An Empirical Study of Web and Distributed Software Risks from Three Perspectives: Project, Process and Product

Ayad Ali Keshlaf
School of Computing Science
Newcastle University
Newcastle, UK
a.a.a.keshlaf@ncl.ac.uk

Steve Riddle
School of Computing Science
Newcastle University
Newcastle, UK
steve.riddle@ncl.ac.uk

***Abstract*—Web and Distributed software development is vulnerable to risks, which may apply to any of three perspectives: Project, Process and Product. However, existing software risk management approaches are mainly concentrating on the Project and only very few of them have touched the Process perspective. Our *WeDRisk* approach has, as one of its main objectives, coverage of Web and Distributed risks from all three perspectives. The work presented in this paper is a result of an experiment to evaluate some aspects of *WeDRisk*. This paper is mainly focused on the evaluation of a clustering of the risks from the three perspectives, and the criteria used for the clustering. The result of the experiment illustrated the importance and usefulness of clustering and considering of the risks from the three perspectives as a way of reducing the effort and time in managing the risks and then increasing the efficiency of risk management in web and distributed developments.**

Keywords- Web and Distributed risk perspectives; Software risk mangement; Clustering of risks

I. INTRODUCTION

The development of the Web and Distributed (W-D) software industry is sharply accelerating over the last five years. This high rate of growth is due to the incremental demand on software applications in all today's activities and technologies as well as the ubiquity of the Internet, which has increased the deployment and development over it [1]. However, with these developments come new problems: a higher management complexity, new challenges and risks such as: Insufficient competence; Wage and cost inflation; Inadequate informal communications; Lack of trust; Culture differences (e.g., different language, different corporate culture and different developers' background); Time-zone difference (leading to ineffective synchronous communication); Development process differences; Knowledge management challenges (most of the existing management approaches are designed for co-located teams); Security issues (Ensuring electronic transmissions confidentiality and privacy) [2][3][4].

The above-mentioned challenges and risks attack all perspectives (project, process and product, hereafter called "3P") of W-D software industry. However, there are diverse definitions for the 3P perspectives and it is difficult to find a clear and unique definition for any of them. The following definitions are used for the purpose of this study [5][6]:

Project perspective concerns aspects such as budgets, plans, goals, responsibilities and schedules.

Process perspective concerns the methods, tasks and activities of producing the software.

Product perspective concerns the final product aspects such as its functionality, maintenance, market competence and security.

Looking at these perspectives it is expected that each one of them includes, or could be affected by, different types of risks. Risk management is, therefore, an important issue from these three perspectives [5][6].

The paper gives a background on related work (Section II), problem and approach (Section III), and then it describes the experiment (Section IV), presenting and analyzing the result of the experiment (Section V). The paper discusses the experiment results in Section VI and then presents the conclusions and suggested future work in Section VII.

II. RELATED WORK

Many software risk management approaches exist such as WinWin Spiral model [5]; GRisk-Mode and tool [7]; GSRM model [8]; Riskit method [9]; GLM Model[10]; GDPS RM Framework [11]. However, the software risk management issue has got only scant attentions in distributed development [1]. A review of software risk management for selection of best tools and techniques, which has been concentrated on recommended approaches (*SEI, SER, SoftRisk, TRM, ARMOR, Riskit*) has concluded that no one tool or technique alone can be considered as a perfect for managing risks in software development [12]. Gorski and Miler in [13] have introduced a concept (*DS-RM-Concept*) and a tool called Risk-Guide for risk management in distributed software development projects, with emphasis on the role of open communication. Kuni and Bhushan [14] introduced the Wipro Offshore Outsourcing Methodology (WOOW), which takes the risks in the account through a model called Risk Management Model.

Keshlaf and Riddle [3] reviewed the existing approaches and highlighted a number of weaknesses in them, especially

 ISBN: 978-1-61208-125-0

in managing W-D development risks. One of the weaknesses is "*... the existing approaches concentrate on project perspective of software development and they do not pay enough attention to other perspectives (Process and Product)*".

III. PROBLEM AND APPROACH

In order to tackle the weaknesses of the existing approaches in managing W-D development risks we introduced a new approach called *WeDRisk* [15]. It consists of five layers (Project, Stakeholder, Risk Management Customization, Implementation, and Evaluation & Auditing) and two supporter components (Communication & Plug-In Controller and Evolution Regulator). The layers consist of components, which contain steps, techniques and guidelines [15]. *WeDRisk* maps risks dependencies during the risk management operation in order to reduce undesired consequences.

Figure 1: Perspectives Clustering Criteria

WeDRisk includes several concepts, which could help in tackling some of the identified weaknesses. One of these concepts is the consideration of the risks from the 3P perspectives. This concept depends on a clustering strategy (using special criteria factors) to deal with the risk from these three perspectives.

The clustering strategy is intended to save time and effort. It locates fewer resources at each perspective as the managing of risks will focus on the relevant perspective risks each time. *WeDRisk* suggests some factors that could help for clustering the risks from the 3P perspectives. These factors are shown in Figure 1.

The suggested criteria groups the risks based on some characteristics and nature of the perspectives. The proposed criteria are identified based on experience, available literature and previous research results. Following sections describe controlled experiment, which was used to evaluate the clustering strategy.

IV. THE EXPERIMENT

This experiment is a part of PhD research at Newcastle University, UK which aims to build a software risk management approach to manage W-D development risks. The approach is called *WeDRisk* and it is currently under development. The aim of this experiment is to test some hypotheses, which are prepared in order to validate the significance of a list of proposed W-D risks and the usefulness of clustering them from the 3P perspectives (project, process and product). The experiment is also used to examine W-D vulnerability to atypical risks and the usefulness of absorbing their side effects.

The experiment has been designed to test four hypotheses (H1-H4). H1 evaluates the importance of potential risks to W-D development. H2, H3 evaluate the consideration of the 3P perspectives and H4 evaluates the atypical risks absorbing strategy. This paper focuses on H2 and H3, which validate the clustering strategy (and our proposed clustering criteria) as a way of considering the risks from the 3P perspectives. The two hypotheses are:

Hypothesis H2: *"If the developers use the proposed clustering criteria then the clustering time of W-D risks from three perspectives will be shorter and the effort will be saved"*

Hypothesis H3: "*Clustering the risks from three perspectives (project, process and product) saves time and effort"*

The choice of the controlled experiment to test these hypotheses was due to the following reasons:

- Difficulties of getting a suitable case study, as many software developers have high confidentiality restrictions for their projects data.
- Unavailability of suitable subjects who have the required experience or education.
- Emulating the real working environment conditions, which are significant to the study.
- It was difficult to ensure the same working environment for all the subjects (to avoid the difference in resources such as internet and computer

 ISBN: 978-1-61208-125-0

speeds, as time is one of the measurements as well as to observe the real effort).

- To avoid any outside influence on the participant, which could be different from one participant to another, as this could lead to some bias in the experiment.
- In such experiment the participants need some clarifications from time to time, which should be provided equally to all participants to avoid any bias.
- It is difficult to get all the participants at the same time in the same room and it is difficult to provide the same support and clarification to a group of subjects who are doing the same tasks at the same time. If so there will be some biases.
- To ensure the exact implementation sequence of the tasks during all experiment stages.

A. Experiment Method

Our experiment design was highly inspired by works in [16][17][18], especially in the way of structuring the experiment, preparing the hypotheses, avoiding bias, collecting, analyzing the data, discussing the result and describing the experiment. Before conducting the experiment we discussed the experiment design with expertise from Carnegie Mellon University and other researches in Newcastle University, who provided us with valuable comments. Based on the provided comments we made some modification to improve the experiment. The modifications included changing the method of recording the time during the experiment and giving more freedom to subjects, in order to reduce the time pressure on them. One other modification related to the arrangement and sequence of handling the experiment material. This also helped in estimating the required time for each participant to perform the experiment: we found 30-35 minutes suitable. We made the required improvement on the experiment material and measurement then we started the real experiment.

In order to give a chance for more replication of this experiment we provide hereafter full details of the experiment so it can be replicated easily for any research reasons.

B. Subjects (Participants)

We recruited 30 participants (male and female) for this experiment. They were PhD students, researchers and MSc students at School of Computing Science, Newcastle University-UK. The majority of them were PhD students or researchers. All of them either have experience with software development or at least participated in software projects in their studies. The subjects were recruited by emails. We sent email to all MSc students, PhD students and researchers at the school and we got a positive response from about 35 of them, but we have chosen only 30 subjects based on specific experience and education criteria.

This set of participants has been selected as we expected that they had enough knowledge or experience with software development and many of them had participated in software development projects as part of their courses. We compensated the participants who performed the experiment with £10 Amazon vouchers for their time. Instead of using the participants' real names or numbers we assigned a special reference number so that it can be used anonymously for future research after this experiment.

C. Introductory

At the beginning of the experiment each participant was asked to fill in and sign a consent form. Then the participants were briefed with the necessary information (e.g., description of the experiment, software risks and proposed list of risks, W-D development, software risk management, software perspectives). After that their assigned tasks in the experiment were explained to them. Each subject was told by the experimenter that he has the right to stop at any time if he feels not happy to continue for any reason and he has to try to be accurate as possible. Participants were told that they have the right to ask any question related to the experiment at any time if need be.

Printed versions of all experiment related information, tasks and instructions were supplied to support the participants' understandings.

In some stages of the experiment the participants were randomly divided into two groups (control and experimental group) based on the nature of the task and needed measurements.

D. Apparatus & Instrumentation

The apparatus, which were used in the experiment include computer for data entry and office environment, normal stationery, hard copies of the experiment material and forms and sport watch (on a mobile).

E. Subjects (Participants) Tasks

The participants' tasks can be summarized as follows:

- Understanding their roles in the experiment.
- Performing the assigned roles.
- Clustering the W-D risks from three perspectives (project, process and product). For this task the participants are divided into groups (control and experimental groups): Control group members perform the clustering operation based on their own knowledge whereas, the experimental group use a specific criteria for clustering the risk from the three perspectives.
- Searching twice for certain perspectives risks before and after the clustering

All the participants were told that they had the right to ask for any clarifications during the experiment and they could stop at any stage of the experiment

F. Avoiding Bias

Experiments are very sensitive to errors. Many errors could arise due to bias in the experiment. In order to avoid bias the required information and instructions were provided to all of the participants as hard copies. However, the

 ISBN: 978-1-61208-125-0

criteria factors were provided to experimental group members only as it is used by them only. Moreover, the dividing of the participants into control and experimental groups was on a random basis. This is also to avoid contradiction in the experiment result.

On all the data documents we used only the participants' reference numbers rather than the names or numbers. This anonymity makes the analysis of the data more reliable and saves the privacy of the participants.

Bias is also avoided at the result analysis. This is achieved by sending the gathered data to a third party to help us with the analysis without giving him any information about the subjects.

G. Data Confidentiality

The collected data are strictly confidential to the experimenter and his supervisor. It is only used for research purposes and not for other intention. The participants bibliographic data (e.g., subjects name and number) were only used for providing the free Amazon vouchers (through the school administration) and were discarded afterwards.

V. RESULT AND ANALYSIS

The collected data from the experiment were in the form of tables and question answers, to test the research hypothesis. Several tasks were designed to test each hypothesis. For this reason, we introduce the results and analysis of the data arranged in order of the hypotheses. In this section each hypothesis is stated and followed by the related result and analysis.

A. Hypothesis H2

In order to test Hypothesis H2 we have divided the subjects into two "control" and "experimental" groups (15 in each). In order to avoid bias and contradictions we used a randomization strategy. The randomization in this case was done on the subjects, when they were divided into the two groups (control and experimental).

The subjects of both control and experimental groups have been asked to cluster the risks in Table I from the 3P perspectives. The control group completed their task without giving them any clustering criteria; whereas the experimental group has been given clustering criteria.

There is a significant difference between the time taken by the two groups shown by the Mann-Whitney U statistical test at (**p-value = 0.0079, U = 168.0**).

Generally the total time used by control group participants for the clustering (**56 minutes**) of the risks was less than the time that was used by the experimental group (**108 minutes**). This could be for reasons such as:

- Actual time for reading the criteria, poor design of the criteria design or it is hard to understand the criteria.
- The speed of answering from the control group could be because there is no restriction on their clustering. This raises questions about the accuracy of their clustering.
- Without the criteria the selections and answers could be different from one cycle to another and from one developer to another. This also applies to the required time for the clustering.

In fact using the criteria first time may take some time from the developer for understanding and reading but it is expected that the next cycles will take a shorter time. More training and improvement on the criteria will make it much easier to understand and use the criteria.

TABLE I. NON CLUSTERED POTENTIAL W-D RISKS

Risk No.	Risk Name
1	Unfamiliarity with international and foreign contract law
2	Inadequate customer requirement (see and change strategy)
3	Poor documentation
4	Low visibility of project process
5	Inadequate process development
6	Not enough measurement and estimations
7	Lack of security precautions
8	Weaknesses in protection procedures for Intellectual Property rights
9	Vendor feasibility
10	Insufficient competence
11	Communication failures
12	Poor sites management control
13	Failure to manage user expectations
14	Insufficient project stakeholder involvement
15	Process instability
16	Poor performance
17	Poor UI
18	Insecure of communication channels
19	Lack of requirement specification
20	Inadequate user involvement
21	Difficulties in ongoing support and maintenance
22	Unrealistic estimation of the number of users
23	Differences in the development methodologies and processes
24	Weak or inadequate contracts
25	Complicated development dependencies between project sites
26	A Cross cultural differences / influence
27	Poor product functionality
28	Market fluctuations
29	Scalability limitations
30	Poor availability
31	Lack of top management commitment
32	Instability in other project sites
33	Lack of Face-To-Face meetings
34	Lack of Management availability and efficiency
35	Unfamiliarity with customer type
36	Constraints due to time zone differences

B. Hypothesis H3

To test Hypothesis H3, data was collected from different tasks (2, 3, 7, 8, 3, 4 and 9), which are stated below. The test uses the difference in time and effort between using clustered and non-clustered risks to test this hypothesis. The used time was obtained from tasks 2, 3, 7 and 8 whereas answers for some questions in task 4 (Q2 and Q3) and task 9 (Q1) were used to evaluate the effort. In order to avoid any influence or bias the tasks 7 and 8 were performed

 ISBN: 978-1-61208-125-0

separately from tasks 2 and 3 (in both time and sequence). The following sections describe how the used time and effort are obtained and estimated:

1) Used Time:

Used time can give a preliminary indication of whether the task is easy, difficult or complicated. Task 2 and task 7 were the same, except that task 2 was on non-clustered risks and task 7 was on pre-clustered risks. In these two tasks the subjects have been asked to ***specify two risks for each one of the three perspectives*.**

Task 3 and task 8 were also the same but task 3 was on non- clustered risks and task 8 was on pre-clustered risks. In these two tasks the subjects have been asked to ***specify the perspectives for three pre-ticked risks by the experimenter***.

While the subject was implementing the tasks (2, 3, 7 and 8) the experimenter was monitoring and recording the time. Table II shows the total of the used time during the tasks 2, 3, 7 and 8. The illustrated values in Table II are for the time used by the subjects for both non-clustered and pre-clustered risks. As shown on Table II the subjects spent less time with the pre-clustered risks compared with non-clustered risks for the above tasks, suggesting that clustering from three perspectives reduces the required time for dealing with the risks.

TABLE II. TOTALS OF USED TIME FOR TASKS 2, 3, 7 AND 8

Non Clustered Risks		**Pre-Clustered Risks**	
Task No.	∑ Used Time	Task No.	∑ Used Time
T 2	128.92	**T 7**	42.13
T 3	26.76	**T 8**	8.29

2) Effort:

It is not easy to evaluate effort. We used a set of questions, which were distributed among the tasks in a specific order to gather subjects' feedback and opinions about the usefulness of clustering of the risks from the three perspectives and the spent effort. Moreover, the experimenter monitored the subjects while they were performing the tasks. For this purpose Q2 and Q 3 in task 4 and Q1 in task 9 were designed and asked to the participants. The questions and the answers are shown below:

Task 4/Q2: ***Was it easy for you to specify the risks or perspectives? (Yes / No)***

This question was answered by **29** participants, **13** of them answered ***Yes*** with percentage **44.8 %** and **16** of them answered ***No*** with percentage **55.1 %**.

Task 4/Q3: ***Do you agree with the idea that the above tasks will be much easier and the time and effort can be saved if risks were clustered from the three perspectives?***

Strongly Agree	***Agree***	***Neutral***	***Disagree***	***Strongly Disagree***
1	***2***	***3***	***4***	***5***

As shown in Figure 2 the number of subjects who voted to ***Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree*** are **4, 22, 3, 0, 0** respectively. This means that the majority of the subjects are in agreement (or strong agreement) in their answers for this question.

Task 9/ Q1: ***To what extent do you agree with the idea statement that "concentrating only on the risks of the appointed perspective saves time and effort"***

Strongly Agree	***Agree***	***Neutral***	***Disagree***	***Strongly Disagree***
1	***2***	***3***	***4***	***5***

Figure 3 illustrates the subjects' answers for Q1 in task 9, as shown on the figure the number of answers on the "agree" side (**Strongly Agree and Agree = 20)** is higher than the "disagree" side (**Disagree and Strongly Disagree = 2),** with **6** subjects answering Neutral. This means that the idea of "concentrating only the risks of the appointed perspective to save time and effort" has strong support from the subjects in the experiment.

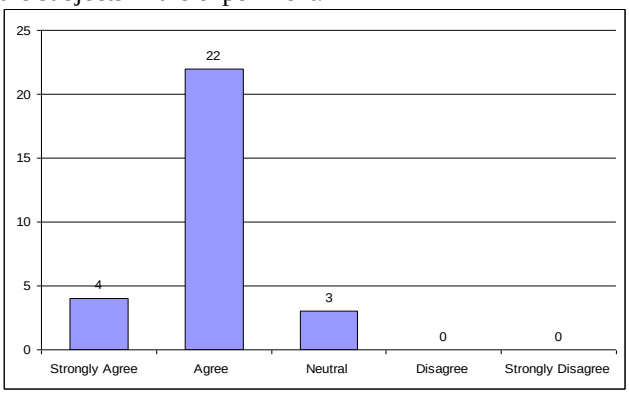

Figure 2: Voting for used effort (clustered and none clustered)

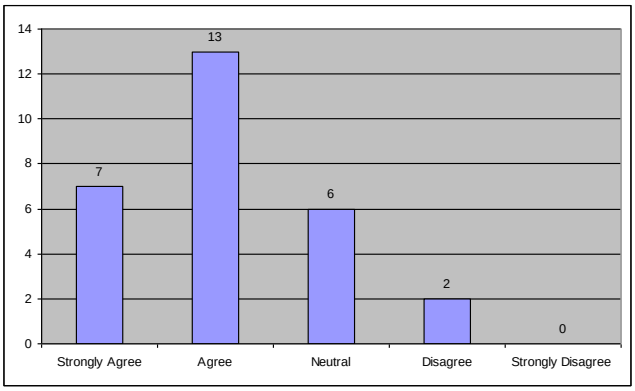

Figure 3: Concentrating on appointed perspective risks saves time & effort

From the above result following points can be remarked:

1- From tasks 2,3,7 and 8 as it can be seen on Table II the total used time for the tasks, which were performed on non-clustered risks was higher than the one, which were performed on pre-clustered risks.

2- After performing tasks 2 and 3 on non-clustered risks the participants were asked "*Was it easy for them to specify the risks or perspectives?"* More than **55%** of them answered **No** to this question. They were asked another question after performing these two tasks, "*Do you agree with the idea that the above tasks will be much easier and the time and effort can be saved if risks were clustered from the three perspectives?"* with 5 options (*Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree*) to select from them. As can be seen in Figure 2 the majority of participants agreed or strongly agreed.

3- After performing tasks 7 and 8 the subjects were asked the same questions but in a different way and in only one question: *To what extent do you agree with the idea statement that "concentrating only on the risks of the appointed perspective saves time and effort" with the same options to answer this question* (*Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree*). Only two subjects disagreed. The rest of subjects agreed (including those who strongly agreed), see Figure 3.

C. The Support of Our Pre-Clustered list

As a side product of the experiment we compared our clustering of the W-D potential list of risks with the clustering of the two groups (control and experimental). The result of that will be used to improve the pre-clustered risks. Table III summarizes the result.

We found that some participants have categorized some risks under more than one perspective.

TABLE III. SUPPORT TO OUR CLUSTERING

Supported By: / Cluster	Both Groups	Control Group only	Experimental Group only	No One
Project Risks	10/13	-	1/13	2/13
Process Risks	4/9	-	1/9	4/9
Product Risks	10/14	-	0/14	4/14
Totals	24/36	0	2/36	10/36

As can be seen in Table III, our clustering of risks has higher support from both control and experimental groups together. In total 66.6 % of our clustering of risks from the 3P perspectives were supported and only 27.7 % were not supported. This is understandable from the numbers shown in Table III. Our clustering for the project and product risks has stronger support from the groups. For the clustering project risks only 2 risks out of 36 were not supported by the groups. Our clustering for the product risk was also strongly supported by the groups as only the clustering of 4 risks out 14 were not supported. By contrast, the support of process risks was medium as the clustering of 4 risks out of 9 was not supported.

VI. DISCUSSION

A. Study Limitation

It would have been preferred if the experiment had been undertaken at one of the software development houses or projects, but this was not feasible as most software companies have restrictions with data security. Several local web development companies were conducted but they were not able to participate.

B. Study Reflection

The following three points summarize the experiment result:

- The result of the experiment was against the Hypothesis H2, the opposite of what was expected. This was clear as the used time by the experimental group was higher than in the case of control groups. The experiment result showed the need for revising and modifying the criteria in order to improve and rectify them.
- Hypothesis H3 is strongly supported by the experiment result.
- The experiment results show the clustering has a significant impact by reducing the time and effort. This result supports the concept of managing the risks from the 3P perspectives in W-D development, because the risks are distributed between the three perspectives and none of them can be ignored. Previous approaches have considered all the risks from the project perspective or, in the best cases (very rare), they might see them from the process perspectives [3]. This wastes developers' time, effort and leads to them locating more resources for one perspective's risks and ignoring others.
- Our pre-clustered risks list of the risks, which is used in the experiment has gained significant support from control and experimental groups. In general the support came from both groups and only in two cases did it come from the experimental group only. However, the clustering of a few risks were not supported by the groups.
- Some risks could affect more than one perspective.

VII. CONCLUSION AND FUTURE WORK

Since it is difficult to find a suitable project and wait for the risks to actually happen, we emulate such a situation pro-actively in an experimental based setting. We have presented the results of the experiment, which is designed to validate some aspects of our research into the *WeDRisk* approach. The results that were presented in this paper cover usefulness of clustering risks from the three "3P" perspectives (project, process and product) and evaluate our criteria factors that can be used for the clustering. The experiment has taken place at School of Computing Science/ Newcastle University, UK. The recruited subjects were 30 participants (MSc, PhD and Post-doctoral

 ISBN: 978-1-61208-125-0

researchers) who either have experience and worked in software development projects or at least have appropriate knowledge with software engineering and software development. The result of the experiment shows the following:

- The clustering of the risks from the three perspectives has got a high degree of support from the subjects.
- It seems that using the criteria for clustering takes more time than clustering without the criteria but:
  - It supports standardization.
  - In the long run, using criteria will take shorter time when the developer becomes familiar with it.
  -Using criteria avoids subjective judgments, which could be different from one practitioner to another.

Without the criteria it is very difficult to decide, which perspective the risk could apply to, particularly if the developer does not have enough experience. In real applications it is expected that developers may have some training on how to use the criteria. The following contributions are made by this work:

- Risks should be considered from the 3P perspectives.
- Clustering identified risks is effective in saving time and effort.

The result of the experiment confirm the importance and usefulness of clustering, considering of the risks from the 3P perspectives as a way for reducing the effort and time in managing the risks and then increasing the efficiency of risk management in W-D developments.

The experiment result also raised the need for updating and improving our proposed clustering criteria to make it more understandable and less time consuming for developers and managers. The result of this experiment will be used to revise and rectify our pre-clustered risks list. Finally, some risks could affect more than one perspective. The experiment has been designed to be ready for any replications in the future if need be.

VIII. REFERENCES

[1] Mishra, D. and A. Mishra, *Distributed Information System Development: Review of Some Management Issues*, in Proceedings of the Confederated International Workshops and Posters on On the Move to Meaningful Internet Systems, Springer-Verlag:, 2009, pp. 282 - 291.

[2] Jim´enez, M., M. Piattini, and A. Vizca´ıno, *Challenges and Improvements in Distributed Software Development: A Systematic Review*. Hindawi Publishing Corporation Advances in Software Engineering Volume 2009, 2009, pp. 1-14.

[3] Keshlaf, A. and S. Riddle, *Risk Management for Web and Distributed Software Development Projects*, in 2010 Fifth International Conference on Internet Monitoring and Protection ICIMP2010, IEEE Computer Society, 2010, pp. 22-28.

[4] Ebert, C., B. Murthy, and N. Jha, *Managing Risks in Global Software Engineering: Principles and Practices*, IEEE International Conference on global software engineering ICGSE'08, 2008, pp. 131-140.

[5] Boehm, B., A. Egyed, J. Kwan, D. Port, A. Shah, and R. Madachy, *Using the WinWin Spiral Model: A Case Stud*, IEEE Computer, 1998, pp. 33 - 44.

[6] Misra, S., U. Kumar, V.Kumar, and M. Shareef, *Risk Management Models in Software Engineering.* International Journal of Process Management and Benchmarking (IJPMB), 2007. **2**(1): pp. 59-70.

[7] Kirner, T. and L. Goncalves, *Software Risk Management: a Process Model and a Tool*, in *Software Engineering Techniques: Design for Quality*, Springer Boston, 2007, pp. 149-154.

[8] Islam, S., *Software Development Risk Management Model – A Goal Driven Approach*, in ESEC/FSE Doctoral Symposium'09 2009, ACM: Amsterdam - The Netherlands.

[9] Kontio, J., *The Riskit Method for Software Risk Management*, Version 1.00 CS-TR-3782 / UMIACS-TR- 97-38, in CS-TR-3782 / UMIACS-TR- 97-38, Computer Science Technical Reports, C.-T.-U.-T.-. 97-38, Editor. 1997, University of Maryland: Maryland.

[10] Fewster, R. and E. Mendes, *Measurement, Prediction and Risk Analysis for Web Application*, in Proceedings of 7th International Software Metrics Symposium, METRICS-2001, IEEE Computer Society, 2001, pp. 338 - 348.

[11] Presson, J., L. Mathiassen, J. Boeg, T. Madsen, and F, Steinson., *Managing Risks in Distributed Software Projects: An Integrative Framework.* IEEE Transaction on Software Engineering, 2009. **56**(2): pp. 508-532.

[12] Rabbi, M. and K. Mannan, *A Review of Software Risk Management for Selection of Best Tools and Techniques*, in Proceedings of 9th ACIS International Conference on Software Engineering, Artificial Intelligence, Networking, and Parallel / Distributed Computing, IEEE Computer Society, 2008, pp. 773 - 778.

[13] Gorski, J. and J. Miler, *Towards an Integrated Environment for Risk Management in Distributed Software Projects*, in Proceedings of 7th European Conference on Software Quality ECSQ2002. 2002.

[14] Kuni, R. and N. Bhushan, *IT Application Assessment Model for Global Software Development*, in *IEEE International Conference on Global Software Engineering (ICGSE'06)*. 2006, IEEE Computer Society, 2006, pp. 92 - 100.

[15] Keshlaf, A. and S. Riddle, *Web and Distributed Software Development Risks Management: WeDRisk Approach.* International Journal On Advances in Software, vol. 3&4 2010. **Unpublished**.

[16] Dunphy, P., A. Heiner, and N. Asokan, *A closer Look at Recognition-Based Graphical Passwords on Mobile Devices*, in Proceedings of the Sixth Symposium on Usable Privacy and Security SOUPS'10, ACM, 2010, pp. 1-12.

[17] Maxion, R. and K. Killourhy, *Keystroke Biometrics with Number-Pad Input*, In IEEE/IFIP International Conference on Dependable Systems & Networks (DSN-10), 2010, pp. 201-210.

[18] Kitchenham, B., S. Pfleeger, L. Pickard, P. Jones, K. Elemam, and J. Rosenberg., *Preliminary Guidelines for Empirical Research in Software Engineering.* IEEE Transactions on Software Engineering, 2002. **28**(8): pp. 721 - 734.

 ISBN: 978-1-61208-125-0