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Risk Assessment Tool for Software Project in Malaysian Public Sector

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Abstract: Software products and services are designed and developed in software project that utilize large amount of resources. Risk assessment is an essential activity for software projects to achieve project's objectives. Quality of risk assessment process could affect the quality of the delivered project or worst it will lead to a project failure. In Malaysian public sector, Information Communication and Technology (ICT) has been rapidly utilized as an enabler to modernize service delivery via multiple electronic channels. This study aims to identify the relevant criteria (variables) in risk assessment and to design and implement a risk assessment tool, specifically tailored to Malaysian Public Sector Software Project. The study were performed through exploratory research methodology focuses on qualitative risk assessment in risk management capacity. The focus group was employed to imply the public sector risk assessment variables for software project. An interview session and discussion with focus group were conducted to gather the requirements in order to achieve our aims. The outcome of this risk assessment tool is to produce risk report table consist of risk probability, risk impact and risk score. The risk assessment tool proposed is believe to be useful in speeding up the process and also to assist the decision making process in risk management area. As for future researches, we are planning to further our study on the complete process of risk management for software project in Malaysia public sector. Investigation of risk assessment should take the complete process of risk management into consideration of performing good risk management tool.

Key words: Risk management for software project, qualitative risk assessment, risk assessment tool, identify, resources

INTRODUCTION

Software products and services developed by organizations are designed and developed in software projects. This utilizes large quantity of resources such as time, cost and human. As define by Project Management Body of Knowledge (PMBOK), project is a temporary endeavour undertaken to create a unique product or service or result for organizations after completion. While project management is the application of knowledge, skills, tools and techniques to project activities in meeting project requirements. It is important to impose good practices for project management, in order to ensure the successfulness of project and avoid unnecessary substantial waste of resources.

Risk is a probability or a threat of damage, loss and other negative situation that causes a negative impact (Boehm, 1989). Risk assessment is an essential activity for software projects for the accomplishment of project's objectives (Boehm, 1989). Low quality of risk assessment process could affect the quality of the project or worst it will cause a project failure. According to Standish Group, in their recently published Chaos Report on the status of the software development success rate, 29% are rated successful, 52% are challenged and 19% are failed project in the year 2015. The study was conducted on 50,000 software project around the world in the year 2015.

Align with Malaysian aspiration to become a high-income economy and an advanced nation by the year 2020, ICT has been rapidly expanded as an enabler to achieve these goals. The implementation of electronic government (e-government) in Malaysian public sector has evidenced the capabilities of modernizing service delivery via multiple electronic channels. This initiative of e-government is targeting to ensure all the civil services to be electronically available by the year 2015.

Malaysian Administrative Modernization and Management Planning Unit (MAMPU) had reported that a study (Nagiah, 2011) executed in year 2010 had discovered that some of outsource and in-house software projects are in the challenged and failure stage in the year of 2010 as shown in Table 1. Therefore, risk assessment is importantly needed to reduce risk of project failure in Malaysian Public Sector Software Project.

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Table 1: Malaysian Public Sector Project status in year 2010

Project status	In house development (%)	Outsource development (%)
Succeeded	63.1	54.0
Challenged	23.7	37.5
Failed	13.2	8.50

Consequently, previous study by Doraisamy *et al.* (2014) has listed top ten problems in software project development in Malaysian public sector as lack of standard development processes/methodologies to monitor the software project; overrun schedule; software projects are in challenging status; software projects do not meet customer expectation; overrun budget; software project do not have clear requirements and specifications; software project are less in quality; less involvements from user/client in the development process; misunderstanding between developer and the project manager and 10 lack of effective monitoring and control of software projects.

There are loads of effort required in risk assessment process from the project team members, stakeholders and especially risk experts. Traditional risk assessment methodologies provide standards and guidelines but manually conducted by risk assessment experts and domain experts. Frequently, in software projects, the risk assessment process is performed manually by humans via gathering information from the stakeholders through discussions, meetings, interviews or brainstorms. The amount of variables that should be considered for proper risk assessment is depending on the size of the project (Wickboldt *et al.*, 2010). Risk assessment processes might take a lot of time and resource consuming task than expected. The risk assessment process also varies accordingly to risk and domain expert experiences and these require additional activities and possibly leading to more resources consume.

The scope of this study is on Malaysian Public Sector Software Project focuses on qualitative risk assessment in risk management capacity. Requirements gathering and analysis were performed through exploratory research methodology. The focus group was employed to imply the public sector risk assessment variables for software project. The risk assessment tool design is grounded by the guidelines and standard of Project Management Body of Knowledge (PMBOK). The tool developed will generate up to the expected value of risk that might occur in a software project and will recommend risk response to mitigate the risk.

Risk management: PMBOK defines risk management as a process of identifying potential project risks, assessing the probability and severity of risk events and planning responses for the most important risk events. Project tracking system is commonly used to assess risk. For example, IBM Rational team concert software which can manage risks and eliminates the need for an external risk management tool. Project tracking system supports software development life cycle in several phases by strengthening the collaboration of team and tasks; frequently used as a repository that stores software development related objects such as source code, tasks, documents and test cases.

Mostly used risk management process or standard are Capability Maturity Model Integration (CMMI), PMBOK, PRojects IN Controlled Environment Version 2 (PRINCE2), IT Infrastructure Library (ITIL) and IEEE Standard for Software Life Cycle Processes (risk management). In the context of Malaysian Public Sector Software Project, PMBOK and PRINCE2 are widely used. A comparison of PMBOK and PRINCE2 (Karaman and Kurt, 2015) discovered that PRINCE2 is preferable for small size software project while PMBOK is better applied in software projects with high user involvement, larger project teams, high level of outsourcing, comprehensive contracts procedure and highly involve stakeholder engagement. Based on these studies, we decided to choose PMBOK as the standard of our risk assessment tool to suit into public sector software project environment.

The knowledge area of software project risk management incorporates planning, identification, analysis, responses and monitoring of risks. PMBOK segregates this process into six processes as shown in Fig. 1. Risk Identification process determines the risks that might affect the project and records the risk characteristics. The process of identifying risk are conveyed through brainstorming, interviewing or creating checklists based on data or information from previous similar projects. Risk Register is a table used to record list of identified risks, potential responses, root causes and risk categories that were captured from risk identification process.

Qualitative risk analysis is a process of assigning priorities for treatment of identified risks using their probability of occurrence and corresponding impact on project objectives of cost, time, scope and quality of products. These processes require an analysis by risk expert and domain expert. The process continued by Quantitative risk analysis where numerical ratings are estimated for the effects of high priority risks aiming to guide the efforts and intensity of response planning. This

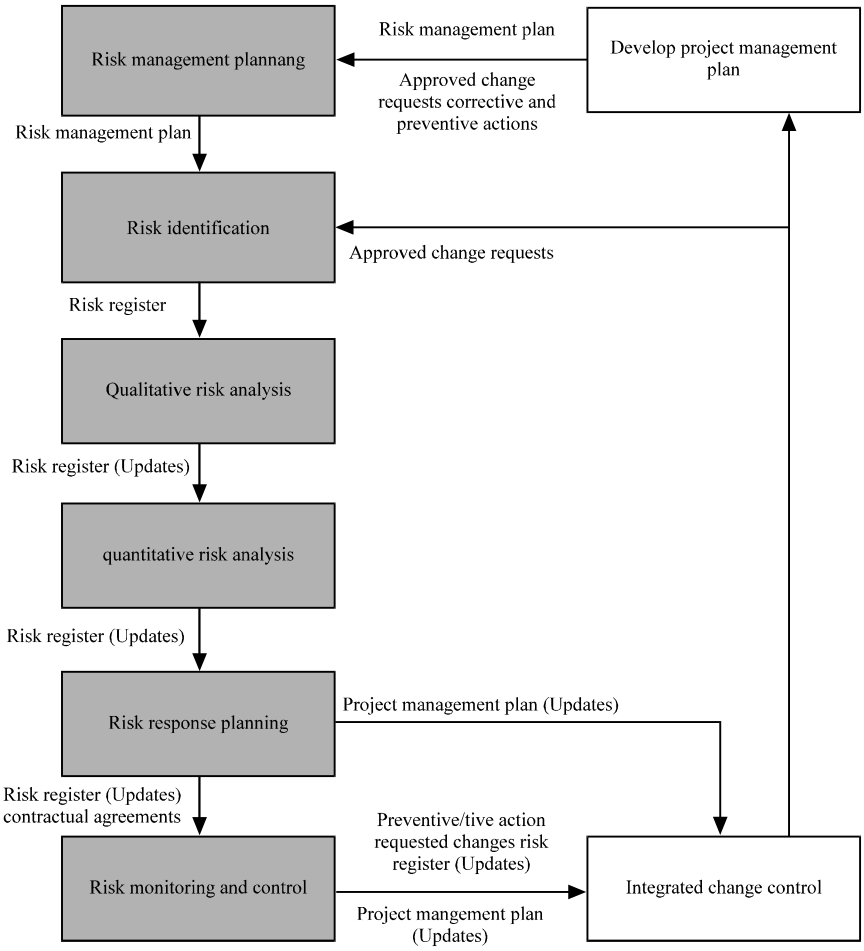

Fig. 1: PMBOK risk management process

is an advanced analysis where data mining techniques such as Bayesian modelling and simulation techniques were applied to generate risk rating. Based on the result, risk management team will prepare risk response plan. The plan will be documented all options and actions to be taken if risk occurred to reduce threats based on qualitative and/or quantitative analysis done earlier. Risk monitoring and control will keep tracking of the identified risks and uncover other newly risks.

Risk assessment

Risk assessment tool: Risk assessment in software project is often performed by calculating two factors: the probability of risk events occurrence and the impact that caused by these events on the project objectives. A computer generated system or software tool could facilitate risk assessment process that usually performed by humans. This could be done by calculating both factors using data and information from a project database. The concept of project database or repository is significant in organizing information in a comprehensive report. This report generated by the risk assessment tool will assist the project managers on decision-making concerning generally to risk management and specifically in risk response activity.

An automated risk assessment framework based on CMMI standard (Choetkiertikul *et al*., 2014) had been constructed to identify risks by analysing the quality of project management using the CMMI qualitative analysis. Data item in a project tracking system are classified into reasearch items (activity, process, change request, issue, requirement, review) and work products (describes a product produced from a research activity). The framework has four main components: Project repository extraction engine (PMR); The rule configuration tool; The calculation of the quality of process based on the defined rule and the process maturity dashboard to view he risk assessment results.

In computer-generated comprehensive risk assessment for IT project management (Wickboldt *et al*.,

2009), probability of risk occurrence is calculated per activity in each research plan of a project in four steps: Search for executions of similar activities in the database of previously project; calculate Risk Affinity (RA) among activities; count number of executions and events affecting objectives using log records and calculate probabilities of risk occurrence for selected activities weighted by their RA values. Then, the impact value estimation will be calculated using almost the same steps as probabilities calculation.

Risk factors in software project: Previous studies have proposed that risk is a complex construct, consisting of many components. The software project had six dimensions: team, organizational environment, requirements, planning and control, user and project complexity (Wallace *et al*., 2004). For high risk projects, requirements risk, planning and control risk and organizational risk are categorized into the most prominent risks whereas for low risk projects complexity is the most prominent. Based on our literature study there are many factors that contributed to the software project risk. In order to narrow down the risk factors for our study purpose, we did a comparison of risk factors from other researchers to identify the most common risk factors in software project.

Qualitative risk analysis: Qualitative risk assessment provides an estimation of the risk severity in a software project. By doing risk assessment, a project manager can manage risk effectively and allocate sufficient attention to significant risks that require high prioritize in risk response to prevent project problems in the future. Qualitative assessment of risks, usually take less time and resources than quantitative analysis.

Risk are identified and managed starting in initiating and are continually kept up-to-date or added to while the project is underway. The Project Management team look at what has happened on the project, the current status and what is yet to come and reassess the potential threats and opportunities. Risk identification is done manually through many techniques such as brainstorming, documentation review, SWOT analysis or combination of many techniques depending on the project.

A study on Malaysian government risk management guidelines and accomplished to discover the qualitative risk assessment used by MAMPU in the MAMPU Risk Management Plan (MaRISK) Version 2015. The risk management process of MaRISK is depicted in Fig. 2.

There are five components in risk management process defined by MaRISK: Risk contexts definition to define and identify the organization and project environments, characteristics, dependencies and stakeholders, their goals and objectives and the scope

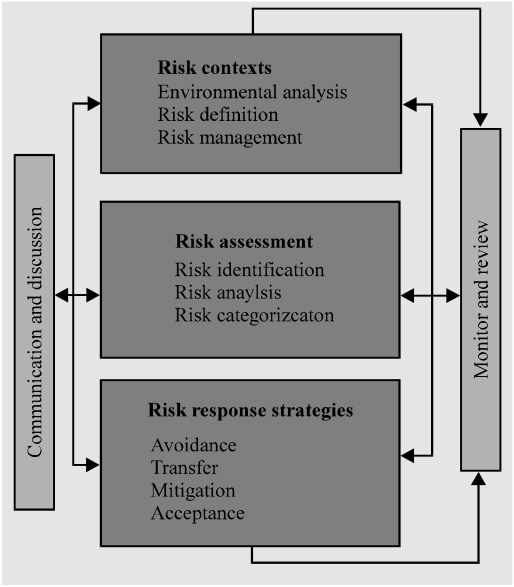

Fig. 2: The risk management process of MaRISK

and boundaries of the specific risk management process; Risk identification are best identified through a collaborative approach involving a wide cross study of stakeholders in the project and recorded. All project team members are responsible for identifying new risks or potential risk; risk response strategies; after the risks have been qualified and quantified, the project team will develop approaches to handle these identified risks by analysing various risk-handling techniques and selecting those best fitted to this project's circumstances. For identified risks, the project team will develop strategies to handle and manage the risks; communication and discussion with team members and stakeholders are needed to ensure all risks are being identified and handle in a proper action as planned and monitor and review process involves tracking of new risks, constantly reviewing existing risks, monitoring trigger conditions for high impact risks as well as reviewing the execution of risk responses while evaluating their effectiveness.

The severity of any software project risk can be defined in terms of two quantities: Impact, the effect that a risk will have on the project if it occurs and probability, the extent to which the risk effects are likely to occur. Upon completion of assessing the probability and impact of the risks in project, the risk will be prioritized based on the probability and impact of the risks. A risk matrix is an effective tool for determining risk priority. The higher rank should be deal with urgency than other lower rank.

MATERIALS AND METHODS

The methodology used to carry out the proposed solution which involve six different phases: Theoretical study; requirements gathering and analysis; prototype development; collecting test data; prototype evaluation and writing report. We constructed a questionnaire from literature review. A focus group consists of experienced software project team members from public sector's project management team and vendors participated in an interview sessions composed of open-ended questions. In order to investigate risk factors and challenges in Malaysian Public Sector Software Project, we conducted our requirements gathering and analysis in two stages: firstly, an interview session with our participants from project management team, sec we did a discussion to refine the finding in stage one. Our participants consist of five members from various government agencies and four members from vendor who involved in project management. Targeted participants are those who has involve in high impact project and has >5 year experienced in software project. Data gathering were done through implementing the focus group approach in two stages. The first stage involved interview session with all participants that aiming to obtain the top 10 risk and to understand the current risk management process in public sector software project. The questions for interview is adopted from literature review and edited to suit the Malaysian public sector environment. The sec stage is done through a discussion with public sector participants to refineand clarify variables for risk in software project and to clarify on software project governance and structure in consideration of reaching the understanding of our finding in the earlier interview session.

The test data were collected randomly from public sector's software project consists of datasets of risk list from three high impact projects. The prototype evaluation was done to ensure the correctness and effectiveness of prototype itself is well designed and implemented. Measurement criteria are: efficiency time needed to produce project risk value and effectiveness to compare result with real project risks.

Requirements analysis: We accomplished to refine the top 10 risk event, determined the scales of risk probability, risk impact, risk degree, risk matric, project organization chart and recommended risk response classification. End result of our discussion is provided in Table 2: Top 10 Risk Event in Software Projects at Malaysian public sector, Fig. 3 shows the software project organization chart and Table 3 recommended risk response classification.

Table 2: Top 10 risk event in software projects at malaysian public sector

Risk rank	Risk event
1	Project scope and user requirements changes/ not clear
2	System functionality do not meet customer expectation
3	Lack of system owner (top management or user) involvement
4	Overrun project schedule
5	Complex architecture and high number of implementation modules
6	Overrun project cost/budget
7	Ineffective communication with project members
8	Ineffective monitoring and control during project
9	Software less in quality
10	Technical issues

Table 3: Recommended risk response classification

Recommended risk response	Risk degree	Scale	Description
Avoid	Extreme risk	13-25	Eliminate risk changing project plan
Transfer/mitigate	High risk	8-12	Change project plan and provide transfer of riske to another
Mitigate	Moderate risk	4-7	Make changes to the project plan to reduce probability
Accept	Low risk	1-3	Accept the risk and prepare for contingency plan/reserve resiurces (fall back plan, cost, schedule, system performance)

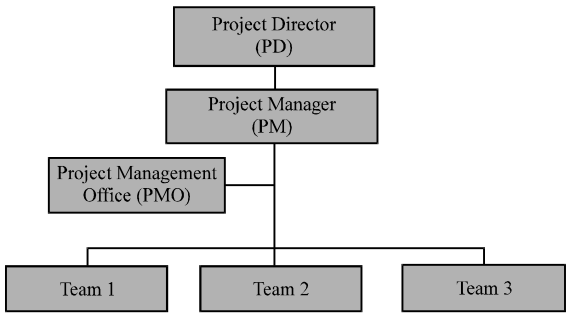

Fig. 3: Software project organization chart

RESULTS AND DISCUSION

Tool evaluation: We designed and developed a web based tool for software project risk assessment for Malaysia public sector namely software project risk assessment tool or known as mySPRAT. Real data from Malaysian Public Sector Software Project were used to evaluate our tool. We have acquired actual risk list from three high impact software projects for the tool evaluation purpose. The software projects are: Test data 1-3. There are two criteria for our evaluation of mySPRAT: Tool efficiency time needed to generate project risk value, risk ranking and recommended risk response and tool effectiveness to compare result generated by the tool with real project risks. Result analysis for these three test data is expressed in Table 4.

Table 4: Result analysis of test data

Test data	Effectiveness	Efficiency
1	Recommended risk response for all risk events (Mitigate) = Risk mitigation in real project risk	Risk ranking and risk degree is automatically calculated Recommended risk response is automatically generated
2	Risk response for (1) and (2) (mitigate/transfer) slightly different than risk mitigation in real project risk (it's a combination of mitigate and Accept) Risk response for (3) and (4) (mitigate) = Risk mitigation in real project risk	Risk ranking and risk degree is automatically calculated Recommended risk response is automatically generated
3	Recommended risk response for all risk events (mitigate) = Risk mitigation in real project risk	Risk ranking and risk degree is automatically calculated Recommended risk response is automatically generated

Result analysis portrays that the efficiency of the tool is high compared to manual calculation for risk degree and risk ranking. Manual process for getting the risk ranking and degree requires project manager to calculate risk score by multiplying risk probability and risk impact and then need to manually refer to the risk matric for the designated risk degree. The mySPRAT risk response is generate automatically mapped to the risk degree. Traditionally risk response is done manually based on the decision made by risk expert subject to their experience and knowledge.

The result analysis for effectiveness of mySPRAT for test data 1 and test data 2 is high because the recommended risk response is 100% accurate. There are slightly different risk recommended response for item 1 and 2 in the test data 2 compared to the actual risk response. Risk response for (1) and (2) is mitigate/transfer while risk response in real project risk is a combination of mitigate and accept. This is happened since there is more than one risk response for the same risk event created. As for the risk response were intended to has different risk action/response indeed to established an option of risk response for the risk event. The evaluation of mySPRAT has shown that the proposed tool is high in effectiveness and efficiency. The tool is beneficial in supporting risk management process as it is useful in risk assessment as it is a time saver solution and helpful in decision making of risk in software project.

As we did our study on current risk management practices in Malaysian Public Sector Software Project, there are some findings that importantly needed an attention for enhancement. The findings are: risk management activities were done manually and subjected to the expertize of the project management team; no guideline provided for government agencies to uniform the risk management process; The risk assessment process were not done in a full cycle process since the monitoring and review part was not done from time to time and the record of risk document did not properly manage and it leads to missing of important data of risk for future references.

CONCLUSION

This study has introduces a new tool for software project risk assessment for Malaysia public sector namely Software Project Risk Assessment Tool or known as mySPRAT. The objectives of this study to identify the relevant criteria in risk assessment for software project in Malaysian public sector and to design and implement a prototype in assessing the software project risk using the identified variables has been achieved by introducing mySPRAT. The tool is a web based that can be used by project team member remotely and provide repository for the software project documentation.

Risk assessment tool proposed is believed to be useful to speed up the process of risk assessment for Malaysian Public Sector Software Project. The contribution of our study could benefited project management team in supporting decision making in risk management by organizing and automating calculation of risk value. The findings should promote awareness on importance of risk management activity in software project to reduce risk of project failure in Malaysian public sector.

The constraint of time and resources limit us for further investigation of our proposed tool. We are hoping to continue our study on Risk Assessment Tool for Public Sector Software Project with solid evidence to improve our tool.

RECOMMENDATIONS

As for future works we are planning tofurther our study on the complete process of risk management for Software Project in Malaysia Public Sector. Investigation of risk assessment should take the complete process of risk management into consideration of performing good risk management tool. A case study on software project successful factor and failure factor should be done to further investigate the risk factors that lead to project failure. We are hoping to fulfil the gap of risk management in Malaysian Public Sector Software Project by doing a further study on risk management. Our

main intention is to propose a framework for Risk Management of Software Project in Malaysia Public Sector.

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