Risk Mitigation Techniques in Agile Development Processes

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***Abstract*— The main purpose of agile development methods is to reduce risks leading to a more successful and effective information system. In fact, analysing priorities, finding and identifying risks are important activities in all development approaches, including Agile development. However, some studies seek to assess risk management based on agile global software development (GSD) and provide mitigation measures to address specific risks. The risk mitigation technique for good development for sustainable development is expected to be designed to achieve time efficiency improvements to obtain greater resources at lower cost and thereby gain and maintain a competitive advantage.**

***Keywords*—** *Agile; Risks; Risk Mitigation; Global Software Development*

1. Introduction

Agile is a group of software development methods that are based on iterative and incremental development [1]. It is widely known for its flexible approach in managing the requirement volatility and emphasis on extensive collaboration between customers and developers [2]. Agile practices are based on the philosophy of close, frequent and collocated collaborations [3]. There are few methods in Agile such as Scrum, XP, FDD and others. All Agile methodologies major characteristic are adaptive planning, iterative & evolutionary development, rapid and flexible response to change and promote communication [4,5]. The very nature of this development process is in obeying the principles of "light but sufficient", people-oriented and communication-centred. Due to the fact that this is lightweight process, it is mostly used for small scale projects [6]. The concept of Agile is that production teams should start with simple and predictable approximations to the final requirement and then continue to increase the depth of these requirements throughout the life of the development. Indirectly this leads further to the refinements of design, coding and testing at every stages of production activity. As a result, the requirements work product is as accurate and useful as the final software should be [7].

Recent trend in software development industry is to move towards Global Software Development (GSD) and it is driven by various factors such as improved network infrastructure, move towards component-based architecture and increased time-to-market pressure [8]. Due to Agile Software Development (ASD) flexible approach in managing requirement volatility and emphasis on extensive collaboration between customers and developers, an increased number of GSD project managers are seriously considering introducing agile practices [9].

Risks in agile projects are defined as an uncertain event or set of events that should it occur will have an effect on the accomplishment of objectives [10]. The events can be categorised into two categories positive or negative risks, while the positive risks mean the rise of an opportunities and negative risks means something that pose threat to the project. So, a need to control activities arises when there is an activity that can pose threat to the project [11].

Identifying, assessing risks, and defining suitable steps to manage these risks are important [10]. Insufficient risk management could result in:

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- Inability to make knowledgeable risk identifications and project resolutions.
- Inability to effectively establish the suitable risk response.
- Absence of effective risk monitoring resulting in unsuccessful or incompetent management of risks.
- Inadequate knowledge of when to participate in risk operations.

The key to handle risks lies in the process of identifying and prioritising of appropriate risk response strategies based on risk exposure and in-line with Agile practices. The ability to judge whether a risk is managed effectively and efficiently comes through monitoring the risk.

2. Related Works

As the paper focus on risk mitigation, it is appropriate to provide brief introduction about the existing risks in Global Software Development which are spilt into 3 categories.

A. Geographical Distance

It is the physical separation between the development teams. Two sites located in a same country with ease to access, means of transportation and reachability are considered as close even it is separated by a large distance. While, two sites which have little transportation and intervening border are not considered geographical close [12].

B. Socio-Cultural Distance

The language, religion, social status, basic assumptions and economical condition difference between the development team members. Culture plays a humongous part on how a people interact on different problem, how they response and how they resolve to the issue [13].

C. Temporal Distance

Time gap between two teams who want to communicate is called temporal distance. Two teams located at two different time zone are one of the factors that result in temporal distance. Geographical distance plays a big part in temporal distance [12].

3. Methodology

SLR guidelines proposed by [14] have been followed for this study. The definition of this process is to identify, assess and interpret all relevant and available research proofs in order to be able to provide answers to the research questions proposed.

A. Research Questions

Table 1 shows the criteria and scope of the research questions structure, which is the Population, Intervention, Comparison, Outcomes and Context [PICOC] structure.

(Table 1) Summary of PICOC

Criteria	**Scope**
Population	Papers proposing techniques for risk mitigation
Intervention	Risk mitigation
Comparison	Agile GSD
Outcomes	Suggest how risk mitigation techniques can be implemented in Agile GSD
Context	Risk mitigation techniques

Based on Table 1, the research questions are:

[Q1] How many studies mentioned risk mitigation in Agile GSD and when were the initial and latest studies?

[Q2] Were any techniques proposed for risk mitigation in Agile GSD?

B. Search Strategy

The search strategy used to construct the search string was based on [15], which is as follows: (1) Major terms are derived for use in the review questions [for example: it will be based on population, intervention, outcome and context] (2) Known keywords mentioned in the articles are listed (3) The use of Boolean AND in order to connect the main terms to outcome, intervention and population.

Therefore, the complete search strings used for this paper are as follows:

[*Agile* OR *Agile Methodology*] AND [*Risk Mitigation* OR *Risk Management*] AND [*Global Software Development* OR *GSD*]

The research paper found were classified according to the publication type. Later, different search methods were employed by manually filtering the conference, journals, books, and websites by checking each of the publications that were published in the year 2008 and later.

C. Selection Criteria

The inclusion criteria for this paper include studies that primarily target Software Engineering and focus on Agile GSD and risk mitigation technique. The priority hierarchy from "most important" to "least important" in regard to publication type is as follows: Journals > Conference Proceedings > Books > Websites > White Papers.

In addition, the paper found must include the following criteria in order to be included in this paper.

- Indexed by known databases such as IEEE Xplore, Springer, SpringSim, ACM, etc.
- Written in English
- Subjects covered must include Software Engineering, specifically in the Computer Sciences field.

D. Qualitative Analysis

To speed up the data extraction process, a form was designed. It was used to gather proof related to the research question and as a qualitative measurement for the study. Table 2 shows the questions that were asked after the keywords chosen for this study were analysed.

(Table 2) Questions

Question	**Answer**
Q2. Was the article about Agile and GSD specifically?	Yes/No
Q3. Was Risk Mitigation mentioned in the paper	Yes/No
Q4. Did the paper make mention of a quantitative measurement regarding the effectiveness of the study?	Yes/No/Partial
Q5. Will the paper contribute to the research conducted?	Yes/No/Partial

4. Results

Appendix A shows the results of the search procedure. Initially, we identified 53 papers. However, after completing qualitative analysis, we only managed to identify 40 papers relevant to the study and SLR references.

Although some of the papers might propose a technique for risk mitigation, they were not selected. This is because they were either not meant for Agile GSD or were for learning purposes.

The papers in Appendix A were reviewed individually while data was extracted, and questions proposed during the qualitative analysis were answered. The answers to the questions have been recorded.

A. Sources of the Study

Based on table from Appendix A, the main sources for the papers were books focusing on Agile Methodology. Although the years of the books vary, fifteen publication came from such sources. Conference proceedings follow as a primary source, with most papers coming from IEEE, ResearchGate and Springer. Finally, there were 9 journals and the rest from white paper. Most of the sources are about risk mitigation and agile methodology. Table 3 below shows the sources of papers found and the amount of paper for each source.

(Table 3) Papers Found

Acronym	**Type**	**Number of publications**
IJCTEE	Journal	1
IJCSSE	Journal	1
IEEM	Proceedings	1
ICGSE	Proceedings	5
EASE	Proceedings	1
JSCE	Journal	1
ICIMTR	Proceedings	1

ICTMS	Proceedings	1
IC3	Proceedings	1
APSEES	Proceedings	1
ITMC	Proceedings	1
AEECT	Proceedings	1
KBEI	Proceedings	1
PACIS	Proceedings	1
ICISA	Proceedings	1
ProjMAN	Proceedings	1
RITO	Proceedings	1
CoCoNet	Proceedings	1
ICSS	Proceedings	1
TOSEJ	Journal	1
ICEMT	Proceedings	1
IST	Journal	3
ICCSA	Proceedings	1
AHFE	Proceedings	1
ITOR	Journal	1
SEKE	Proceedings	1
IET	Journal	1
CCIS	Proceedings	1
UBMK	Proceedings	1
PICMET	Proceedings	1
ECIS	Proceedings	1
Book Review	Book	15
White Paper		1

5. Discussion

In this section, we discuss about the answers to the studies research questions.

Q1: How many studies mentioned risk mitigation in Agile GSD and when were the initial and latest studies?

Around 30 studies mentioned both risk mitigation and Agile GSD. 12 papers talked about risk mitigation. Only 5 mentioned Agile GSD. The latest study that mentioned agile GSD and risk mitigation was from 2018 and, according to this SLR, the initial study was from 2008

Q2: Were any techniques proposed for risk mitigation in Agile GSD?

This SLR found 17 papers provide existing techniques for risk mitigation in Agile GSD.

6. Conclusion

There are quite a few established studies regarding risk mitigation in Agile GSD. We conducted an extensive literature review using 9 journals, 28 conferences, 15 books and 1 white paper, with most of the material coming from 2014. Based on this review, we noted that there is extensive evidence that integration would definitively benefit IT organizations that use the Agile GSD in developing software. Without proper risk mitigation plans development process of a software can bring unnecessary risks.

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Appendix A

ID	Author	Year	Title	Type	Q1	Q2	Q3	Q4
S1	Gaurav Kumar	2012	Impact of Agile Methodology on Software Development Process	Journal	Y	N	P	P
S2	Abdulaziz Alsahli	2017	Agile Development Overcomes GSD Challenges: A Systematic Literature Review	Journal	Y	Y	Y	P
S3	M. J. Akhtar	2010	Scrum Adoption, Acceptance and Implementation	Proceedings	Y	N	N	P
S4	V. Mudumba	2010	A New Perspective on GDSD Risk Management	Proceedings	Y	Y	P	Y
S5	Emam Hossain	2009	Using Scrum in Global Software Development: A Systematic Literature Review	Proceedings	Y	N	Y	P
S6	Emam Hossain	2009	Risk Identification and Mitigation Processes for Using Scrum in Global Software Development: A Conceptual Framework	Proceedings	Y	Y	N	Y
S7	Franz Zieris	2013	Doing Scrum Rather Than Being Agile: A Case Study on Actual Nearshoring Practices	Proceedings	Y	N	N	P
S8	Indira Nurdiani	2011	Risk Identification and Risk Mitigation Instruments for Global Software Development: Systematic Review and Survey Results	Proceedings	Y	Y	P	Y
S9	J. M. Verner	2012	Systematic Literature Reviews in Global Software Development: A Tertiary Study	Proceedings	N	N	P	N
S10	Suprika Vasudeva Shrivastava	2010	Distributed Agile Software Development: A Review	Journal	Y	Y	N	P
S11	Arif Ali Khan	2013	A Proposed Framework for Communication Risks during RCM in GSD	Proceedings	Y	Y	N	Y
S12	Suprika Vasudeva Shrivastava	2013	Risks in distributed agile development: A review	Proceedings	Y	Y	N	Y
S13	Ruchi Agrawal	2016	Prioritizing and Optimizing Risk Factors in Agile Software development	Proceedings	Y	Y	Y	P
S14	Christopher R. Nelson	2008	Explicit Risk Management in Agile Processes	Proceedings	Y	Y	N	P
S15	Lubna Siddique	2014	Practical Insight about Risk Management Process in Agile Software Projects in Norway	Proceedings	Y	Y	N	P
S16	Aalaa Albadarneh	2015	Risk Management in Agile Software Development: a Comparative Study	Proceedings	Y	Y	P	Y
S17	Benjamin Gold	2015	Using Risk Management to Balance Agile Methods	Proceedings	N	Y	N	N
S18	Yehia Ibrahim Alzoubi	2014	Agile Global Software Development Communication Challenges: A Systematic Review	Proceedings	Y	Y	N	P
S19	Muhammad Usman	2014	Analysing and Reducing Risk Factor in 3-C's Model Communication Phase used in Global Software Development	Proceedings	Y	Y	N	P
S20	Zakari Tsiga	2017	Implementation of a Risk Management Simulation Tool	Proceedings	Y	Y	N	P
S21	Sunil Kumar Khatri	2014	Best Practices for Managing Risk in Adaptive Agile Process	Proceedings	N	Y	Y	P
S22	Hycinta Andrat	2015	An Alternative Approach for Risk Assessment in Scrum	Proceedings	N	Y	Y	P
S23	Marc Schmalz	2014	Risk Management in Video Game Development Projects	Proceedings	N	Y	N	N
S24	Ansgar Lamersdorf	2010	Studying the Impact of Global Software Development Characteristics on Project Goals: A Causal Model	Journal	N	N	P	Y
S23	Shakeel A. Khoja	2010	Quality Control and Risk mitigation: A Comparison of Project Management Methodologies in Practice	Proceedings	Y	Y	P	Y
S24	J. M. Verner	2014	Risks and Risk Mitigation in Global Software Development: A Tertiary Study	Journal	N	Y	N	P

S25	Suprika Vasudeva Shrivastava	2014	Categorization of Risk Factors for Distributed Agile Projects	Journal	Y	Y	P	Y
S26	Suprika Vasudeva Shrivastava	2016	A Risk Management Framework for Distributed Agile Projects	Journal	Y	Y	Y	Y
S27	Joana Oliveira	2016	Is Scrum Useful to Mitigate Project's Risks in Real Business Contexts?	Proceedings	Y	Y	P	Y
S28	Muhammad Ahmed	2018	Estimation of Risks in Scrum Using Agile Software Development	Proceedings	Y	Y	N	P
S29	Breno Gontijo Tavares	2017	Risk management analysis in Scrum software projects	Journal	N	Y	N	N
S30	Breno Gontijo Tavares	2017	Risk Management Analysis in Software Projects which Use the Scrum Framework	Proceedings	N	N	P	N
S31	Muhammad Hammad	2018	Integrating Risk Management in Scrum Framework	Proceedings	Y	Y	Y	Y
S32	S. Sundarajan	2014	Case Study on Risk Management Practice in Large Offshore-Outsourced Agile Software Projects	Journal	Y	Y	P	Y
S33	Antti Välimäki	2009	Global Software Development Patterns for Project Management	Proceedings	Y	N	N	N
S34	Murat Dogus Kahya	2018	Geographical Distance Challenges in Distributed Agile Software Development: Case Study of a Global Company	Proceedings	Y	Y	P	P
S35	Lucio Ribeiro	2009	A Case Study for the Implementation of an Agile Risk Management Process in Multiple Projects Environments	Proceedings	Y	Y	Y	Y
S36	C. Sharon	2015	A Case Study of Risk Management in Agile Systems Development	Proceedings	N	Y	N	N
S37	Sadhana Deshpande	2011	Global Software Development Coordination Strategies - A Vendor Perspective	Book	N	N	N	N
S38	A. Moran	2016	Risk Management in Agile Projects	Book	N	Y	P	P
S39	Rory V. O'Connor	2009	Software Process Improvement	Book	Y	Y	N	P
S40	A. Moran	2014	Agile Risk Management	Book	Y	Y	P	P
S41	B. Meyer	2014	Agile!	Book	N	N	N	N
S42	A. Moran	2015	Managing Agile	Book	Y	Y	P	P
S43	T. Silva da Silva	2017	Agile Methods	Book	N	N	P	N
S44	Dingsyor	2010	The Agile Consultant	Book	Y	Y	N	P
S45	R. Freeman	2016	Agile Software Development	Book	Y	Y	N	P
S46	C. Schmidt	2016	Agile Software Team Development	Book	N	Y	Y	P
S47	A. Medinilla	2012	Agile Management	Book	N	Y	N	P
S48	O. Hazzan	2014	Agile Anywhere	Book	N	N	N	N
S49	J. Dalton	2018	Great Big Agile	Book	Y	Y	P	P
S50	V. A. Santos	2018	Agile Methods	Book	N	N	P	N
S51	T. J. Brizard	2015	Broken Agile	Book	Y	Y	P	P
S52	A. Elbanna	2015	Risks of Agile Software Development: Learning from Adopters	White Paper	N	Y	N	N
S53	J. Munch	2011	Risk Management in Global Software Development Projects: Challenges, Solutions, and Experience	Proceedings	N	Y	N	P