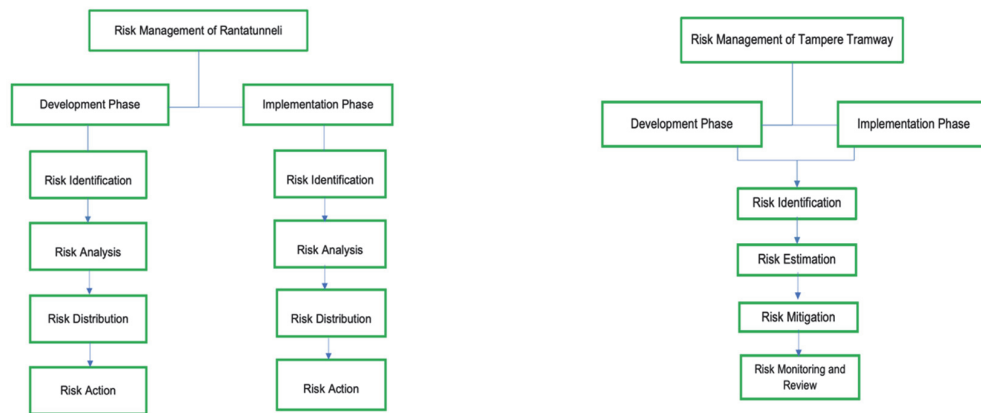


Fig. 1. RM processes of TRP and TTP

4.2. Categorizing the Project Risks

In the TRP, risks were categorized based on the work of the specialist groups and phases in which the risks were identified in the development and implementation phases. The identified risks were categorized based on PM skills or risks by specific technological discipline. In the TTP, many of the risks were classified and categorized during the development phase, and it was continuing to emerge day-by-day. The identified risks were mainly related to cost and constructability. Later, in the implementation phase, risks related to work safety, project, cost, schedule and operation are being identified. Table 3 shows different risks and their category in both projects.

Table 3

Risk Name and Risk Categories of TRP and TTP

Tampere Rantatunneli Project (TRP)		Tampere Tramway Project (TTP)	
Risk Name	Risk Category	Risk Name	Risk Category
Polluted soil	Technical risk	Active urban environment	External Risk
Quality of rock	Technical risk	Project permission	External Risk
Ground water level control	Technical risk	Construction collapse	Operational Risk
People acceptance	Social risk	Contaminated soil	Operational Risk
Tunnel malfunction	Operational risk	Worker accident	Work safety Risk
Staff turnover	Schedule risk	Staff turnover	Management Risk
Breach schedule	Schedule Risk	Breach schedule	Schedule risk
Material price increase	Market Risk	Material price increase	Cost/Market risk
Subcontractor failure	Market Risk	Subcontractor failure	Market risk
Political oppose	Political Risk	Adverse weather	Environmental risk

4.3. Risk matrix

To access the risk matrix, at first the risk severity is assessed. A risk grading scale is used (Table 4) in which a score of 1 represents the lowest probability and impact on the project and score of 5 represents the highest probability and most major impact on the project.

Table 4
Risk Grading scale

Grading Value	Probability of occurrence	Impact size
1	Almost impossible	Insignificant
2	Improbable	Less significant
3	Possible	Significant
4	Probable	Very significant
5	Almost certain	Critical

Using the risk grading scale, RPN (Risk priority number) was calculated in Table 5 to find out the seriousness of the risk, where $RPN = \text{Probability of occurrence} \times \text{Impact}$.

Table 5
Risk Severity Calculation of TRP and TTP

Risk No.	Tampere Rantatunneli Project (TRP)			RPN	Tampere Tramway Project (TTP)			RPN
	Risk	Probability	Impact		Risk	Probability	Impact	
R1	Polluted soil	5	4	20	Active urban environment	5	4	20
R2	Quality of rock	3	4	12	Project permission	4	4	16
R3	Ground water level control	4	4	16	Construction collapse	4	4	16
R4	People acceptance	3	4	12	Contaminated soil	3	3	9
R5	Tunnel malfunction	2	5	10	Worker accident	3	4	12
R6	Staff turnover	2	3	6	Staff turnover	2	3	6
R7	Breach schedule	1	4	4	Breach schedule	2	4	8
R8	Material price increase	2	4	8	Material price increase	2	4	8
R9	Subcontractor failure	1	3	3	Subcontractor failure	1	3	3
R10	Political oppose	3	3	9	Adverse weather	4	3	12

The risk matrix for TRP and TTP were developed using Table 4 and Table 5. Fig. 2 shows the risk matrix for TRP and TTP respectively. In TRP, the polluted soil and Ground water level control (R1 & R3) are on high risk whereas in TTP; active urban environment, project permission and construction collapse (R1, R2 & R3) are on high risk.

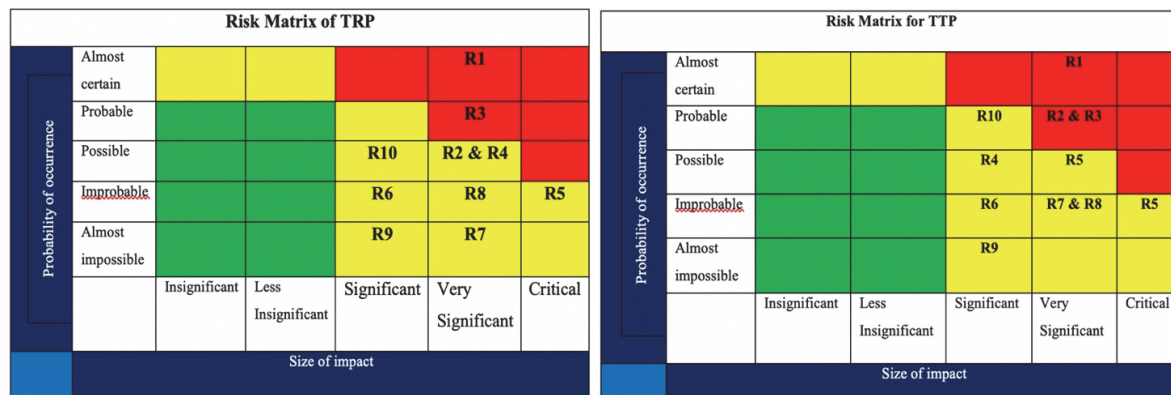


Fig. 2. Risk Matrix for TRP and TTP

4.4 Risk Management Performance Measurement (RMPM)

The TRP team did not set any specific criteria to measure their RMPM; rather it set project success criteria, through which to judge its RM performance. Though they usually used to judge RM performance effectiveness through tracking the identified risk and managed risk. This risk tracking process also used as the continuous RM improvement tool as management was able to identify any gap and later improve that lacking. The main criteria it used for measuring success were TOC (target outturn cost), KPI for KRA (key performance index for key result area) and positive and negative modifiers. The KPI that was set for measuring success were schedule, safety, usability and public image. At the project end, success was achieved in all four areas of the KPI. The TOC for project

implementation was set by the alliances in the development phase in a way that the leftovers will be split between the alliance partners. The final outturn cost was Euro 195,938, 844 and the cost was Euro 192,183,048. The TOC undercut was Euro 3,755,796 which was due as an incentive bonus. Figure 3 represents the whole scenario of how TRP determines their RMPM which is totally based on the final incentives.

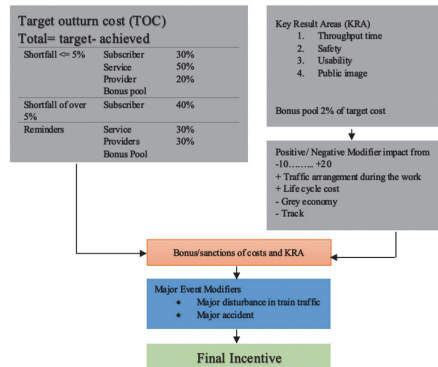


Fig. 3. Performance measurement system TRP (Value for Money, 2018)

The alliance team set some key result area (KRA) which are judged by comparing the minimum performance target with the industry average. Table 6 shows that for specific KRA’s (schedule, safety, usability, public image), there is a KRA point for each KRA. The indicator to measure each of the KRA was set from -100 to +100 points (Up to +100 points for breakthrough and outstanding performance, up to -100 points for total failure regarding meeting minimum requirement criteria, 0 score if the meet minimum requirement criteria are met).

Table 6
‘KPI for KRA’ for TRP

KRA	Target (0 level)	Result	KRA points
Schedule	Complete by 15 th May, 2017	Completed 15 th November, 2016	100
Safety	14-16 160-200	11.9 56	15.1 84.4
Usability	Constant traffic flow with some disruptions	3 minor disruptions	94
Public Image	85-90	88	0

The positive and negative modifier criterion in Table 7 was used to provide the reward or give penalties to the alliances for those tasks which were very crucial for the project’s success. To set indicator values for this criterion would not have been practical. A positive modifier could add up to 20 points whereas a maximum of 10 points could be deducted for a negative modifier.

Table 7
Positive and negative modifiers for TRP

Pos. Modifier	Target	Result	KRA	Neg. Modifier	Target	Result	KRA
Traffic disturbance during construction	KVL same as before the project KVL max -7% compared to before the project	KVL -1% less than before the project	+5	Highway 12 traffic disturbance	Traffic stopped for 6-24 hour	None	0
Damages	Below 0.75% of the TOC	0.2% of the TOC	+5	Train traffic disturbance	Train stopped 6-24 hour	None	0
Significant accolade	Award received	RIL award winning site 2016 PRY award winning project 2017	+5	Grey economy	Observed once Observed once	None	0
Life cycle cost	Impact over Euro 100,000 p.a	Below Euro 100,000 p.a	0				

Based on the calculated weighted KRA, contractors received Euro 4,681,509 as an incentive bonus. This was split so that LMK Infra Oy received Euro 4,100,299, A-insinoorit Oy received Euro 331,008 and S&R Oy received Euro 250,202. In total, the project performance was significantly

higher than expected, as it fulfilled all of the key objectives. On the contrary, the TTP's project implementation phase started in 2017. The project team is defining its RM and RMPM plan continuously by measuring the number of identified risks and number of risks eliminated, using a risk level calculation. No fixed KPI for measuring the RM performance has been set so far. Presently, the team is temporarily judging its RMPM through comparison of the number of open hazards with the number of controlled or hazards. In its current RMPM system, the project team follows the steps presented in Fig. 4.

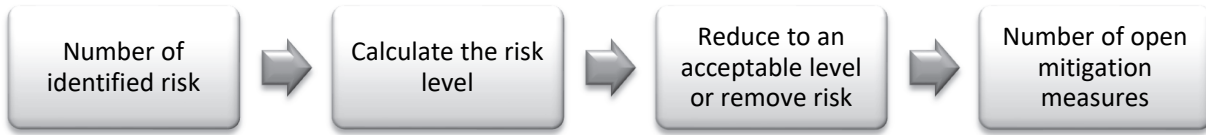


Fig. 4. RMPM process steps of TTP

5. Discussion

The practical case analysis used in this project helped to demonstrate the benefits of RM in construction projects. In case of RM in TRP, it was easier to identify the potential risks through the alliance project team than it would have been for partners to do separately. The alliance team followed the “Big Room” concept where they joined in an open space and discussed about PRM issues. The project finished six months ahead of schedule and TOC was less than predicted. Pain/Gain method was used between all parties instead of one single party only. There were some arguments between team members during PM discussion about RM managing issues, such as, identifying methods of risk, risk mitigation ways, risk responsibilities, contrast decisions with risk accepting, removing, transferring and fixing the risk reserve budget etc. In spite of the arguments, after a certain period, teams were agreed upon a specific method. On the other hand, the TTP is comparatively new and the questionnaire interview showed that the initial planning concerning the project timeline, budget risk and uncertainty management and QC was done by the team and the project team has successful progress in terms of RM, timeline and cost controlling till now. Both project teams put high emphasis on the risk management issues.

The RM team of both projects followed the basic RM process for risk identification, evaluation, mitigation and monitoring which is also suggested by previous researchers (Ward & Chapman, 2003; Kahkonen & Arto, 2008; PMBOK,2016). After the risk identification phase, the Monte Carlo Simulation Method was used to calculate the risk impact level. From the analysis, it's found that risk identification is the most crucial stage on both development and implementation phase. Apart from that, every personnel of the team were aware of the Rm issues and responsible to track and identify any potential risk. Moreover, TRP maintained a balanced risk reserve budget in their final budget plan. The RM team of TRP successfully identified the risks and managed them in an efficient way as they used to track risk mitigation in a periodical manner. Thus, this research findings support that with a properly planned and balanced RM approach, any complex construction project's risk can be managed efficiently and effectively which lead to project success.

In the literature, there are very few methodologies regarding RMPM. Amongst them, the most commonly used RMPM for large construction projects are Balanced Score Card (BSC), Earned Value Management System (EVMS), Key Performance Indicator (KPI) and Risk Management Index (RMI), with KPI being the most commonly used. In this research, TRP did not directly specify any indicators rather it set some goals, along with some fixed KPI, TOC, positive and negative modifiers. The reason to overlook the RMPM in TRP was because they have a project success measuring criteria and the team might not find the necessity to implement any separate criteria. Another reason might be their well-balanced risk tracking and mitigation process. Though their RM process was successful without having any RMPM, still RMPM is on the table of improvement. On the other hand, TTP is yet to determine KPI parameters to assess its RMPM. The team did not directly specify

any indicators or performance assessment criteria for the RMPM, as this project is on its initial stage, but it is following risk mitigation measures with the number of open hazards being compared with the number of controlled or removed hazards. To measure the RMPM, the RM management program might include with the managements KPI and also it might be included in organization's compliance audit. Some KPI might be implemented to measure the RM performance through establishing objectives and performance measures which presented in Table 8 with KPI example (Section 2.4).

Table 8
KPI for RM performance measurement

Objectives	Performance Measures	KPI
All personnel should be trained under RM program by Q3	% personnel trained by Q3	95% by Q3
Risk registers need to be developed for all function areas by Q3	% functional areas developed risk registers	98% by Q3
All new risks should be included in the risk register and assigned the responsible person within the 24 hour of risk identification	% new risk included in the risk register by 24 hour of risk identification	100%
All risks need to be managed by specific timeline	% risk managed by the timeline	98%

6. Conclusion

The prime goal of this research article is to provide a deep understanding of the role of project RM in construction projects through presenting risk identification, prioritization and management of implementation, and finally, the importance of measuring the effectiveness and efficiency of RM performance. In this research, the empirical analysis of RM and RMPM was conducted on qualitative feedback concerning two large construction projects. The research was carried out by performing an extensive literature review on RM and measurement of RM performance, followed by real case analysis through a semi-structured interview and questionnaire. The literature review shows that project failure has been increasing for the last few decades (Raz et al., 2002; Flyvbjerg et al., 2003; Mulcahy, 2003) as general RM standards are not always sufficient due to complexity (Atkinson et al., 2006). RM has become an integral part of PM in construction projects as construction projects suffer the highest rest of failure. In-depth, risk analysis is an effective plan an contribute significantly towards project success. In order to be effective, a RM plan should also include RM performance measurement (Basova & Mitselsky, 2011; Goh, 2012). RM alone cannot guarantee project success, as without evaluation of current performance, the project manager cannot know the true scenario of the RM plan. Ultimately, an efficient and effective RM strategy with RMPM helps organizations achieve success in their projects, enables efficient use of resources and maximizes profitability.

This study reveals the different methods in organizing RM and evaluate the RMPM on construction projects and their importance on the projects. The findings from this study point out the alliance contracting impacts on RM, effective use of RM tools and the importance of RMPM. Thus, the findings and analysis of this study will help other project managers to imply practically in the following manners- (1) forming the alliance contract for large, complex projects for the efficient use of resources, (2) focusing on the RM process and the decision by judging project difficulty level as large construction projects possess high risk and thus RM process needs more close attention, (3) making a well-balanced RM plan with regular tracking of the identified risks as it reduces the risk occurrence probability, (4) Having a well-balanced risk reserve cost in the final budget, (5) maintaining the risk workshop concept periodically to get and tract about any new emerging risk in order to have the project team well informed about those, (6) giving the risk tracking and managing responsibility to every person of the project team, (7) focusing on implementing RM performance measuring criteria to make sure efficient and effective uses of RM resources. Project managers must make sure a well-balanced RM plan and RMPM in order to get the desired project success. Even though every large project, nowadays, give utmost focus on the RM; RMPM must also get incorporated with those RM plan to get most efficient project result.

This research was performed using a qualitative approach where interviews were carried out. The Data was interpreted and analyzed, which can lead to subjective or biased interpretation. In both cases, interviews were taken from the project owner or manager, which may lead to limited information being revealed. Whilst an attempt was made to limit bias, it cannot be completely ruled out. It was also not possible to conduct more interviews because of organization's protocols. Additionally, being present with the project for a long time during the project's development and implementation phase might result in more effective observation and more accurate results. Furthermore, the empirical analysis of this research only concerned on construction projects. Empirical analysis of projects from different industry of different country might give different perspective. In this article, one of the case projects analyzed is only in the early phase of construction, this information about its RM performance measurement plan was limited.

For further improvement of this study, more case could be included for empirical analysis and compared to other complex projects, such as technological projects. Similar study could also be conducted including multiple international stakeholders, which may give a different perspective and reveal additional issues. Another scope might be to use both qualitative and quantitative approaches together to increase the reliability and impact of the study. Further research should continue, specifically, on developing RM performance management methods on complex projects as there is little study on this topic. Establishing specific and efficient KPI for measuring RM performance for construction projects would be another scope for further research.

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