Implementing risk management in software projects

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ABSTRACT. The paper presents a tool supporting risk management in software projects. It provides some details of the functionality, user interface, design and implementation of the tool. It also reports on an experiment that was carried out in order to provide an early feedback on the usability of the tool.

INTRODUCTION

Software projects are exposed to various risks where risk is understood as a possibility of loss, damage or disadvantage. Essential features of a risk are that it brings about negative consequences and that there is a degree of probability that these negative consequences come true. The risks related to the whole project are defined in relation to project goals. The goal of any project is to deliver, in time and within the budget constraints, a product that meets client's needs and expectations. The essential factors of the project success are the quality, the time and the budget [Van Scoy 92]. In the essential project aspects, the lack of risk management results in schedule slippage, budget overrun, unsatisfactory quality of the product, failure to accomplish company business goals of the project and disappointment of the employees and breakdown of their careers. More information on a general approach to risks can be found in [Galagher 99, Rosenberg 99, Van Scoy 92, Gorski 2000].

Present software projects are often facing expanding and changing client demands and are put under schedule pressure. The systems are growing in size and become increasingly complex. To shorten the development time the systems are built out of reused (but often not reusable) components. The personnel turnover is high and the size and diversity of project groups are growing. Consequently, despite of the progress in technology, the software engineering project management still faces similar problems as twenty years ago [Brooks 95]. The requirements are not defined precisely which results in constant expansion of the system scope or even in rejection of the final system. The involvement of people is relentlessly adding the factor of human mind and personality to the technical difficulties of the project. The resulting software is constantly error-prone, the co-operation among the project members is often poor and the expectations of the clients are not satisfied. Altogether, it calls for some significant improvements to the software engineering process. One of such innovative approaches is called *risk management*.

Risk management means that we change our attitude towards risks. A project without risk management faces serious problems only after the risks came to the surface as a material fact (the deadline is not met, the budget is overrun, the quality is poor). Then, the only thing to do is to strive to minimise the negative influence of the consequences of those facts on the project. The reaction is always expensive and time-consuming. A project with risk

management aims at early identification and recognition of risks and then actively changes the course of actions to mitigate and reduce the risk. This requires open communication, forward-looking view and team involvement in the management and the knowledge base of typical problems. The lack of these exposes a project to a great risk of failure [Higuera 94].

Much work on risk management has been already done at the Software Engineering Institute [SEI]. The generic risk management methodology tailored to the specific environment of a software engineering project was transformed into five recurring phases [Van Scoy 92, Sisti 94, Higuera 94, Higuera 96, Rosenberg 99]. The subsequent phases cover following the risk management aspects:

- Risk assessment:
  - identification,
  - analysis
- Risk mitigation:
  - planning,
  - tracking,
  - controlling
- Communication.

The process starts with the identification of existing risks. Once the risks are identified, they are evaluated and prioritised and then appropriate corrective actions are planed and executed. To reach the acceptable level of success guarantee, the introduced actions must be controlled and the risks in mitigation must be continuously tracked for their status. This process continues throughout the project schedule and across all the phases of development.

The risk management paradigm defines a set of continually performed activities that are based on communication among the project participants including all the project members, the customer representatives and the upper management of both, the developer and the customer's organisation. The cost and effort of these activities must be smaller than the estimated profit from the successful risk mitigation. To reach the desired 'return of investment', the risk management efficiency may be increased by means of computer-based tools.

This paper describes a tool, named ΘRisk Guide, implementing risk management in a software project. The paper details the usage of the tool, provides some design and implementation data and suggests possible applications. This is followed by the presentation of a validation experiment. In conclusion we present plans of further extensions of the tool.

THE SYSTEM

ΘRisk Guide is a pilot implementation of an experimental risk management tool. The goal is to have an environment where we can experiment with various risk management strategies and techniques. Presently the tool offers support mainly in the risk identification phase. In general, it is built upon the concept of project reviews that are aimed at gathering risk-related information from project members. The result is the list of identified risks summarising the input collected from all the project members. This way the tool supports communication of risk information within the project.

The most advanced support of ΘRisk Guide comes from the automatic risk identification based on the answers to the checklist questions. The system offers a knowledge base of checklists that are related to the lists of common risks. The knowledge base is hierarchically structured that facilitates choosing checklists that are relevant to the viewpoint of the particular user. The tool is designed to support many members of a project and multiple projects at a time with independent risk identification. All those projects are sharing the same knowledge, however.

ΘRisk Guide records and maintains information on:

- projects developed at the time,
- system users (both members and non-members of the projects).
- reviews of risk at certain point of the development,
- risks identified during the review.

Users of ΘRisk Guide take different roles in the risk management process. They can be divided into the following categories:

Administrator	–	The supervisor of the system, who manages user accounts.
Risk Manager	–	The manager of the risk management process, who edits project and review data, assigns the other roles to people and evaluates identified risks.
Project Member	–	A project member that, through checklists, supplies risk related information.
Non-member User	–	Any user. He/she can browse the knowledge base of checklists and risks, read project descriptions and get the information on risks identified during reviews.

The system implements some access control mechanisms. The Administrator, Risk Manager and Project Member users are subjected to the authentication process (password based) whereas Non-member User identities are not controlled (note however that the latter are restricted to read-only access).

The general scenario of ΘRisk Guide usage includes:

- registration of system accounts for all the users by the Administrator,
- registration of a project by Risk Manager,
- opening a review by Risk Manager,
- answering the checklist questions by Project Members followed by automatic risk identification,
- closing the review by Risk Manager,
- evaluation of identified risks by Risk Manager,
- selection of the highest priority risks by Risk Manager.

More details on the present version of ΘRisk Guide can be found in [Miler 2000].

USE CASES

ΘRisk Guide functionality is detailed with the help of use case diagrams. The collection of use cases is presented in Fig.1. The actors represent different roles as defined in the previous section.

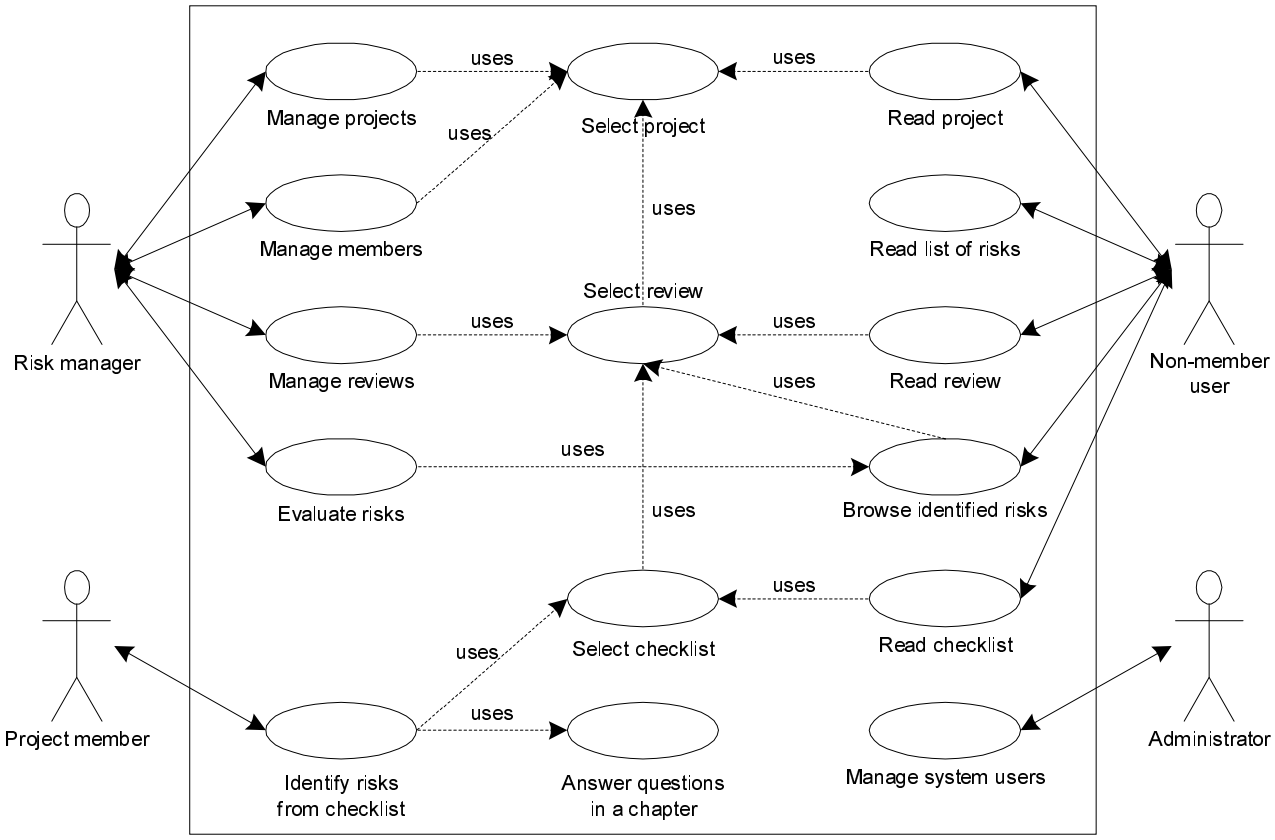

Fig.1. The use case diagram of ΘRisk Guide

The scope of the Risk Manager use cases is as follows:

Manage projects – Defines a new project; Selects a project; Edits the description of an existing project; Closes a project; Continues a closed project; Deletes a closed project.

Manage members – Selects a project; Assigns non-member users to the project; Dismisses project members; Appoints another manager a risk manager of the project.

Manage reviews – Creates new review; Selects an active project and a review; Closes a review; Reopens a closed review; Deletes a closed review.

Evaluate risks – Risks are selected from the list of identified risks in a selected closed review of a given active project. For each identified risk, provides the evaluation of its possibility, severity and timeframe. The overall risk evaluation is calculated from the evaluation matrix. A risk can be re-evaluated at anytime.

The scope of the Project Member use cases is as follows:

Identify risks from a checklist – Chooses an open review and an active project; Chooses a checklist, browses it in the review mode and selects a checklist chapter.

Answer questions in a chapter – Provides answers to the questions of the selected checklist chapter. Once the answers are accepted, the list of newly identified risks is displayed.

The scope of the Non-member User use cases is as follows:

Browse identified risks – Browses the list of risks identified in a selected review of a given project. The list is prioritised basing on the evaluation of risks the number of project members that identified the risk.

Read project – Overviews the description of a selected project.

Read review – Overviews the description of a selected review.

Read checklist – Selects a checklist; Reads the selected checklist from the knowledge base and/or the list of risks linked to each particular question of the checklist.

Read list of risks – Reads the whole list of risks registered in the knowledge base.

The scope of the use cases common to all the users is as follows:

Select project – Selects a project from the list of active or closed projects registered in the system.

Select review – Selects a review from the list of open or closed reviews registered for a selected project.

Select checklist – Selects a checklist from the list of checklists registered in the knowledge base.

The scope of the Administrator use case is as follows:

Manage system users – Creates user accounts Edits existing accounts; Enables and disables accounts; Deletes accounts.

USER INTERFACE

The user interface of ΘRisk Guide is a set of ASP web pages accessed with an Internet browser. Example pages are presented in Fig. 2-5.

The most complex data structure is a checklist. It is implemented as a hierarchic construct with the top item being the checklist itself. The checklist consists of many 'hierarchy classes' being the chapters, subchapters and points. The structure is recursive, so its depth is not limited by the design. Each 'hierarchy class' contains questions that form another recursive data structure of sub-questions with no design-defined limit. Each question has a set of answer alternatives assigned to it. The risks stored in the knowledge base are also structured using the concept of recursive 'hierarchy classes'. The contents of the checklists and the risk lists are fixed – presently no modification functions are available to the users.

As for now, ΘRisk Guide knowledge base offers the SEI Taxonomy-Based Questionnaire [Sisti 94] as a checklist and Steve McConnell's Complete List of Schedule Risks [McConnell 93, McConnell 96] as a list of risks. Due to the flexible data structures, however, it is possible to extend the lists of checklists risks and to modify the relationships between them.

Fig.2. ΘRisk Guide Main Page

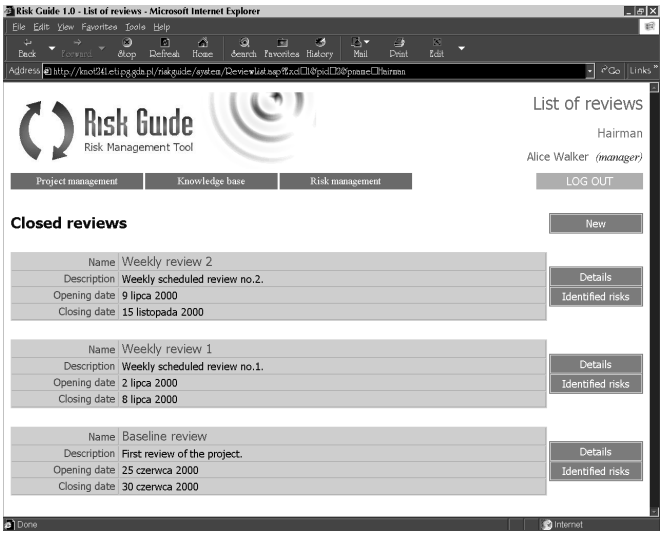

Fig.3. List of closed reviews in a project

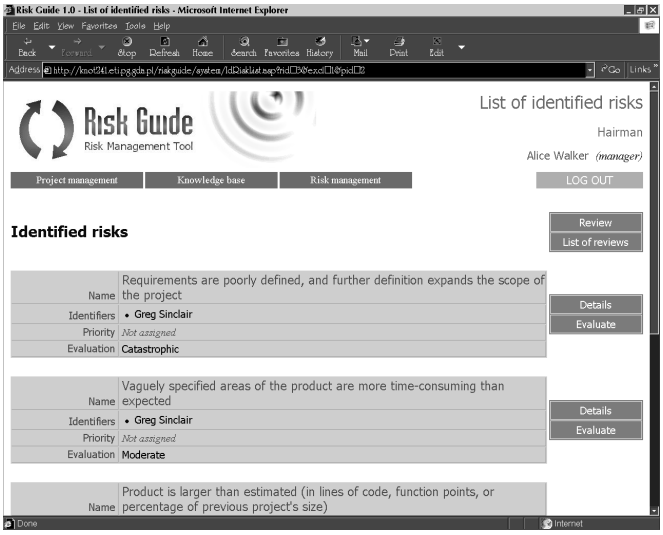

Fig.4. List of risks identified in a review

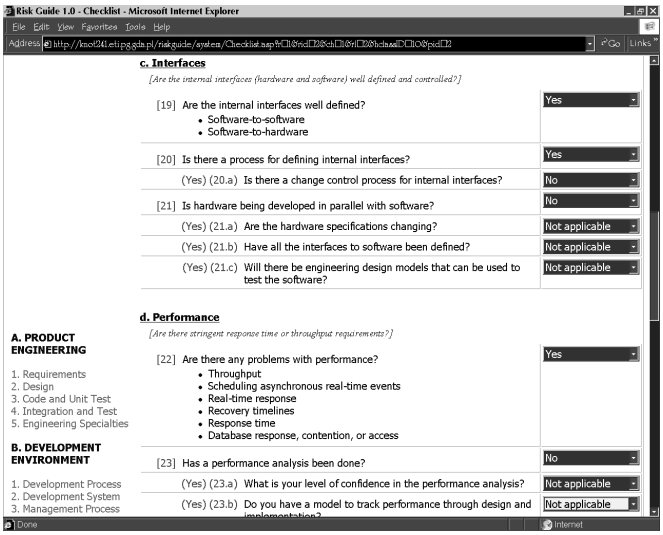

Fig.5. Fragment of a checklist chapter

SYSTEM DESIGN

ΘRisk Guide has the object oriented design and is implemented at the top of a relational database. This required that the data transformation layer – a database wrapper must have been implemented. Due to the wrapper concept, the database data structures are manipulated like objects from the user interface. It implies that the data records have their identities assigned resulting in object-like data editing functions. ΘRisk Guide provides object versioning and exclusion that ensures change traceability and modification rollbacks. The objects excluded from edition cannot be further modified and used in new references, but they keep the existing references intact. Further on, the excluded objects can be included back or deleted for good.

The system architecture conforms to the client-server model with one central server possessing and providing all the information and the user terminals connected via the network of any type. It is a universal approach suitable for local area networks and the Internet.

The ΘRisk Guide software architecture uses the three-tier distributed application concept developed by Microsoft. According to this concept, the applications are built at three levels: database, server components and interface. This concept is helpful in implementation of Internet applications. The technology used in the construction of ΘRisk Guide implies the following features of the system:

- encapsulation of data processing,
- limited software requirements for client workstations,
- multi-access,
- effective communication,
- open user interface,
- easy system updating and development.

VALIDATION EXPERIMENT

The experiment was planned and carried out in order to test the usefulness of the system in practical use.

In the academic year 2000/2001, ΘRisk Guide was used as a supporting tool during the course on Software Project Management at the Technical University of Gdańsk. The course was given to the students of Informatics, at the fourth year of study. There is a student project associated with the course. The project aims at the familiarisation with the selected project management activities such as effort estimation, project planning and system analysis. The students work in groups and their task is to practice effort estimation and project planning with respect to, in most cases imaginary, projects (6 of those projects were real, related to other courses). As the first step a group (of 3-4 people) worked out a project vision and elaborated a preliminary project plan. Then, they used ΘRisk Guide and practised risk identification. The output from the system (the identified risks) was then taken under consideration in the next step: the development of a detailed project plan.

The experiment constraints are given in Table 1.

Table 1. Experiment constraints

No. of groups	38
Group size	3 to 4 students
Range of projects considered by groups	3 man-months (3 persons / 1 month) ÷ 40.5 man-years (27 persons / 1.5 years)
Statistics of projects	22 projects of size from 10 to 40 man-months, 10 projects of size from100 to 250 man-months, 6 other projects
Duration of the experiment	10 weeks
Phases covered	Planning, Design
Tasks	• Prepare a preliminary project plan; • Identify project risks (answer TBQ questions, evaluate risks, select top 5 risks, describe top 5 risks, prepare mitigation and contingency plans for top 5 risks); • Elaborate detailed project plan.
Deliverables	• Preliminary project plan, • Risk management plan (list of identified risks generated by ΘRisk Guide); • Risk evaluation; • Detailed description of top 5 risks; • Mitigation and contingency plans for top 5 risks; • Detailed project plan.

To assess the experiment, a questionnaire was distributed among the students to gather their opinions about ΘRisk Guide and the effectiveness of its support. In total, questionnaires from 25 groups were collected. The questionnaire answers, scaled from 1 (poor) to 5 (excellent), provided the following results:

Table 1. Tool assessment

overall system presentation	3.94
readability of the user interface	3.80
ease of access to system functions	3.06
overall ease of use	2.82
system performance	4.42
system reliability	4.34

Table 2. Support assessment

better understanding of vulnerable project areas	3.45
pointing out potentially omitted problems	3.77
help in elaboration of more realistic detailed plans	3.24
increase of awareness and interest in risk management	3.03
acquirement of general knowledge on software engineering projects	3.99

Finally, the participants were asked if, in their opinion, the system could be useful in the risk management process of a real-life software engineering project. The answer was 3.29.

CONCLUSIONS

In this paper we pointed out to the importance of risk management in the course of software projects and to the need of tool support in this area. We presented a risk management supporting tool, detailing its functionality and the user interface appearance as well as giving some design and implementation details. The tool offers in particular:

- automatic risk identification from interactively answered on-line checklists,
- qualitative risk evaluation,
- taking into consideration the opinion of every individual project member,
- great communication support for distributed project teams,
- effective information sharing and distribution,
- support for many projects and reviews at a time.

We have also presented the results of a validation experiment carried out on a number of student projects. Although it is not enough to derive any definitive conclusions, the results of the experiment are in our opinion quite encouraging.

The following features are considered important for future development of the system:

- mitigation functions of risk management process: planning, tracking and controlling,
- further communication support (informal messages, impromptu risk identification and tracking),
- checklists management including modifications and introduction of new checklists,
- knowledge base of common mitigation activities,
- risk evaluation dependent on project size registered in the knowledge base,
- risk analysis tools with great visualisation capability and probability calculus support.

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