Risk Assessment Factors for SME Software Development Companies in Malaysia

Abdullahi Mohamud Sharif
Department of Computer and Information Science
Universiti Teknologi PETRONAS (UTP)
Sri Iskandar, Malaysia
msharif_g01396@utp.edu.my

Shuib Basri
Department of Computer and Information Science
Universiti Teknologi PETRONAS (UTP)
Sri Iskandar, Malaysia
Shuib_basri@petronas.com.my

***Abstract*—There are large, medium, and small enterprises which develop software projects that can be influenced by a risk. Identifying risk is first step of perfectly assessing and controlling risks in a project. In the literature, a lot of researchers identified risk factors in software projects but none of these can be generalized as base of risk factors in the software projects as they differ in time, culture, and being studied in different application areas while using different research methodologies. Majority of the researchers focused on general software projects while few of them focused on specific application areas like virtual projects or e-commerce projects but no research focused identifying risk factors of software projects in terms of the firm size. In this paper, we are studying risk factors that Small and Medium Enterprise (SME) in Malaysia perceive as risk in their software development projects. 202 respondents from 25 enterprises located in three states in Malaysia was surveyed and analyzed. Finally, the top risk factors for each risk dimension were presented along their relationship with project risks.**

***Index Terms*—Risk, Risk Identification, Risk Assessment, Risk Management, Risk Factors, Software Development, Malaysia, Small and Medium Enterprise.**

I. Introduction

Software projects developed by Small and Medium Enterprises (SME) are growing fast as they are taking part in the economic growth of world countries. According to [1], as per 2012 there are 645,136 enterprises established in Malaysia which 90% of them are in the service sector. The service sector includes Information Communication Technology (ICT) companies which software development enterprises are part of this sector. In service sector which ICT companies include, 79.6% of the companies are microenterprises. These incubators develop different software projects in a tight budget and scheduling which may raise severe threats (risks) to their project that can lead to have high impact to the project or the company itself. According to [2] , "*Small projects typically carry the same or more risk as do large projects.* [While] *many customers and millions of dollars are lost each year on small projects in product and service organizations*". A threat can be positive or negative and in this study we are focusing on negative threats that these companies face during their software development and how they perceive risks in their projects.

In general, risk is defined as "*the possibility of suffering loss that describes the impact on the project which could be in the form of poor quality of software solution, increased costs, failure, or delayed completion*" [3]. In order to prevent or reduce the impact of the risk, a necessary step is to identify the risk factors that can cause fatal effect to the project. As in [4], risk identification is the first step in the risk assessment which is part of the risk management domain.

There are a lot of researches being carried out since 1979 in order to identify risk factors for software projects. These factors, as mentioned by in [5], are conducted in different time dimensions, culture, and being studied in different application areas by applying different research methods. Each difference has its own impact on identify top risk factors that these researchers found in their analysis. However, in this paper we are studying risk factors in SME software development companies in Malaysia. A more detailed of these issues are discussed in next section.

For the coming sections, risk factors being adapted in this study will be discussed in section II and how they are being derived from the literature. The study methodology used in this research is discussed in section III and then a detailed data analysis with their results are elaborated in section IV with a conclusion and future recommendations in section V.

II. Risk Factors

Software development risk factors were probed since 1979 and a lot of articles being published about risk factors in software development. Han and Huang [6] summarized some of the risk factors found in the literature and their dimensions as shown in Table 1 with update of recently published risk factors in software projects.

TABLE I. Updated Summary of Risks in Software Projects [6]

Author (YEAR)	Dimension	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

978-1-4799-0059-6/13/$31.00 ©2014 IEEE.

Author (YEAR)	Dimension	Software Risks
Carney et al. (2003)	4	21
Wallace et al. (2004)	6	27
Huang S. et. al. (2004)	6	28
Han and Huang (2007)	6	27
Arshad N.H et. al. (2007)	6	44
Tesch D., et al. (2007)	6	70
Pare et al. (2008)	7	23
Reed and Knight (2011)	0	55

Most of the researchers in Table 1 adapted risk factors from the literature in order to do further studies while few of them used Delphi study to identify risk factors. For example, Reed and Knight [7] combined 55 risk factors from the literature. Han and Huang [6] also adapted the 27 list factors from [8] while Tesch et. al [9] adapted 92 risk factors derived from [10],[11], and [12]. These updated risk factors mentioned in Table 1 as mentioned in [5] have four factors that impact their outcome:

1. They have being conducted in different times from 1979 till 2011.
2. Each research was conducted in different culture which has its impact on the perceived importance level of risk factors
3. The studied application areas were completely different as some researchers focused specifically on risks in virtual projects, e-commerce, or in general software development projects.
4. The researchers applied different method in identify and analyzing top risk factors.

These factors impacted the outcome of each research as there is no convention list of risk factors can be determined. For example, as in [10], in 2001 listed the most and widest risk factors that being identified by three different panels from Hong Kong, USA, and Finland using Delphi study technique. The list they identified combined nearly half of them the previous risk factors being mentioned in the literature since 1979 till 2001. A lot of researchers use their list as way to analyze further in the risk assessment for software development projects.

However, as our research is focuses in Malaysia, [13] presented in 2007 top ten risk factors in software development projects. Their researches also effects the four impact factors mentioned above.

On the other hand, the researchers used the combination of risk factors that derived from [8] and [10] as they are the most widely risk factors used in the literature, and from [7] as they combined all possible risk factors from the literature in their recently 2011 published article.

Furthermore, as mentioned in Table 1, researchers categorized risks into groups which some of them they adapted from the literature. As in [10], risks are grouped into 14 dimensions. But in [8] researchers probed all risk dimensions in the literature and analyzed them based on their respective references and come out with 6 dimensions which most of the researchers use them in their risk grouping. In this paper, also we adapted the risk dimension mentioned in [8].

The risk dimensions that researchers categorized risks in this study which are adapted from [8] are:

1. User Risks
2. Team Risks
3. Requirement Risks
4. Project Complexity Risks
5. Planning and Control Risks; and
6. Organizational Environment Risks

After combining the different list of risk factors and removing the redundancy and also carried out content validity, the summarized 56 risk factors used in this study are mentioned with their respective dimensions in Table 2.

TABLE II. RISK FACTORS

User Risks	
User1	It's hard for the users to accept the change
User2	There is conflict between users
User3	Users have negative attitudes toward the project
User4	Users are not committed to the project
User5	Facing lack of cooperation from users side
User6	It's very hard to satisfy end-user expectations
User7	There is no end user buy-in
Team Risks	
Team1	The project team doesn't have required experience
Team2	Team members doesn't have sufficient training
Team3	There is lack of specialized skills by the team
Team4	During the project, there was less meetings
Team5	Project manager replaced during project period
Team6	There are ineffective team members, for example due to early staffing
Team7	During the project, there was too many meetings
Team8	Personnel turnover
Team9	Inexperienced project manager
Requirement Risks	
Req1	There are misunderstanding of the requirements
Req2	System requirements are changed continually
Req3	System requirements are not sufficiently identified
Req4	There are unclear system requirements
Req5	There are incorrect system requirements
Req6	The deliverables of the project have poor quality
Project Complexity Risks	
Comp1	Project involved the use of new technology
Comp2	The project has high level of technical complexity
Comp3	The project uses immature technology
Comp4	Integration of project components is complex
Comp5	The project interrupted by higher priority project
Planning and Control Risks	
PC1	There is lack of effective project management methodology
PC2	Project progress not monitored closely enough
PC3	Inadequate estimation of required resources
PC4	Poor project planning
PC5	The project milestones were not clearly defined
PC6	The project communication was not effective
PC7	There is lack of effective development process
PC8	Cost overruns
PC9	The change is not managed properly
PC10	Improper definition of roles and responsibilities
PC11	The decision making process is poor
PC12	The scope is changed many times
PC13	The project was not based on sound business case
PC14	All stakeholders are not identified probably
PC15	Creation of meaningless intermediate deliverables to give the impression deadlines are being met
PC16	The time estimate was not realistic
PC17	Failure to get project plan approval from all parties
PC18	The project objectives was unclear

Organizational Environment Risks	
OE1	The management was not helpful
OE2	Change in organizational management during the project
OE3	Corporate politics have negative effect on the project
OE4	The organizational environment is not stable
OE5	The organization undergoing restructuring during the project
OE6	More organizational units involved in the project
OE7	The approval of funding took more time
OE8	The project is critical to the organization
OE9	There are hidden agendas impact the project
OE10	The project excessively used outside consultants

In this research, we are analyzing the level of importance of each risk factor has in the context of SME companies in Malaysia. Our focus is to identify top risk factors for each dimension and how these six dimensions affect the project risks.

In next section, we discuss the methodology that we used in order to identify and analyze the above risk factors and determine the top risk factors for each risk dimension.

III. Study Methodology

Structured questionnaire consisting of two sections using 5 Linker-scale were distributed randomly to different companies located in Klang Valley, Johor, and Perak states in Malaysia. As mentioned in [1], the SME companies located in these three states accommodate nearly one-third (32.6%) of total SME companies in Malaysia.

A total of 25 companies were distributed to 450 questionnaire forms and only 211 forms were returned. After checking the data received, 9 incomplete forms were discarded. As a result, only 202 forms became valid survey forms yielding a response rate of 46.44%. A detailed study of the background of these companies and the knowledge of their staff in working project management related projects are discussed in [14].

Factor analysis using SmartPLS [15] application was conducted to analyze the data and provide the cross loading of risk items. The test of internal consistency (reliability) of the instrument items were carried out first. Reliability is assessed with both Cronbach's Alpha and composite reliability. A value of at least 0.70 was used as the threshold to indicate adequate reliability [16]. Table III shows the reliability of the constructs. All of the constructs had satisfactory reliability and scored well above 0.70.

TABLE III. Reliability of Constructs

Construct	No. of Item	Cronbachs Alpha	Composite Reliability
Comp	5	0.7844	0.8515
OE	10	0.9095	0.9257
PC	18	0.9464	0.9522
Req	6	0.8726	0.9044
Team	9	0.8606	0.8933
User	7	0.7181	0.8251

Comp: Project Complexity. OE: Organizational Environment. PC: Planning and Control. Req: Requirement.

The top risk factors for each risk dimension and the relationship of these risk dimensions towards project risks were discussed in detail in next section.

IV. SME Software Development Risk Factors

In this section, the importance level of each risk factor corresponding to its risk dimension is discussed in detail. Each risk factor were rated to the importance level of the risk based on the risks existed in most recently completed software project. A value of at least 0.7 or greater was used as a threshold to indicate the adequate factor loading of each factor. Any factor that loads less than 0.7 was suppressed.

Table IV shows risk dimensions along with the top risk factors in each category.

TABLE IV. Top Risk Factors For Each Risk Dimension

Risk Dimension	Top Rated Risk
User	Users have negative attitudes toward the project
Team	Team members don't have sufficient training
Requirement	There are misunderstanding of the requirements
Project Complexity	Integration of project components is complex
Planning and Control	The project communication was not effective
Organizational Environment	The organizational environment is not stable

The cross loading of all factors that are greater than 0.7 were depicted in Table V.

TABLE V. Risk Factors Loading

	Comp	OE	PC	Req	Team	User
Comp_1	0.66	0.31	0.22	0.31	0.18	0.27
Comp_2	0.77	0.38	0.35	0.32	0.24	0.32
Comp_3	0.71	0.47	0.53	0.42	0.45	0.42
Comp_4	0.77	0.50	0.45	0.43	0.36	0.28
Comp_5	0.74	0.50	0.54	0.42	0.44	0.39
OE_1	0.46	0.77	0.67	0.49	0.54	0.28
OE_10	0.45	0.71	0.48	0.38	0.43	0.32
OE_2	0.46	0.75	0.54	0.45	0.45	0.34
OE_3	0.47	0.72	0.48	0.40	0.49	0.45
OE_4	0.52	0.84	0.68	0.46	0.54	0.36
OE_5	0.46	0.75	0.55	0.45	0.48	0.31
OE_6	0.41	0.77	0.54	0.45	0.46	0.40
OE_7	0.41	0.76	0.51	0.33	0.41	0.38
OE_9	0.48	0.78	0.54	0.44	0.48	0.35
PC_10	0.51	0.50	0.77	0.49	0.50	0.42
PC_11	0.45	0.60	0.81	0.49	0.54	0.42
PC_12	0.48	0.54	0.70	0.56	0.51	0.41
PC_13	0.37	0.52	0.72	0.44	0.50	0.46
PC_14	0.36	0.50	0.71	0.38	0.45	0.49
PC_15	0.50	0.57	0.70	0.45	0.48	0.42
PC_16	0.49	0.52	0.74	0.57	0.54	0.39
PC_17	0.32	0.54	0.69	0.49	0.55	0.41
PC_18	0.41	0.54	0.76	0.50	0.52	0.39
PC_2	0.39	0.56	0.73	0.45	0.59	0.39
PC_3	0.51	0.52	0.74	0.54	0.51	0.46
PC_4	0.44	0.56	0.79	0.60	0.54	0.35
PC_5	0.48	0.53	0.77	0.54	0.53	0.38
PC_6	0.46	0.65	0.81	0.50	0.58	0.41
PC_7	0.43	0.59	0.73	0.42	0.52	0.30
PC_9	0.45	0.46	0.74	0.51	0.46	0.39
Req_1	0.46	0.49	0.54	0.82	0.51	0.36

	Comp	OE	PC	Req	Team	User
Req_2	0.38	0.42	0.47	0.77	0.44	0.36
Req_3	0.37	0.41	0.47	0.78	0.46	0.35
Req_4	0.42	0.32	0.46	0.82	0.42	0.39
Req_5	0.45	0.51	0.56	0.82	0.57	0.42
Req_6	0.39	0.48	0.62	0.68	0.56	0.49
Team_1	0.27	0.35	0.52	0.41	0.74	0.36
Team_2	0.27	0.41	0.48	0.47	0.79	0.43
Team_3	0.35	0.41	0.54	0.45	0.75	0.36
Team_4	0.33	0.46	0.49	0.43	0.70	0.44
Team_5	0.45	0.57	0.57	0.50	0.75	0.42
Team_8	0.39	0.53	0.45	0.44	0.70	0.37
Team_9	0.38	0.50	0.55	0.56	0.74	0.31
User_3	0.31	0.34	0.41	0.38	0.42	0.77
User_4	0.33	0.27	0.42	0.34	0.38	0.73
User_6	0.37	0.28	0.28	0.36	0.25	0.69
User_7	0.36	0.46	0.47	0.40	0.46	0.74

Comp: Project Complexity. OE: Organizational Environment. PC: Planning and Control. Req: Requirement.

As can be seen in table V, the item loadings in their corresponding columns are all higher than the loadings of the items used to measure the other constructs. Furthermore, when examining across the rows, the item loadings are higher for their corresponding constructs than for others. Therefore, the measurements satisfy the two criteria recommended by Chin (1998). The corrected loading factors are discussed in below sub sections.

A. User Risks

According to [8], describes risks in this dimension as "*The lack of user involvement during system development is one of the most often cited risk factors in the literature. If the attitudes of users toward a new system are unfavorable, then it is likely that they will not cooperate during a development effort, leading to an increased risk of project failure*".

In user risk dimension, there were 7 risk items that was asked the respondents to rate their level of importance based on their last project experience. The highest loaded risk factor in user risk dimension which loaded 0.77 is "U*sers have negative attitudes toward the project*". This is the top risk factor in this dimension and clearly mentions that project user's attitude is unfavorable and may have high impact to the project.

Furthermore, the second and third highest loaded factors were loaded closely to each other as their loading is 0.74 and 0.73 respectively and they are: "*There is no end user buy-in*" and "*Users are not committed to the project*". This is likely be the result of the negative attitude of the user toward the project as it was top factor in this dimension. The least loaded factor in the risk domain was: "*It's very hard to satisfy end-user expectations*" and it loaded 0.69, a very close to the threshold value.

On the other hand, the remaining 3 risk factors loaded less than 0.70 and they are considered less important to the SME software development companies. These risks factors are: It's hard for the users to accept the change, there is conflict between users, and facing lack of cooperation from user's side.

B. Team Risks

The 9 risk items in team risk dimension were all loaded above the threshold except one item. In [8], team risks refer to *"issues associated with the project team members that can increase the uncertainty of a project's outcome*".

The top risk factor in this dimension is: "*Team members don't have sufficient training*". The next high loaded factors are "*There is lack of specialized skills by the team*" and "*Project manager replaced during project period*". On the other hand, the risk "*There are ineffective team members, for example due to early staffing*" is loaded below 0.7 and was not included in the analysis.

C. Requirement Risks

All risk items in requirement dimension was loaded more than 0.7 and three of them were loaded closely to each other. These factors which loaded 0.82 are: "*There are misunderstanding of the requirements*", "*There are unclear system requirements*", and "*There are incorrect system requirements*". The misunderstanding, unclear, and incorrect system requirement are what respondents considered the most important risk factors in the requirement domain.

D. Project Complexity Risks

In this dimension, all risk items in project complexity are loaded above the threshold but all of them are less than 0.8. In [8], project complexity is defined as "*The inherent complexity of a software project in terms of the difficulty of the projects being undertaken*".

As you can see in table V, the highest two factors in this dimension loaded at 0.77 and they are: "*Integration of project components is complex*" and "*The project has high level of technical complexity*". Although these microenterprises develop mostly small and medium software projects but still they consider integrating the components of these projects is challenging and one of the top risk factors in this domain.

E. Planning and Control Risks

In planning and control risk factors, the researchers analyzed 18 risk items and only two factors did not loaded above the threshold while the majority was above the required threshold. Two factors loaded at 0.81 were the highest factors in this dimension and they are: "*The project communication was not effective*" and "*The decision making process is poor*". The other items loading are shown in table V.

F. Organizational Environment Risks

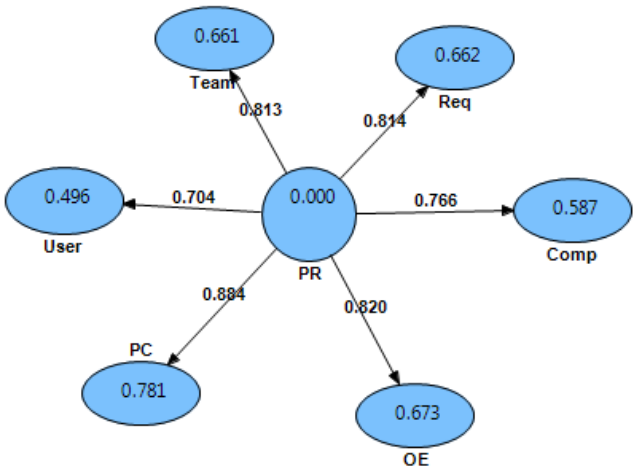
The sixth dimension, organizational environment risks, contains 10 risk items and only one item loaded below the threshold. The top risk factor in this dimension which loaded 0.84 is "*The organizational environment is not stable*". Interestingly, this factor loaded the highest among all risk factors for all dimensions. This finding shows that, these microenterprises face competitive pressures that sometimes make the entire project obsolete.

V. Risk Dimensions Relation to the Project Risk

In this section, the researchers analyze the relation of these six risk dimensions have to the grouping project risks in the context of SME software development companies in Malaysia.

We developed the model using SmartPLS [15] by analyzing the PLS Algorithm

Fig. 1 shows the estimates of the path coefficients indicating the strength of the relationships between the dependent and independent variables and estimates of the R^2 values, which represent the amount of variance in the independent variable explained by the dependent variables.



PR: Project Risk. Comp: Project Complexity. OE: Organizational Environment. PC: Planning and Control. Req: Requirement.

Fig. 1. Example of a figure caption. *(figure caption)*

Fig. 1 shows the R^2 of the constructs. The user variable explains 49.6% of the variance which is the least variance among other dependent variables. Planning and Control explained 78.1% of the variance.

Also as shown in Fig. 1, the standardized regression weights or the effects of the six risk dimensions to the project risk are all above 0.7 which explains they all have strong relation to the project risk. However, to examine further whether the above relationship is significant, we tested the t-statistics for the standardized path coefficients by running bootstrap with 500 re-samples. Any value above 1.96 is significant at the 0.05 level or 95% confidence interval. The results of the analysis were all above 3.29 which p-value is less than 0.001. This shows that each risk dimension has strong relationship to the project risks.

VI. Conclusion

In this research, we analyzed the importance level of risk factors that software development microenterprises in Malaysia perceive as high important risk. The researchers also analyzed the relationship of the six dimensions of risk factors toward project risks.

Finally, the researchers are studying further how these microenterprises can identify, analyze, and prioritize the risks in their projects and the possible solutions of mitigating and managing these risks.

References

[1] National SME Development Council, "SME Annual Report 2011/2012," 2012.

[2] C. F. Gray and E. W. Larson, *Project Management: The Managerial Process*, 4th ed. McGraw-Hill Irwin, 2008.

[3] M. Boban, Z. Pozgaj, and H. Seric, "Strategic for Successful Software Development Risk Management," *Management*, vol. 8, pp. 77–91, 2003.

[4] B. W. Boehm, "Software Risk Management: Principles and Practices," *IEEE Softw.*, vol. 8, no. 1, pp. 32–41, 1991.

[5] Tharwon Arnuphaptrairong, "Top Ten Lists of Software Project Risks□: Evidence from the Literature Survey," in *Proceedings of the International MultiConference of Engineers and Computer Scientists 2011 Vol I, IMECS 2011*, 2011.

[6] W.-M. Han and S.-J. Huang, "An empirical analysis of risk components and performance on software projects," *J. Syst. Softw.*, vol. 80, pp. 42–50, 2007.

[7] A. H. Reed and L. V. Knight, "Major Virtual Project Risk Factors," *J. Inf. Technol. Manag.*, vol. XXII, 2011.

[8] L. Wallace, M. Keil, and A. Rai, "How Software Project Risk Affects Project Performance: An Investigation of the Dimensions of Risk and an Exploratory Model," *Decis. Sci. 35*, vol. 2, pp. 289–321, 2004.

[9] D. Tesch, T. J. Kloppenborg, and M. N. Erolick, "IT Project Risk Factors: The Project Management Professionals Perspective," *J. Comput. Inf. Syst.*, pp. 61–69, 2007.

[10] R. Schmidth, K. Lyytinen, M. Keil, and P. Cule, "Identifying Software Project Risks: An International Delphi Study," *J. Manag. Inf. Syst.*, vol. Vol. 17, no. No. 4, pp. 5–36, 2001.

[11] E. Oz and J. J. Sosik, "Why Information Systems Projects are Abandoned: A Leadership and Communication Theory and Ex-ploratory Study," *J. Comput. Inf. Syst.*, vol. 41, no. 1, pp. 66–78, 2000.

[12] R. E. Fairley and M. J. Willshire, "Why The Vasa sank: 10 Problems and Some Antidotes for Software Projects," *IEEE Softw.*, vol. 20, no. 2, pp. 18–25, 2003.

[13] N. H. Arshad, A. Mohamed, and Z. M. Nor, "Risk Factors in Software Development Projects," in *Proceedings of the 6th WSEAS Int. Conf. on Software Engineering, Parallel and Distributed Systems*, 2007, pp. 51–56.

[14] A. M. Sharif, S. Basri, and H. O. Ali, "A Study on SME Software Development Background and Risk Assessment Implementation in Malaysia," *World Appl. Sci. J.*, vol. 26, no. 12, pp. 1637–1642, 2013.

[15] C. M. Ringle, S. Wende, and A. Will, "SmartPLS." Hamburg, Germany, Hamburg, Germany, 2005.

[16] J. Nunnaly, *Psychometric theory*. New York: McGraw-Hill, 1978.