A Systematic Approach for Identifying Requirement Change Management Challenges: Preliminary Results

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ABSTRACT

Requirement Change is one of the most challenging tasks in software development lifecycle, particularly in the complex context of Global Software Development (GSD). During the last decade, many studies are carried out to address these problems, however, careful examination of these works suggests that there's a potential research gap. This paper has performed a Systematic Literature Review (SLR) to identify the most significant/commonly studied challenges of requirement change management process and furthermore this process under GSD context. We identified ten challenges such as impact analysis, cost estimation, artifacts documents management, requirement traceability, requirements dependency, conflicts with existing requirements, time estimation, change prioritization, user involvement, and system destabilizing. Furthermore, three challenges such as communication and coordination, knowledge sharing, management, and Change Control Board (CCB) management are identified for globally distributed projects. We also mapped these identified challenges to Requirement Change Management Process (RCMP) outcomes proposed in our previous study. We believe that mapping between RCM challenges and RCMP outcomes will enhance the practical significance of this study results. Considering the systematic literature review results, we suggest that there is a need to develop a framework for requirement change management for quality software systems development.

CCS CONCEPTS

Software Engineering, Software Requirements Management

KEYWORDS

Requirement change management, Requirements evolution, Global software development, Systematic literature review

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1 INTRODUCTION

Requirements Engineering (RE) is one of the critical phase of Software Development Life Cycle (SDLC), and a study in the UK reported that 40% of the total software development process problems are related to RE process [1]. Furthermore, requirement change is the only fact that is perpetual throughout a project lifecycle and sometimes about 50% of the system requirements modified before they are put into service [2]. An improvised, vague and poorly executed requirement change management process can result in many problems related to cost and time, and even jeopardize the project success [3-5]. The study conducted by Standish (2017) revealed that requirement change increases the project cost by three times and project time by two times [6].

A number of factors have driven these changes, such as evolving customer needs or business goals, organizational policies, working or system operating environment, and government regulations. Similarly, having various ways to express the requirements by different stakeholders also results in ambiguity and inconsistency in requirements, and causes requirement change [7]. Furthermore, because of various benefits such as low cost, access to skillful teams, and access to market, many companies has adopted GSD paradigm [8]. However, the presence of cultural, temporal, and geographical differences in GSD complicates this process even further [9-11]. Additionally, requirements change also negatively impacts work distribution in GSD projects [12].

In spite of the importance of an effective RCM process in software quality and success, little research has been carried out to identify and analyze the key RCM challenges, and even ISO/IEC standards don't have RCM as a formal process.

In order to develop an RCM framework and eventually to design quality software systems, we carried out a systematic and methodological approach (SLR) to identify the most important/commonly studied challenges that influence the RCM process. In addition to core RCM process challenges, we identify some other challenges that affect the RCM in globally distributed projects. In previous study, we proposed a novel RCMP, which fills

the research gap identified in ISO/IEC standards [13], and to achieve practical significance of identified challenges, we developed a mapping of identified challenges to RCMP outcome. We believe that our SLR on key RCM challenges or risks lays a critical foundation to develop an RCM framework and a mapping of RCM challenges to RCMP outcome helps to make effective use of SLR results.

The rest of this paper is organized as follows. A literature review of existing research is presented in section 2. Section 3 introduces the research methodology of the current research. Initial results are presented in section 4. Lastly, conclusion and future work are discussed in section 5.

2 BACKGROUND

Software development is a dynamic process, and requirement change or evolution is inevitable and driven by a number of factors like change in market trends, business goals and customer needs [14]. Accordingly, effective requirement change management model or framework is required to develop quality software systems. Furthermore, in the context of GSD, the presence of diverse sets of stakeholders, temporal, and geographical differences make the RCM process more difficult for globally distributed projects [15, 16].

In the past, many empirical studies have been carried out to explore different aspects of RCM process. Accordingly, Jayatilke and Lie [17] investigated the existing research/literature on causes of change, processes, and techniques designed to manage requirement change problems. Formal and semi-formal processes of RCM have been critically evaluated. They used the same approach as we performed, however, this study focuses on only generic concepts related to RCM process such as cause of change etc. and somehow missed the potential challenges that lie in RCM process. In another study, Ali and Li [18] implemented a three-stage requirement change management model for globally distributed projects. Their results showed the practical significance of proposed approach and addresses some of the important aspects of RCM problems. However, their approach is inadequate in two perspectives: First, they missed the communication mechanism across different GSD sites with the consideration of different project management approaches in GSD paradigm. Second, they missed the constitution and execution of CCB.

Furthermore, Khan, A. et. al. [19, 20], used empirical technique such as SLR, questionnaire to investigate the communications risks of RCM process in GSD projects. They concluded that, due to geographical, socio-cultural, and temporal differences, communication and coordination is crucial in RCM process of globally distributed projects. These two studies investigated communication risks affecting RCM process in globally distributed projects which is one of the challenges that influence RCM in GSD paradigm, however these empirical studies missed many other important aspects of GSD paradigm such as knowledge management and sharing, and CCB management.

To the best of our knowledge, little research has been undertaken to explore the challenges associated with RCM process. Only one study [21] carried out, and they identified some challenges related to RCM process, including reusability, change activity management, software artifacts management, and change automation. However, they used ordinary literature review technique which is not as systematic as SLR and missed some relevant papers.

In Summary, no systematic empirical study such as SLR has been undertaken to identify the RCM process challenges. Secondly, the temporal, cultural and geographical differences in GSD paradigm instigate many challenges in RCM process. Accordingly, there is a need to investigate the challenges that affect the RCM process of globally distributed projects. We believe that our SLR results about RCM process challenges for globally distributed projects would fill the identified research gaps and at the same time would help to develop a framework to handle requirement change problems.

3 RESEARCH METHODOLOGY

Systematic Literature Review (SLR) is an approach to identify, access, and elucidate the existing research relevant to a specific research areas, or phenomenon of interest [22]. An SLR provides an opportunity to achieve a deeper insight into a relevant area. An SLR is a defined and methodical way of identifying, assessing, and analyzing published primary studies, which are usually not fully addressed in ordinary literature reviews approaches. An SLR also allows researchers to identify potential research gaps in published research for future research activities. The major steps of the SLR process followed in this study are:

- Construct and execute search strategy for relevant studies.
- Perform a study selection process.
- Apply quality assessment criteria.
- Extract data and analyze the extracted data.

Research question formulation is the first step of an SLR process. In this paper, we formulated the following two research questions:

RQ1: What are the challenges of an RCM process?

RQ2: What are the challenges of an RCM process in global software development?

In the second phase, we formulated the search strategy according to our defined research questions. In the third phase, studies relevant to the phenomena of interest were selected based on a defined selection process. And then on selected primary studies quality assessment were performed. In the last, the data was extracted from selected primary studies for further analysis. The SLR was undertaken by three researchers, i.e. one student and two academic staff members.

3.1 Search Strategy

This subsection presents the search strategy to execute an SLR process. To design the search strategy, we perform the following steps:

- Extract search terms from defined research questions.
- Identify synonyms or search term for main search keywords.
- Design search string using AND and OR boolean operators.

In this study, the following keywords were identified as major search terms.

RQ1: Challenges, Requirement Change Management

RQ2: Challenges, Requirement Change Management, Global Software Development

By performing cross-validation in well reputed academic repositories, we identified the following main search terms or synonyms for each search keyword.

Challenges: “Challenges” OR “problems” OR “difficulties” OR “complications” OR “obstacles” OR “barriers” OR “hurdles” OR “risks”

Requirement Change Management: “Requirement change” OR “Requirement Volatility” OR “Requirement Creep” OR “Requirement Change management” OR “Requirement change difficulties” OR “Requirement change analysis” OR “Requirement change identification/type” OR “requirement change models/processes”

Global Software Development: “Global software development” OR “global project management” OR “GSD” OR “Global Software Development” OR “Offshore software development” OR “distributed software development” OR “offshore outsourcing” OR “Global Software Engineering” OR “Distributed Software Engineering” OR “GSE”

After defining the synonyms or search term for each search keyword, we have defined the following search strings (only RQ1 presented as sample).

{“Challenges” OR “problems” OR “difficulties” OR “complications” OR “obstacles” OR “barriers” OR “hurdles” OR “risks”} AND

{“Requirement change” OR “Requirement Volatility” OR “Requirement Creep” OR “Requirement Change management” OR “Requirement change difficulties” OR “Requirement change analysis” OR “Requirement change identification/type” OR “requirement change models/processes”}

Some relevant publications used to validate the search terms and search string. The following academic research repositories were used for this study.

- IEEE Access. (<http://ieeexplorer.ieee.org>)
- Science Direct. (<http://www.sciencedirect.com/>)
- Springer Link. (<http://link.springer.com/>)

- ACM Digital Library. (<http://dl.acm.org>)
- Google Scholar. (<http://scholar.google.com/>)

Because these research sources differ in their search mechanisms, we customized the search strings accordingly.

In the next phase, primary studies selection process was performed. The student performed the primary studies selection process and the academic staff members cross verified the selection process. In the first iteration, studies were selected based on the paper title and abstract. In the second iteration, the selected studies were shortlisted by reading the complete papers. Additionally, general criteria for inclusion and exclusion of studies will be applied. The broad search was conducted in May and June 2018 and the studies published or available online till 30, June 2018 are included in data extraction process.

The following inclusion criteria were used in the selection process:

- Conference Proceedings, book chapters and Journals published after 1995.
- Studies focused on answering our research questions.

Furthermore, the following exclusion criteria were used:

- Papers written in non-English language.
- Master thesis, and PhD dissertation.
- Technical reports, and white papers.

In the next phase, each paper was assessed based on the quality criteria shown in Table 1. There are two possible answers Yes=1 and No=0 for each quality assessment question. The minimum quality score of 3 (75%) was used to select primary studies. Finally, 43 studies were selected based on the inclusion and quality assessment criteria.

Table 1: Quality assessment

Quality Criteria	Notes
Are the research goals clearly stated in the paper?	Yes =1 No =0
Is the proposed technique clearly described and justified?	Yes =1 No =0
Was the research empirically validated?	Yes =1 No =0
Does this study discuss the RCM challenges for general RCM process or GSD projects?	Yes =1 No =0

4 INITIAL RESULTS AND DISCUSSION

This section introduces the preliminary findings of an SLR and mapping between RCM challenges and RCMP outcomes. The total number of results obtained by executing the search strings are shown in Table 2. Appendix A lists the complete list of studies selected by SLR.

Next, we will discuss RCM challenges frequency and their mapping RCMP outcomes. Below is the list of outcomes of the RCMP proposed in [13].

1. *Items to be changed are identified and recorded.*
2. *Change impacts are analyzed.*
3. *The cost and schedule of changing items are estimated.*
4. *Changes to the items under requirement change are approved.*
5. *Changes to the items under requirement change are implemented.*
6. *Changes to the items under requirement change are verified and validated.*
7. *Changed items deliverables are updated and communicated to concerned parties*

Table 2: Search Execution

Resource	Total Results	Initial Selection	Final Selection
IEEE Xplore	60	29	16
ACM	15	10	03
Science Direct	41	16	10
Springer	68	34	14
Total	184	89	43

The SLR has identified 43 papers. Among them 32 are deal with general RCM challenges and 11 of them with RCM under GSD context.

A coding scheme based on grounded theory was used to review the literature and conceptualize the underpinning RCM challenges. We have identified, labelled and grouped the related challenges to general categories and calculated the frequency. Furthermore, similar or related challenges were semantically compared and grouped under relevant categories. Our study discovered ten challenges of general RCM process, which are listed in Table 3 with frequencies (appears in how many papers) and their mapping with RCMP outcomes.

Table 3: RCM process challenges ranking and their mapping to RCMP outcomes

Challenges	Frequency (total=32)	%	RCMP outcomes
Impact Analysis	21	67	2
Cost Estimation	8	25	3
Artifacts Documents Management	8	25	1, 4, 7
Requirement Traceability	7	22	1, 7
Requirements Dependency	5	16	1
Change Conflicts with Existing Requirements	4	12	4, 6
Time Estimation	4	12	3

Change Prioritization	2	6	4, 5
User Involvement	2	6	1, 3, 7
System Destabilizing	1	3	-

From the above table, we can see that impact analysis is the most highly cited challenge (67%) and it is mapped to outcome 2 of RCMP outcomes. In RCM process, inclusion/exclusion or modification of requirements requires careful analysis of new system state, consistency with existing business goals and impact on other operational constraints [4, 7].

Cost and time estimation are one of the critical aspects of project management cited by (25%) and (12%) of the primary studies respectively. It is obvious these two challenges are mapped to outcome 3. Artifacts documents management is another key challenge of RCM process studied and cited by (25%) of existing research. The management of SDLC phases product such as requirement document, design document, source code, and testing document is crucial, especially if change occurs in the last phases of SDLC such as during testing. In connection with RCMP outcomes, it can be mapped to outcome 1, 4, and 7, because these three also deal with documents management. Similarly, Requirements traceability is cited by (22%) of primary studies and can be mapped to outcome 1 and 7 of RCMP outcomes.

The other key challenge of RCM process is requirement dependency (16%), which impacts RCM in the early phase and can be mapped to outcome 1. Similarly, requested change conflict with existing requirements is cited in 12% of primary studies, impacts RCM process during approval and implementation, and accordingly can be mapped to outcome 4 and 6. Additionally, change prioritization and user involvement are less frequently studied and can be mapped to outcome 4, 5, 1 and 3, 7 respectively.

Finally, system destabilizing is another challenge, but it seems difficult to find suitable mapping with RCMP outcomes. This is an open question that needs further assessment of both literature and RCMP.

Apart from general RCM process, we have identified three key challenges that are specific to the RCM of globally distributed projects, as shown in Table 4.

Table 4: RCM-GSD challenges ranking and their mapping to RCMP outcomes

Challenges	Frequency (total=11)	%	RCMP outcomes
Communication & Coordination	10	91	1, 3, 7
Knowledge Management & Sharing	8	73	1, 4, 7
Change Control Board (CCB) Management	2	18	4

In GSD paradigm, the teams are distributed across different geographical development sites, and the presence of temporal and

cultural differences often cause many difficulties. Communication & coordination are the key challenges that impacts RCM and this point is confirmed in this research (91%), and mapped to outcome 1, 3, and 7, because these outcomes requires communication with the end user. The next key challenge is knowledge management and sharing cited in 73% of primary studies. It is mapped to RCMP outcome 1, 4, and 7 similar to artifacts documents management. Finally, CCB management deals with change approval cited in 18% of primary studies and is mapped to outcome 4. Considering the above discussion, some mappings are obvious, and some mappings are arguable and could be adjusted in the future.

There are some limitations of this study. The main limitation of this study is incompleteness. Our findings depend on the set of keywords and search engines, which might not cover all relevant studies. In order to limit the risk of incompleteness in keywords lists, we used a set of well-known RCM papers to build the search terms. We also used four different electronics databases to reduce inherent limitations of existing search engines. Also, the search engine may miss some most recent publications. However, we believe that our preliminary results cover most relevant published works.

5 CONCLUSION AND FUTURE WORK

Requirement change management is an important aspect of the requirement engineering phase and plays a crucial role towards project success. Changed customer needs, market trends, and organizational or business needs are the main reasons of RCM. In the presence of temporal and geographical differences, this process becomes even more difficult. The requirement evolution could overshadow the benefits gained through the presences of globally distributed teams.

As a first step to address these issues, we identified a list of RCM challenges through SLR. The most cited RCM challenges are impact analysis, time and cost estimation, artifacts documents management, requirements traceability, requirements dependency, and requested change conflicts with existing requirements. In addition to these challenges for the general RCM process, three challenges are identified that influence the RCM process in globally distributed projects. Finally, we map these identified challenges with the RCMP outcomes proposed in our previous study. We believe that, mapping of SLR results with RCMP outcomes helps industry professional to make effective use of SLR results.

In the future, we plan to conduct an empirical study with the industry professionals to validate our SLR results. We also aim to improve the mapping of RCM challenges with RCMP outcomes.

REFERENCES

- [1] T. Hall, S. Beecham, and A. Rainer, "Requirements problems in twelve software companies: an empirical analysis," *IEEE Proceedings-Software*, vol. 149, no. 5, pp. 153-160, 2002.
- [2] G. Kotonya and I. Sommerville, *Requirements engineering: processes and techniques*. Wiley Publishing, 1998.
- [3] M. Bano, S. Imtiaz, N. Ikram, M. Niazi, and M. Usman, "Causes of requirement change-a systematic literature review," 2012.
- [4] S. Lock and G. Kotonya, "An integrated framework for requirement change impact analysis," in 4th Australian Conference on Requirements Engineering, 1999.
- [5] I. Sommerville and J. Ransom, "An empirical study of industrial requirements engineering process assessment and improvement," *ACM Transactions on Software Engineering and Methodology (TOSEM)*, vol. 14, no. 1, pp. 85-117, 2005.
- [6] "Standish-Group: Chaos - the state of the software industry (2017)."
- [7] W. Hussain, D. Zowghi, T. Clear, S. MacDonell, and K. Blincoe, "Managing Requirements Change the Informal Way: When Saying 'No' is Not an Option," in *Requirements Engineering Conference (RE), 2016 IEEE 24th International*, 2016, pp. 126-135: IEEE.
- [8] J. D. Herbsleb and A. Mockus, "An empirical study of speed and communication in globally distributed software development," *IEEE Transactions on software engineering*, vol. 29, no. 6, pp. 481-494, 2003.
- [9] H. Holmstrom, E. O. Conchuir, J. Agerfalk, and B. Fitzgerald, "Global software development challenges: A case study on temporal, geographical and socio-cultural distance," in *Global Software Engineering, 2006. ICGSE'06. International Conference on*, 2006, pp. 3-11: IEEE.
- [10] D. Damian, L. Izquierdo, J. Singer, and I. Kwan, "Awareness in the wild: Why communication breakdowns occur," in *Global Software Engineering, 2007. ICGSE 2007. Second IEEE International Conference on*, 2007, pp. 81-90: IEEE.
- [11] I. Richardson, G. Avram, S. Deshpande, and V. Casey, "Having a foot on each shore-bridging global software development in the case of SMEs," 2008.
- [12] S. Mahmood, S. Anwer, M. Niazi, M. Alshayeb, and I. Richardson, "Key factors that influence task allocation in global software development," *Information and Software Technology*, vol. 91, pp. 102-122, 2017.
- [13] S. Anwer, L. Wen, T. Rout, and Z. Wang, "Introducing Requirements Change Management Process into ISO/IEC 12207," in *International Conference on Software Process Improvement and Capability Determination*, 2018, pp. 185-199: Springer.
- [14] E. J. Barry, T. Mukhopadhyay, and S. A. Slaughter, "Software project duration and effort: an empirical study," *Information Technology and Management*, vol. 3, no. 1-2, pp. 113-136, 2002.
- [15] V. Sinha, B. Sengupta, and S. Chandra, "Enabling collaboration in distributed requirements management," *IEEE software*, vol. 23, no. 5, pp. 52-61, 2006.
- [16] R. Sangwan, M. Bass, N. Mullick, D. J. Paulish, and J. Kazmeier, *Global software development handbook*. Auerbach Publications, 2006.
- [17] S. Jayatilake and R. Lai, "A systematic review of requirements change management," *Information and Software Technology*, vol. 93, pp. 163-185, 2018.
- [18] N. Ali and R. Lai, "A method of requirements change management for global software development," *Information and Software Technology*, vol. 70, pp. 49-67, 2016.
- [19] A. A. Khan, S. Basri, and P. Dominic, "Communication risks in GSD during RCM: Results from SLR," in *Computer and Information Sciences (ICCOINS), 2014 International Conference on*, 2014, pp. 1-6: IEEE.
- [20] A. A. Khan, J. Keung, S. Hussain, and K. E. Bennin, "Effects of geographical, socio-cultural and temporal distances on communication in global software development during requirements change management a pilot study," in *Evaluation of Novel Approaches to Software Engineering (ENASE), 2015 International Conference on*, 2015, pp. 159-168: IEEE.
- [21] H. Ahmed, A. Hussain, and F. Baharom, "Current challenges of requirement change management," *Journal of Telecommunication, Electronic and Computer Engineering (JTEC)*, vol. 8, no. 10, pp. 173-176, 2016.
- [22] B. A. Kitchenham, Kitchenham, B.: *Guidelines for performing Systematic Literature Reviews in software engineering*. EBSE Technical Report EBSE-2007-01. 2007.
- A01: S. Ahn and K. Chong, "Requirements change management on feature-oriented requirements tracing," in *International Conference on Computational Science and Its Applications*, 2007, pp. 296-307: Springer.
- A02: S. Jayatilake, R. Lai, and K. Reed, "A method of requirements change analysis," *Requirements Engineering*, vol. 23, no. 4, pp. 493-508, 2018.
- A03: A. AlSanad and A. Chikh, "The Impact of Software Requirement Change-A Review," in *New Contributions in Information Systems and Technologies*: Springer, 2015, pp. 803-812.
- A04: M. Kausar and A. Al-Yasiri, "Using Distributed Agile Patterns for Supporting the Requirements Engineering Process," in *Requirements Engineering for Service and Cloud Computing*: Springer, 2017, pp. 291-316.
- A05: I. Navarro, N. Leveson, and K. Lunqvist, "Semantic decoupling: reducing the impact of requirement changes," *Requirements engineering*, vol. 15, no. 4, pp. 419-437, 2010.

APPENDIX A: List of Studies Selected in SLR

- A06: L. Lin and J. H. Poore, "Pushing requirements changes through to changes in specifications," *Frontiers of Computer Science in China*, vol. 2, no. 4, pp. 331-343, 2008.
- A07: J. J. Lin and Y.-S. Lin, "Research and Development of a CMMI-Compliant Requirement Management System for Software Engineering," in *International Conference on Computer Supported Cooperative Work in Design*, 2007, pp. 76-86: Springer.
- A08: K.-D. Mu, W. Liu, Z. Jin, J. Hong, and D. Bell, "Managing software requirements changes based on negotiation-style revision," *Journal of Computer Science and Technology*, vol. 26, no. 5, p. 890, 2011.
- A09: M. A. Chauhan and C. W. Probst, "Architecturally Significant Requirements Identification, Classification and Change Management for Multi-tenant Cloud-Based Systems," in *Requirements Engineering for Service and Cloud Computing*: Springer, 2017, pp. 181-205.
- A10: D. Damian, J. Chisan, L. Vaidyanathasamy, and Y. Pal, "Requirements engineering and downstream software development: Findings from a case study," *Empirical Software Engineering*, vol. 10, no. 3, pp. 255-283, 2005.
- A11: J. Lockerbie, N. A. M. Maiden, J. Engmann, D. Randall, S. Jones, and D. Bush, "Exploring the impact of software requirements on system-wide goals: a method using satisfaction arguments and i* goal modelling," *Requirements Engineering*, vol. 17, no. 3, pp. 227-254, 2012.
- A12: M. Heindl and S. Biffl, "Modeling of requirements tracing," in *Balancing Agility and Formalism in Software Engineering*: Springer, 2008, pp. 267-278.
- A13: T. O. de Jesus and M. S. Soares, "An Event-Based Technique to Trace Requirements Modeled with SysML," in *International Conference on Computational Science and Its Applications*, 2017, pp. 145-159: Springer.
- A14: B. B. Chua, D. V. Bernardo, and J. Verner, "Criteria for estimating effort for requirements changes," in *European Conference on Software Process Improvement*, 2008, pp. 36-46: Springer.
- A15: T. Gorschek and M. Svahnberg, "Requirements experience in practice: Studies of six companies," in *Engineering and Managing Software Requirements*: Springer, 2005, pp. 405-426.
- A16: C. Ting, "The Control and Measure of Requirements Stability in Software Project," in *International Conference on Information and Management Engineering*, 2011, pp. 387-394: Springer.
- A17: J. Shah and N. Kama, "Issues of Using Function Point Analysis Method for Requirement Changes During Software Development Phase," in *Asia Pacific Requirements Engineering Conference*, 2017, pp. 156-163: Springer.
- A18: N. Ali and R. Lai, "A method of requirements change management for global software development," *Information and Software Technology*, vol. 70, pp. 49-67, 2016.
- A19: A. A. Khan, S. Basri, and P. Dominc, "A proposed framework for communication risks during RCM in GSD," *Procedia-Social and Behavioral Sciences*, vol. 129, pp. 496-503, 2014.
- A20: S. Jayatilleke and R. Lai, "A systematic review of requirements change management," *Information and Software Technology*, vol. 93, pp. 163-185, 2018.
- A21: D. Lloyd, R. Moawad, and M. Kadry, "A supporting tool for requirements change management in distributed agile development," *Future Computing and Informatics Journal*, vol. 2, no. 1, pp. 1-9, 2017.
- A22: R. A. Aziz and B. Wong, "The interplay between requirements relationships knowledge and requirements change towards software project success: an assessment using partial least square (PLS)," *Procedia Computer Science*, vol. 46, pp. 732-741, 2015.
- A23: A. Goknil, I. Kurtev, K. van den Berg, and W. Spijkerman, "Change impact analysis for requirements: A metamodeling approach," *Information and Software Technology*, vol. 56, no. 8, pp. 950-972, 2014.
- A24: C.-Y. Chen and P.-C. Chen, "A holistic approach to managing software change impact," *Journal of Systems and Software*, vol. 82, no. 12, pp. 2051-2067, 2009.
- A25: R. Sugden and M. Strens, "Strategies, tactics and methods for handling change," in *ecbs*, 1996, p. 457: IEEE.
- A26: A. A. Khan, J. Keung, S. Hussain, and K. E. Bennin, "Effects of geographical, socio-cultural and temporal distances on communication in global software development during requirements change management a pilot study," in *Evaluation of Novel Approaches to Software Engineering (ENASE)*, 2015 International Conference on, 2015, pp. 159-168: IEEE.
- A27: N. Assawamekin, "An ontology-based approach for multiperspective requirements traceability between analysis models," in *Computer and Information Science (ICIS)*, 2010 IEEE/ACIS 9th International Conference on, 2010, pp. 673-678: IEEE.
- A28: L. Lin, S. J. Prowell, and J. H. Poore, "The impact of requirements changes on specifications and state machines," *Software: Practice and Experience*, vol. 39, no. 6, pp. 573-610, 2009.
- A29: M. Shafiq et al., "Effect of project management in requirements engineering and requirements change management processes for global software development," *IEEE Access*, 2018.
- A30: A. Teka, N. Condori-Fernandez, I. Kurtev, D. Quartel, and W. Engelsman, "Change impact analysis of indirect goal relations: Comparison of NFR and TROPOS approaches based on industrial case study," in *2012 IEEE Model-Driven Requirements Engineering Workshop (MoDRE 2012)*, 2012, pp. 58-67: IEEE.
- A31: M. Weber and J. Weisbrod, "Requirements engineering in automotive development-experiences and challenges," in *Requirements Engineering*, 2002. *Proceedings. IEEE Joint International Conference on*, 2002, pp. 331-340: IEEE.
- A32: W. Hussain, D. Zowghi, T. Clear, S. MacDonell, and K. Blincoe, "Managing Requirements Change the Informal Way: When Saying 'No' is Not an Option," in *Requirements Engineering Conference (RE)*, 2016 IEEE 24th International, 2016, pp. 126-135: IEEE.
- A33: F. Mokammel, E. Coatanéa, M. Bakhouya, F. Christophe, and S. Nonsiri, "Impact analysis of graph-based requirements models using PageRank algorithm," in *Systems Conference (SysCon)*, 2013 IEEE International, 2013, pp. 731-736: IEEE.
- A34: S. Imtiaz, N. Ikram, and S. Imtiaz, "Impact analysis from multiple perspectives: Evaluation of traceability techniques," in *Software Engineering Advances*, 2008. *ICSEA'08. The Third International Conference on*, 2008, pp. 457-464: IEEE.
- A35: I. Keshta, M. Niazi, and M. Alshayeb, "Towards Implementation of Requirements Management Specific Practices (SP1. 3 and SP1. 4) for Saudi Arabian Small and Medium Sized Software Development Organizations," *IEEE Access*, vol. 5, pp. 24162-24183, 2017.
- A36: A. A. Khan, S. Basri, and P. Dominic, "Communication risks in GSD during RCM: Results from SLR," in *Computer and Information Sciences (ICCOINS)*, 2014 International Conference on, 2014, pp. 1-6: IEEE.
- A37: A. Khatoon, Y. H. Motla, M. Azeem, H. Naz, and S. Nazir, "Requirement change management for global software development using ontology," in *Emerging Technologies (ICET)*, 2013 IEEE 9th International Conference on, 2013, pp. 1-6: IEEE.
- A38: Y. Hafeez et al., "A requirement change management framework for distributed software environment," in *Computing and Convergence Technology (ICCCT)*, 2012 7th International Conference on, 2012, pp. 944-948: IEEE.
- A39: Y. Jin, J. Zhang, P. Ma, W. Hao, S. Luo, and Z. Li, "Applying pagerank algorithm in requirement concern impact analysis," in *Computer Software and Applications Conference*, 2009. *COMPSAC'09. 33rd Annual IEEE International*, 2009, vol. 1, pp. 361-366: IEEE.
- A40: W. Lam, V. Shankaraman, S. Jones, J. Hewitt, and C. Britton, "Change analysis and management: a process model and its application within a commercial setting," in *Application-Specific Software Engineering Technology*, 1998. *ASSET-98. Proceedings. 1998 IEEE Workshop on*, 1998, pp. 34-39: IEEE.
- A41: V. Sinha, B. Sengupta, and S. Chandra, "Enabling collaboration in distributed requirements management," *IEEE software*, vol. 23, no. 5, pp. 52-61, 2006.
- A42: R. Lai and N. Ali, "A requirements management method for global software development," *AIS: Advances in Information Sciences*, vol. 1, no. 1, pp. 38-58, 2013.
- A43: H. Ahmed, A. Hussain, and F. Baharom, "Current challenges of requirement change management," *Journal of Telecommunication, Electronic and Computer Engineering (JTEC)*, vol. 8, no. 10, pp. 173-176, 2016.