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Implementation of a risk management simulation tool

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Abstract

Risk management is an essential part of project management. Proactive management of risk in projects helps increase the success rate of projects and the reduction of potential costs. The paper presents a new tool for implementing the risk management process in projects. The tool allows participants to understand a project further, and to analyse risks in a project using various methods such as risk exposure and Monte Carlo method. From the results of the study, the tool helps in improving the understanding and implementation of risk management in projects. The tool implementation and results are discussed in this paper.

1. Introduction

A risk is "*an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives*[1]." Mitigating risk in a project increases the likelihood of success in that project. Tsiga et al. [2] have highlighted the importance of risk management in projects. The management of risk can prove to be difficult for

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inexperienced project managers. This can have a knock-on effect on the delivery of a projects with respect to its objectives [3].

In general, the risk management process consists of 6 phases[4]. These procedures are incorporated into a project and are performed iteratively until the end stage of the project lifecycle. Various techniques and tools are continuously being developed with the aim of supporting and enhancing risk management activities.

Risk management techniques have always been incorporated into projects, but a large majority of projects still surpass initial cost and time estimates [5]. Various tools have been developed from academia to better understand this and to support in the management of risk. Such tools include SCRUMIA[6], SimSE[3] and ARMI 2.0[7].

ARMI 2.0[7] is a piece of risk management software that educates players on the risk management process. The participants are grouped into teams where each team makes decisions based on a limited budget. The tool provides gamers with an already established set of risks that could occur in IT projects. It randomizes the possibility of a risk occurring in a project and each risk has a predefined cost on the hypothetical project. The aim of the game is to help the participants minimize their expenses during a project. On the other hand, SimSE[3] and SCRUMIA[6] are games that focus on teaching the technical elements of software development without highlighting risks and their importance.

The current tools provide insights on risk management and its element, but they tend to focus on software development and do not provide sufficient focus on risk and its management in generic projects. These tools tend to be more of a teaching exercise and are difficult to incorporate into real life projects. Tsiga et al.[2,8] have highlighted the importance of risk management in projects and the need for a tool that eases understanding and implementation of risk management in projects.

The risk tool introduced in this paper provides a solution for this. The tool is built in a way that helps the user to identify the type of project they are working on and give some suggestions on how to accomplish such a project. It also provides templates for standard risk registers that calculate probabilities and causes. The tool then goes further by allowing users to perform various risk simulations on all or partial lists of the identified risks in the table.

2. Methodology

In building the risk management tool, an iterative approach was implemented. This allowed the tool to be built in chunks and eased the development process. Various software development packages were used during the development process. The tool was developed using the Java development kit to handle the back-end logic and HTML to handle the front-end interface and to display the results. The tool implementation is discussed further in Section 3. The tool employs the Obeng project classification[9] to help users in further understanding their projects and various quantitative risk assessment methods such as the risk exposure[10] and the Monte Carlo simulation[11] methods.

Once the application was completed, it underwent various testing to ensure the integrity and quality of the software. The tests carried out on the tool include unit, integration and system testing. After these tests were completed, the tool was trialed with project participants in the petroleum industry. This trial was carried out in a closed room meeting with 21 project participants. The entire process of introducing the tool and demonstrating it took approximately 2 hours. Once completed, the participants answered a quick questionnaire designed to get their perceptions of the tool.

3. Tool implementation

The tool is designed to allow users to run the application easily from any internet browser, and this was done to ensure compatibility with different operating systems. Once users execute the application, they have the capability to run through it. Figure 1 shows the context diagram of the risk tool from the user's point of view.

In the first step, users are required to answer a few questions. These questions are used to gather generic information about the project currently ongoing. The questions are based on the Obeng project classification[10], and questions about the project budget, management reserve (for unknown risk) and contingency (for known risk) are also asked in this section. Once all the questions have been answered, users are then taken to an advice page. This page gives suggestions about the project. The recommendations generated are based on the Obeng project type. Figure 2 provides a screenshot of the kind of advice given to users after answering the questions.
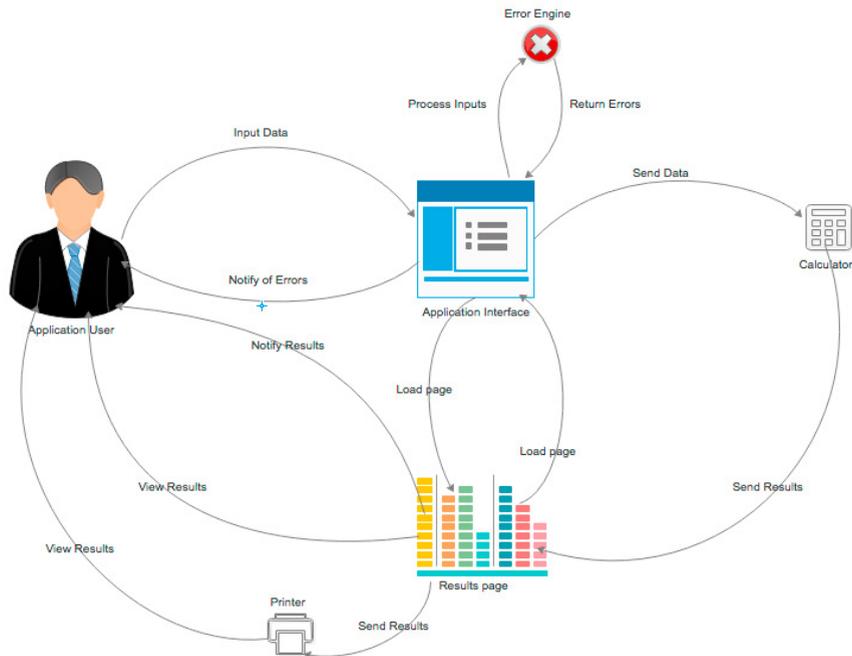
Fig. 1. Risk tool context diagram.
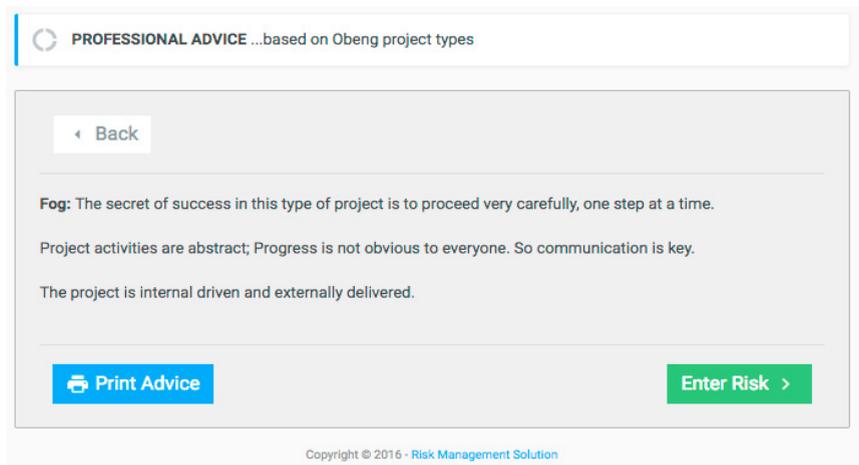
Fig. 2. Tool advice (after answering questions).

In the second stage, users proceed to where they can input individual risks that could affect the project in a risk table. Here, users input all the relevant information on each risk that could occur in a project. After all the risks have been entered, the tool calculates the risk exposure (probability*impact) for each risk and then sorts the risks in descending order. Once completed, users can enter numerical information on each risk, and this information is based

on the iron triangle (quality, time and cost). The data input range that can be put into each aspect of the iron triangle is 1 to 5. This would give users the capability to depict the information entered in the iron triangle aspect as a radar diagram. An example of the radar diagram is shown in Figure 3.
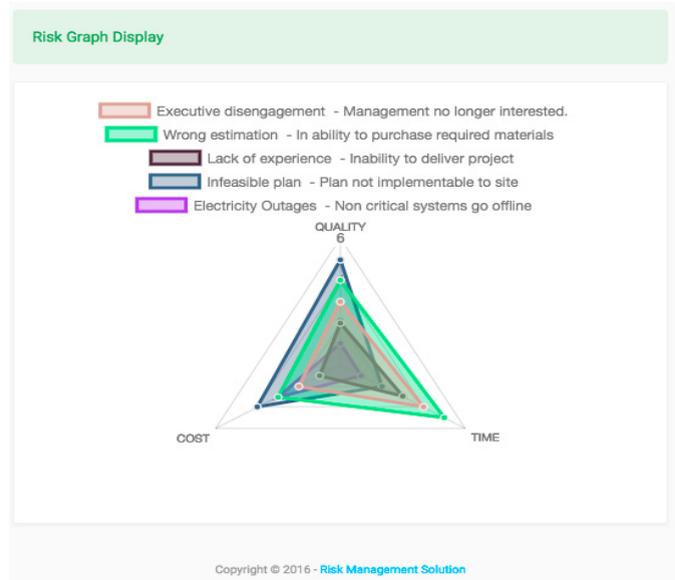

Fig. 3. Radar graph (of the risks identified in risk table).

In the third stage of the application, users are presented with a risk table. Here they can enter their mitigation options for each risk, the numerical cost of the risk, the schedule (days) and the probability (0<x<1) for each risk. Once all the relevant information has been entered, users can select the precise risks to be included in the simulations. Figure 4 depicts the risk table at this stage.

Fig. 4. Risk table.

Once the risk table has been completed as shown in Figure 4, the users have two options. The first "Risk Simulation" allows them to perform/implement the Monte Carlo method on the risks selected. The method is implemented with 1000 iterations and the calculations are performed on the duration and cost. An example of the results can be seen Figure 5 and Figure 6 respectively. The second "Project Expenditure" also implements the Monte Carlo method on the numerical cost of the risks involved but also considering the project base cost. Figure 7 depicts the results of the project expenditure. This option does not include the calculation for schedule because of the added complexity of knowing if a risk would affect part of the project deliverable that is on the critical path or not.

Finally, once users view the graphs, they can decide to deselect or reselect risks to include in new graphs or even go back to the previous table to modify it for re-calculation.
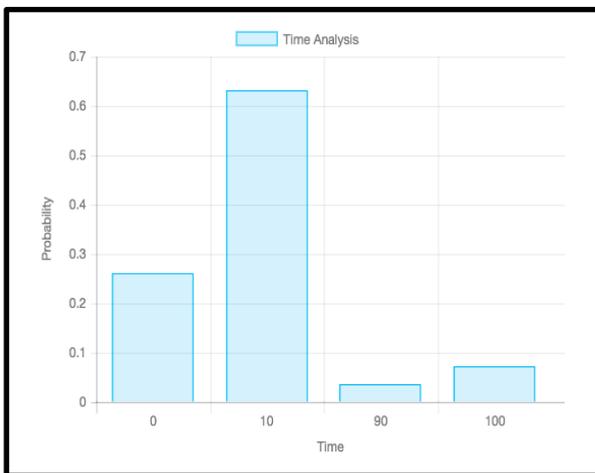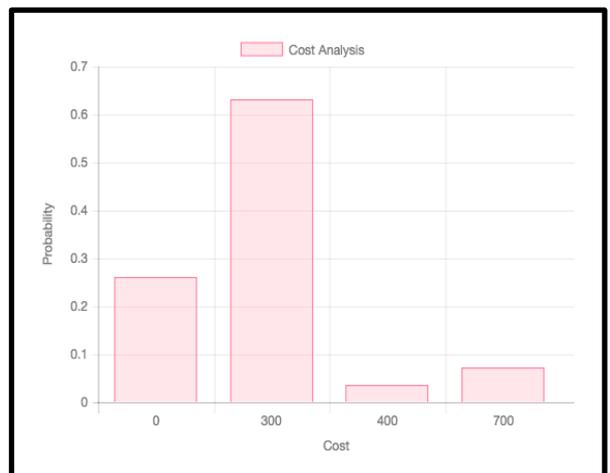

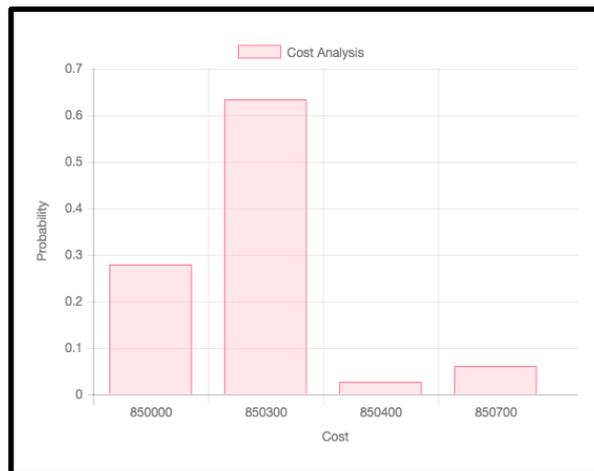Fig. 5. Schedule risk simulation

Fig. 6. Cost risk simulation

Fig. 7. Project expenditure risk simulation

4. Conclusion

The risk management tool is an innovative tool which is aimed at improving the understanding of risk management and its implementation in projects. Its novelty comes from the simple yet effective way in which data is presented to users, coupled with the advice (based on Obeng classification) for identification and management of risk. Users must answer questions before they proceed to the risk identification stage. Once the questions have been answered the tool provides feedback on the type of project they are working on.

Once the first stage is completed, users proceed to the risk identification stage. This allows them to perform various analyses and evaluations of a group of risks or an individual risk. In the analysis stage, various calculations can be performed to calculate the risk exposure of certain risks on a project. The tool is designed in a simple and easy to use manner and is not limited to implementation to a specific industry.

Based on the results of the survey, discussions and observations, 80.9% of the respondents believe that the tool does assist them in understanding the project they are currently undertaking. The tool further provides an excellent set of risk evaluation and quantification techniques not only by performing calculations but depicting the results in graphs to ease understanding of the risk exposure on a project.

The respondents of the survey also gave some recommendations for improvement of the tool, their recommendations have been noted and would be included in the second version of the tool currently being developed.

Acknowledgements

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