Top Ten Lists of Software Project Risks : Evidence from the Literature Survey

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Abstract—Software project risk management is crucial for the software development projects. It is used for project planning and control purposes during the project execution. Risk management will help reduce project failure. To mange software project risks, the first step is to identify a list of risks for checklist. Researchers have tried to investigate common risk factors and proposed the top ten lists of software risks. However, a number of top ten lists were suggested in the literature. This article compiled a list of top ten software risk lists reviewed in the literature. The results from the analysis reveal that planning and control is the dimension of risks which mentioned most and misunderstanding of the requirement lack of management commitment and support are the most frequent mentioned software risks. However, project managers may benefit from applying these results but have to aware of the factors affecting these results

***Index Terms*—software risks, top ten software risks, software risk checklist.**

I. Introduction

PM-BOK (Project Management Body of Knowledge) defines risk as: "an uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives." Whereas PRINCE2, the UK government sponsored project management standard defines risk as: "uncertainty of outcome." In all, risks are related to 2 key elements: future events, and may cause effects [1].

Software project risk management is a complex activity. It has to deal with uncertain events of the software project and their causes. To predict the uncertainty software risk is not easy. Many researchers have tried to overcome this obstacle by suggesting a number of lists of software project risks. The software project managers can use these lists as identification check lists to identify the risk that may relate to their software projects.

However, there are number of top ten lists in the literature. Then, the question are: which one is the proper list to use and what are the most common top ten software risks? This article compiled a list of top ten software risk lists reviewed from the literature and analyzed the findings to get the answers for these questions.

This article is organized as follows. Section 2 gives the review of software project risks. Section 3 discusses the findings. Section 4, discusses the limitations and the conclusion are given in sections 5.

II. Software Risks and the Top Ten List Reviewed

This section reviews software project risks and the top ten lists from the literature. There are several studies on software project risks since 1981 that suggest possible software risks.

In their recent experimental study, Han and Huang [2] gave a good review on software risk research. Risks were reviewed from 12 studies. Table I gives the details of the studies and risk reviewed from [2].

TABLE I
Summary of software Risk Research [2]

Author(Year)	Dimension of Risks	Number of Software Risks
McFarlan (1981)	3	54
Boehm (1991)	0	10
Barki et al. (1993)	5	55
Summer (2000)	6	19
Longstaff et al.(2000)	7	32
Cule et al. (2000)	4	55
Kliem (2001)	4	38
Schmidt et al. (2001)	14	33
Houston et al. (2001)	0	29
Murti (2002)	0	12
Addision (2003)	10	28
Carney et al. (2003)	4	21

Table II shows 27 software risks reviewed in [3]. They categorized software risks into 6 dimensions, namely user (U), requirement (R), project complexity (Comp), planning and control (P&C), team (T), and organizational environment (Org). These dimensions will be used for the discussion for the rest for this paper.

From table I, study of software risk has appeared since 1981. McFarlan [4] introduced three dimensions of software risks – project size, technology experience, and project structure and identified 54 risks. It is not easy to handle all the 54 risks. Therefore, a number of empirical studies appeared later, suggested to put attention on the top ten software risk list. These include the following studies:

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Boehm [5]; Schmidt et al.[6]; Addision and Vallabh [7]; Addision [8]; Han and Huang [2]; Pare et al. [9].

TABLE II
SIX DIMENSIONS OF SOFTWARE RISKS OF WALLICE ET AL.[3]

Risk dimension	Abbreviation	Software risk
User	User1	Users resistance to change
	User2	Conflicts between users
	User3	Users with negative attitudes toward the project
	User 4	Users not committed to the project
	User5	Lack of cooperation from users
Requirements	Reqm1	Continually changing requirements
	Reqm2	System requirement not adequately indentified
	Reqm3	Unclear system requirements
	Reqm4	Incorrect system requirements
Project complexity	Comp1	Project involves the use of new technology
	Comp2	High level of technical complexity
	Comp3	Immature technology
	Comp4	Project involves the use of technology that has not been used prior project
Planning & Control	P&C1	Lack of effective project manage technology
	P&C2	Project progress not monitored closely enough
	P&C3	Inadequate estimation of required resources
	P&C4	Poor project planning
	P&C5	Project mile stone not clearly defined
	P&C6	Inexperience project managers
	P&C7	Ineffective communications
Team	Team1	Inexperience team members
	Team2	Inadequately trained development team members
	Team3	Team members lack of specialized skill required by the project
Organizational Environment	Org1	Change in organizational management during the project
	Org2	Corporate politics with negative effect on the project
	Org3	Unstable organizational environment
	Org4	Organization undergoing restructuring during
		the project

Boehm [5] surveyed several experienced project managers and suggested a top ten software risk recommended for checklist in Table III. To get a better view of the list, these top tem risks will be mapped to the six dimensions of software risks of Wallice et al. [3] (shown in table II). The mapping shows that the top ten risks comprises 3 requirement (R), 2 project complexity (Comp), 4 planning and control (P&C), 1 team (T). One observation is the list places more frequency on planning and control and requirement while there is no risk in the user (U) and organizational environment (Org) dimension.

Schmidt et al. [6], an international study, used Delphi method to collect opinion of 11 experts from Hong Kong, 13 from Finland and 19 from USA. And proposed three top ten software project risks lists, one from each countries (Table IV, V and VI). The top ten risks of the USA (Table IV) comprises 3 user (U), 1 requirement (R), 5 planning and control (P&C), and 1 organizational environment (Org). The list places more frequency on planning and control and user. Here, there is no risk in team (T) and project complexity (COMP).

The top ten risks of Hong Kong (Table V) comprises of 5 user (U), 2 requirement (R), 1 planning and control (P&C), and 2 organizational environment (Org). The list places more importance on user. Here, there is also no risk in team (T) and project complexity (COMP).

The top ten risks of the Finland (Table VI) comprises of 1 user (U), 2 requirement (R), 4 planning and control (P&C), 2 team (T), and 1 organizational environment (Org). Here, there is also no risk in project complexity. The list places more frequency on planning and control.

TABLE III
TOP TEN LIST OF BOEHM [5]

Rank	Software Risk	Dimension
1	Personnel shortfalls	T
2	Unrealistic time and cost estimates	P&C
3	Developing the wrong software functions	R
4	Developing the wrong user interface	R
5	Gold plating	P&C
6	Late changes to requirements	R
7	Shortfalls of external supplied components	P&C
8	Shortfalls of externally performed tasks	P&C
9	Real-time performance shortfalls	Comp
10	Straining science capabilities	Comp

TABLE VI
TOP TEN LIST OF SCHMIDT ET AL. [6], (USA)

Rank	Software Risk	Dimension
1	Lack of top management commitment to the project	Org
2	Misunderstanding of the requirements	R
3	Not managing change properly	P&C
4	Failure to gain user commitment	U
5	Lack of effective project management skill	P&C
6	Lack of adequate user involvement	U
7	Failure to manage end-user expectations	U
8	Lack of effective project management methodology	P&C
9	Unclear / misunderstood scope/ objectives	P&C
10	Changing scope / objectives	P&C

Addision and Vallabh [7] reviewed 14 risks from literature, then 70 project managers obtained using snowball sampling were polled and 36 returned. Top ten software risks from the survey are shown in Table VII.

The top ten risks of the (Table VII) comprises of 1 user

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(U), 3 requirement (R), 4 planning and control (P&C), 1 team (T), and 1 organizational environment (Org). The list places more importance on planning and control, and requirement. There is also no risk in project complexity (COMP).

TABLE V
TOP TEN LIST OF SCHMIDT ET AL. [6], (HONG KONG)

Rank	Software Risk	Dimension
1	Lack of top management commitment to the project	Org
2	Lack of adequate user involvement	U
3	Failure to gain user commitment	U
4	Lack of cooperation from users	U
5	Change in ownership of senior management	Org
6	Changing scope / objectives	P&C
7	Misunderstanding of the requirements	R
8	Lack of frozen requirements	R
9	Failure to manage end-user expectations	U
10	Conflict between user departments	U

TABLE VI
TOP TEN LIST OF SCHMIDT ET AL. [6], (FINLAND)

Rank	Software Risk	Dimension
1	Lack of effective project management skill	P&C
2	Lack of top management commitment to the project	Org
3	Lack of required knowledge /skill in the project personnel	T
4	Not managing change properly	P&C
5	No planning or inadequate planning	P&C
6	Misunderstanding of the requirements	R
7	Artificial deadlines	P&C
8	Failure to gain user commitment	U
9	Lack of frozen requirements	R
10	Lack of "people skill" in project leadership	T

TABLE VII
TOP TEN LIST OF ADDISON AND VALLABH [7]

Rank	Software Risk	Dimension
1	Unclear or misunderstood scope/objectives	P&C
2	Misunderstanding of requirements	R
3	Failure to gain user involvement	U
4	Lack of senior management committee	Org
5	Development of wrong software functions	R
6	Unrealistic schedules and budgeting	P&C
7	Continuous requirement changes	R
8	Inadequate knowledge/skills	T
9	Lack of effective project management methodology	P&C
10	Gold plating	P&C

Addision [8] studied risks in the development of e-commerce project using Delphi method to collect opinion of 32 project managers in South Africa. Top ten software risks from his research are shown in Table VIII.

The top ten software risks (Table VIII) comprises of 2 user (U), 2 requirement (R), 1 project complexity (Comp), 2 planning and control (P&C), 2 team (T), and 1 organizational environment (Org). The risks scattered in all categories. The risks in this top ten list are also different from those mentioned before in that there are 4 e-commerce specific risks for e-commerce project – risk number 3, 4, 5, and 6.

TABLE VIII
TOP TEN LIST OF ADDISON [8]

Rank	Software Risk	Dimension
1	Misunderstanding the user requirements	R
2	Absence of the declared business benefits	P&C
3	Too narrow focus on the IT project issues and overlooking the impact on the distribution channels and the business in general	R
4	Inadequate security features being built into the system	Comp
5	Lack of e-commerce project experience	T
6	Lack of understanding of web page design principles	T
7	Lack of top management commitment and support	Org
8	Failure to manage end user expectation (U)	U
9	Insufficient procedures to ensure security, integrity and availability of the database	P&C
10	Lack user of commitment and involvement	U

Han and Huang [2] surveyed 115 project managers. The managers were asked to give the probability of the 27 software risks reviewed from literature via a web. Top ten software risks from the survey are shown in Table IX.

The top ten software risks (Table IX) comprises of 4 requirement (R), 1 project complexity (Comp), 4 planning and control (P&C), and 1 organizational environment (Org). There is also no risk in team (T) and user (U) mentioned. The list places more frequency on requirement and planning and control.

TABLE IX
TOP TEN LIST OF HAN AND HUANG [2]

Rank	Software Risk	Dimension
1	Continually changing system requirements	R
2	System requirements not adequately identified	R
3	Unclear system requirements	R
4	Lack of an effective project management methodology	P&C
5	Incorrect system requirements	R
6	Poor project planning	P&C
7	Inadequate estimation of required resources	P&C
8	Project involved the use of new technology	Comp
9	Project progress not monitored closely enough	P&C
10	Corporate politics with negative effect on project	Org

Pare et al. [9], followed Schmidt et al. (2001), used a Delphi method to obtain opinion of 19 experts in Canada. And proposed a top ten software project risks lists shown in

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Table X.

The top ten software risks in Table X comprises of 2 user (U), 3 planning and control (P&C), 3 team (T), and 2 organizational environment (Org). Surprisingly there is also no risk in requirement and project complexity (COMP). The list places more frequency both on planning and control and team.

TABLE X
TOP TEN LIST OF PARE ET AL. [9]

Rank	Software Risk	Dimension
1	Lack of project champion	T
2	Lack of commitment form upper management	U
3	Poor perceived system usefulness	U
4	Project ambiguity	P&C
5	Misalignment of system with local practices and process	P&C
6	Political games or conflicts	Org
7	Lack of required knowledge or skill	T
8	Changes to membership on the project team	T
9	Organizational instability	Org
10	Insufficient resources	P&C

III. FINDINGS FROM THE TOP TEN LISTS

From the Top ten software risk lists reviewed in the previous section, the frequency of the software risks reviewed are shown in Table XI and XII. Table XI shows the frequency of each dimension and Table XII shows frequency of each software risk item.

Table XI shows that the top three most mentioned dimensions are planning and control (27 out of 80), requirement (17 out of 80) and user (13 out of 80) respectively. This indicates that across all studies, the project managers advocated that these software risks -- planning and control, requirement and user, are the most importance risk. The least mentioned risk items are complexity and team related risks.

These are factors the project managers should be more aware when work on a software project. The other observation is that the experienced project managers put less emphasis on project complexity. Or in other words, they did not see technical complexity or new technology as a threat to the software project.

All of the software risks appeared only once or twice (Table XII), except 7 factors in Table XII. The most frequent mentioned software risk are misunderstanding of requirements and lack of top management commitment and support with the frequency of 5 out of 8 studies. Lack of top management commitment and support comes third. Next are failure to gain user commitment, failure to manage end user expectation, changes to requirements and lack of an effective project management methodology, all are with frequency of 3 out 8 studies.

TABLE XI
SOFTWARE RISKS FREQUENCY BY DIMENSION

Dimension	Total frequency
User	14
Requirement	17
Complexity	4
Planning and Control	**27**
Team	9
Organizational Environment	9
Total	80

TABLE XII
SOFTWARE RISKS ITEM FREQUENCY

NO.	RISK ITEM	FREQ.
1	Misunderstanding of requirements (R)	5
1	Lack of top management commitment and support (Org)	5
3	Lack of adequate user involvement (U)	4
4	Failure to gain user commitment (U)	3
5	Failure to manage end user expectation (U)	3
6	Changes to requirements (R)	3
7	Lack of an effective project management methodology (P&C)	3

This implies that project managers should be more careful with these software risks such as misunderstanding of requirements, lack of management commitment and support, lack of user involvement, failure to gain user commitment, failure to manage end user expectation, changes to requirements and lack of an effective project management methodology.

Notice that risks related to complexity and team dimension do not show in the top list. It is consistent with tables XI. This would indicate that the complexity of the technology used, team handling, organizational environment dimensions are now less problematic in the eyes of most project managers

IV. DISCUSSION AND IMPLICATIONS

This section addresses the factors that may have contributed to the differences found on the top ten lists (Table XIII).

The top ten software risk lists may give an insight to understand the overall picture but using it may need to understand the limitations and implications of the lists. From the observations, all of the research conducted have many different factors that may lead to diverse results and hence has to use them carefully. These include the followings four factors:

1. Time dimension
2. Culture
3. Application areas
4. Research method

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TABLE XIII
FACTORS AFFECTING THE FINDINGS

No.	Author	Year of study	Country	Application area studied	Research method & question set	Subjects	Type of question asked
1	Boehm	1991	USA	Generic	N/A	N/A	Importance of Risks
2	Schmidt et al.	2001	USA	Generic	Delphi	19	N/A
3	Schmidt et al.	2001	Hong Kong	Generic	Delphi	13	N/A
4	Schmidt et al.	2001	Finland	Generic	Delphi	11	N/A
5	Addison and Vallabh	2002	South Africa*	Generic	Questionnaire, 23 questions	36	Importance of Risks
6	Addison	2003	South Africa	e-commerce	Delphi	32	Importance of Risks
7	Han and Huang	2007	Taiwan*	Generic	Questionnaire, 27 questions	115	Probability of Risks
8	Pare et.al.	2008	Canadian	Health care	Delphi	19	Importance of Risks

A. Time dimension

Time dimension refers to the time when the research was conducted. The earliest top ten software list was suggested by Boehm in 1991[5] and the latest was in 2008. The time span may affect the concord of the findings. Many of the risk items mentioned in Boehm [5] are not appeared in the later studies. The only related risk item remains --"Late changes to requirements". There may be many reasons to this. Over the years, many factors have changed especially technology and education. It is hypothesized that the advancement in education and technologies may have affected software risk management process. At present, project managers, users and technical staffs are well educated and equipped. These changes may make some risks not anymore threaten to the software project management process.

B. Culture

Culture is referred to the country where the research was conducted. Of the 8 lists, 2 were from the USA, another 2 were from South Africa, and 4 were from other different countries –Canada, Finland, Hong Kong, and Taiwan. The author suspects that the respondents' background from different countries may be another affecting factor. Findings from one country may not be able to generalize to other country.

C. Application areas

Most of the studies, 6 out of 8, did not defined specific application domain of their studies, only one of the studies defined their risk studies in e-commerce [8] and another was in health care industry [9]. Some of the top ten software risks in the e-commerce study are e-commerce specific, for example, in Table VIII, risk number 5 -- Lack of e-commerce project experience (Team), risk number 6 -- Lack of understanding of web page design principles (Team). Risk number 4 --Inadequate security features being built into the system (COMP), may also considered risk specific to e-commerce application. These risks are e-commerce specific and they have to be used as such.

D. Research method

The research method concerns the data gathering method, the subjects and the questions used in the research. There were two method of studies utilized --Delphi method or questionnaire survey. The differences in the subjects participated in the research and the questions used in the research may also affect the results of the top ten lists.

1) The Delphi method or questionnaire survey

The research method utilized may be another factor affecting the results. Table XIII shows that 5 out of the 8 studies used Delphi method whereas two studies used questionnaire survey. Addison and Vallabh [7] used questionnaire survey with 23 questions while Han and Huang [2] also utilized questionnaire survey with 27 questions.

2) The subjects participated in the research

The subjects in each research were different in quantity and also in quality. The subjects were ranged from 11 managers [6] to 115 managers [2].

3) The questions used in the research

The other observation is that the questions used were two different kinds of question. Most of the studies asked the respondents to rate the important of the software risks while only Han and Huang [2] asked for the probability of the software risks. This could also result in the different software risks in the top ten lists.

V. CONCLUSION

To success in managing a software project, project manager needs to understand the nature of software risks. This paper surveys eight top ten software risks lists from the literature. The results from the analysis (table XI) show that planning and control is the dimension of risks which mentioned most (27), followed by requirement (17), User (14), Team (9), organizational environment (9) and the least

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mentioned, complexity (4). Across all eight lists (table XII), project managers find the most frequent mentioned, with frequency of more than 2 from out of 8, are

1. Misunderstanding of the requirements (5),
2. Lack of management commitment and support (5),
3. Lack of adequate user involvement (4),
4. Failure to gain user commitment (3),
5. Failure to manage end user expectation (3),
6. Changes to requirements (3), and
7.Lack of an effective project management methodology (3).

These answered the research questions: which list is the proper list to use and what are the most common top ten software risks? It is encouraged that an organization should develop its own list from their software project experience. Whereas at the beginning, when an organization has not developed its own lists yet, the top ten lists available in the literature could be helpful. However, project managers have to aware of the factors affecting these results, i.e. the time dimension, culture and research method.

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