

Categorical Classification of Factors Effecting Knowledge Management in Software Crowdsourcing: Hypothetical Framework

Nasir Hussain

*College of Computer Science and Technology, Nanjing University of Aeronautics and Astronautics (NUAA),
Jiangjun Road no.29, Jiangning District, Jiangsu Province, Nanjing, China*

Keywords: Knowledge Management, Software Crowdsourcing, Success Factors, Failure Factors, Quantitative Research.

Abstract: Within Software Crowdsourcing, Knowledge Management has a great significance in both academia and industry as a valuable tool used to manage knowledge from the crowd. The aim of this research is to ascertain which success are and which are failure factors of Knowledge Management in Software Crowdsourcing. Literature review techniques and Quantitative Research techniques were applied in order to establish the success and failure factors. By utilizing the literature review method a total of twelve success factors were established of which seven is supported. Eight failure factors were established out of which six are supported. Subsequent to the analysis, a framework is presented in which the factors are further linked to the implementation of Knowledge Management in Software Crowdsourcing. This research and its suggested framework will also prove useful for academics to further gain a comprehensive view of Knowledge Management factors in Software Crowdsourcing for use in future studies.

1 INTRODUCTION

Crowdsourcing is a tool used by small and medium enterprises (SMEs) (Khan et al, 2019; Brabham, 2008). Crowdsourcing software development is different to other platforms. Before any development starts, organizations would need to first predetermine their needs and requirements and how this will affect crowd membership. Software crowdsourcing is a web based model that brings together solutions from a distributed network of individuals. How states that crowdsourcing represents the process in which an organization takes a process that was previously performed by its employees and giving it to a large network of individuals in order to collaborate. Organizations would post a problem online to which a large number of individuals with different ideas on how to solve the problem will respond. A reward could be given to the individual with the best idea, after which the organization can then market it as their own (Brabham 2008).

Knowledge Management within Software Crowdsourcing is a challenge to manage. Knowledge Management has undergone a systematic development process over the first years of the twenty-first century and has been shown to be a much discussed topic within numerous different industry groups (Aurum et al, 2008; Khan et al, 2016). The

skills utilized in order to achieve knowledge is progressing more rapidly and is in line with today's knowledge driven economy.

However there are many Knowledge Management tools available on how to manage knowledge from within the crowd. We will be introducing a technique that will enable the management of knowledge in Software Crowdsourcing (Alan Frost, 2014). We've placed our focus on Knowledge Management factors in Software Crowdsourcing as well as to study and test for any other influences that may the success and failure factors in Knowledge Management in Software Crowdsourcing (Alavi and Leidner, 2001).

Knowledge Management is faced with a difficult situation as to how to manage knowledge from within the crowd as there are so many different frameworks. These frameworks are however mostly developed for the needs of large international companies (Ergazakis et al, 2006). Therefore the same needs still exist specifically in using software in crowdsourcing. This research is therefore aimed directly towards a Knowledge Management system specifically focused on Software Crowdsourcing in line with the needs and necessities required to handle, regulate the collection and storing as well as the sharing of information (Akhavan and Fathian 2006).

Based on the discussion we have developed the following research questions.

RQ1: Using literature and empirical study, which factors are identified that would either have a positive or negative impact on Knowledge Management within Software Crowdsourcing?

RQ2: What would be the likely framework for the factors to have either a positive or negative outcome on Knowledge Management in Software Crowdsourcing?

RQ3: What would be the most suitable framework to be introduced within a successful Knowledge Management in Software Crowdsourcing platform?

2 BACKGROUND STUDY

Knowledge Management is a valuable component within Software Crowdsourcing platforms. It takes individual's knowledge and transforms it into hierarchical information where it can be shared with others in the group. In turn other individuals in the group can then collaborate and add to it (Wong & Aspinwall, 2006). Although Knowledge Management has been extensively researched, there is no single all-fitting method. There is also a variety of systems, tools and methods.

Many researches have come up with different views on Knowledge Management (Khan et al, 2018). One of which states that it is the gathering of techniques view information through association with end goals to assess its feasibility and achievement.

Moreover it has characterized Knowledge Management as the act of specifically utilizing learning from past encounters with basic leadership. This is in line with current and future basic leadership exercises which is specifically the required motivation behind enhancing the organization.

Knowledge is a kind of stream that can exchange knowledge between the knowledge provider and the knowledge demander (Wong and Aspinwall, 2006). Knowledge Management is getting the correct information to the correct individuals at the right time so they can settle on the best choices.

In conclusion, all Knowledge Management methodologies focuses on the fact that it's an important asset and that knowledge should be presented to users timeously. Therefore it is a process that assists organizations to capture, select, organize, distribute and transfer significant information in order to gain a business advantage.

In this paper we discuss the primary steps towards developing the proposed framework (Knowledge Management in Software Crowdsourcing). We discuss the success and failure factors that could have

a positive or negative impact on Knowledge Management in Software Crowdsourcing. These factors will assist in the development of the factors component of Knowledge Management in Software Crowdsourcing.

The reported success and failure factors will assist with the theory of Knowledge Management in Software Crowdsourcing.

3 RESEARCH METHODOLOGY

This research study will be performed by utilizing literature review and has been used as a prelude to the research report and proposal. A good review can extract new ideas from others' work by combining and summarizing previous sources (Brettle and Gambling, 2003). On top of that, new theories can be built from the evidence discussed and new directions for future research can be suggested. It can also be used to facilitate evidence used in daily practice, by supplying answers to clinical questions (Khan et al, 2017; Brettle and Gambling, 2003). Literature reviews are also ideally used within publishing through initial research questions including access to a literature databases and some basic evaluation and writing skills.

4 PROPOSED FRAMEWORK

The focus of this research is to identify success and failure factors in Knowledge Management in Software Crowdsourcing. The contextual factor was also added to the framework to test the sensitivity of organizations of different sizes. The proposed framework groups the variables based on whether they are success or failure factors in Knowledge Management in Software Crowdsourcing. Below is a brief discussion thereof.

4.1 Success Factors

The following success factors categorized below includes the variables which produces positives within Knowledge Management in Software Crowdsourcing.

4.1.1 Organizational Culture

Organizational culture is a bottoms-up process. It starts with the junior staff and works its way up to the top of the organization.

a. Crowd Involvement

Organizational culture is very important to the successful implementation of activities within Knowledge Management. Lack of trust amongst co-workers will block their ability to group together during discussions. The greater the trust, the more likeliness there is of openness in discussions that will lead to data being shared more willingly (Khan et al, 2017). Making errors is a part of learning, individuals should not be punished when applying new information. Focusing on errors will deter them from collaborating with others as there will be a sense of disappointment.

H1: Crowd Involvement has a positive impact on Knowledge Management in Software Crowdsourcing.

b. Cultural Norms and Values

Every culture has its own styles, values and norms which can potentially cause difficulty in people from diverse cultural backgrounds when they try to communicate with each other. (Holmstrom et al., 2006) Between companies, working norms can also differ to some extent.

H2: Culture Norms and Values has a positive impact on Knowledge Management in Software Crowdsourcing.

c. Cultural Awareness

Cultural awareness involves teams recognizing their difference in opinion during for example software development. By adjusting their ways of thinking and responding differently they can promote mutual understanding instead (Winkler et al., 2008). Interpretation can be further promoted by team members having a sense of cultural awareness. An example hereof, (Imsland et al.,2003) teams from Russia and Norway were collaborating using English. A misunderstanding took place due to diverse communication style and national cultural backgrounds within each of the two teams. The Norwegians would state their intentions explicitly without much dependence on the context. The Russians however communicate their intentions indirect without it being clearly stated. Non-verbal communication is used mostly in high-context cultures such as Anglo and Northern European cultures (Khan et al, 2016). It can therefore be noted that cultural awareness plays an important part in Knowledge Management in Software Crowdsourcing.

H3: Culture Awareness has a positive impact on Knowledge Management in Software Crowdsourcing.

d. Mutual Understanding

Mutual understanding is best achieved through overcoming cultural, social and political differences (Espinosa et al., 2007). The level of understanding is improved between team members through public relation and in-person meetings. However this could be challenging for globally distributed teams due to possible cost saving strategies. Mutual understanding can be effective if miscommunication and misinterpretation is avoided. (Azeem and Khan, 2011). Factors that will assist with mutual understanding is socio-cultural fit, language skills, conflict handling, cognitive based trust and regularity in the work place (Jimnez et al., 2009).

H4: Mutual Understanding has a positive impact on Knowledge Management in Software Crowdsourcing.

4.1.2 Knowledge Resources

Knowledge resources within an organization could be realistically tapped into by that organization. It can therefore reside within individuals and groups, or exist at an organizational level.

a. Human Capital

Human capital refers to information held by owner-managers and staff in relation to organizational knowledge, ideas and skills. The more training is provided, individuals will be more likely to continue contributing. Organization information, knowledge and experience is collated over the years and is therefore company assets that have developed over time (Alan Frost, 2014).

H5: Human Capital has a positive impact on Knowledge Management in Software Crowdsourcing.

b. Knowledge Capital

Knowledge capital is the current information that an organization has which can be in the form of reports, records or data which can either be manually filed or located within a system. Most SMEs do not have sufficient advanced ICT systems due to constraints. All information should be kept up to date and staff should have access to it (Cheng Sheng Lee, 2015).

H6: Knowledge Capital has a positive impact on Knowledge Management in Software Crowdsourcing.

4.1.3 Knowledge Process

Knowledge process is the allocation of relatively high-level tasks to an outside organization or a different group possibly in a different geographic

location within the same organization.

a. Knowledge Acquisition

Knowledge acquisition activities can be anything from sending employees on training courses (Cheng Sheng Lee, 2015) to the attendance of seminars and exhibitions where knowledge is gathered. Due to the relaxed organizational culture in SMEs, employees are able to interact with managers and peers more easily. Knowledge can also be gained from customers and suppliers.

H7: Knowledge Acquisition has a positive impact on Knowledge Management in Software Crowdsourcing.

b. Knowledge Creation and Generation

Knowledge creation is when new knowledge and ideas have been generated. During the process of employees working together, knowledge is created as it facilitates teamwork and thereby the generation of more conversation amongst employees (Bergman et al, 2004; Alan Frost, 2014). Another way for a group to generate ideas is through brainstorming sessions. Group discussions stimulates conversation and it is therefore a preferred interaction method.

H8: Knowledge Creation and Generation has a positive impact on Knowledge Management in Software Crowdsourcing.

c. Knowledge Transferring and Sharing

Informal social interaction is mostly used in the sharing of knowledge (Cheng Sheng Lee, 2015). Knowledge can also be shared during meetings where employees hold discussions and thereby share their ideas and knowledge (Bergman et al, 2004). In SMEs this process may be of a more informal nature as in relation to larger organizations. Meetings are an important way to discuss any current projects including deadlines that are to be met.

H9: Knowledge Transferring and Sharing has a positive impact on Knowledge Management in Software Crowdsourcing.

4.1.4 Organizational Factors

Organizational factors associated with the occurrence and persistence of operational successes and failures.

a. Management Leadership and Support

Management in Knowledge Management roles play a most important part in order to initiate and drive successful Knowledge Management implementation,

including keeping employees involved in the process (Cheng Sheng Lee, 2015). Commitment is encouraged as a way to introduce a system and environment for Knowledge Management activities (Khan et al, 2017). Motivation by top management can be used as a way to establish commitment and therefore promote a way to keep employees to take part in even more in Knowledge Management activities. Motivation can either be in the form of money or some non-monetary item. This will inspire employees to keep contributing information.

H10: Management Leadership and Support has a positive impact on Knowledge Management in Software Crowdsourcing.

b. Organizational Infrastructure

ICT infrastructure is an important factor in Knowledge Management within organizations. Within some organizations there are rarely advanced ICT systems nor document management systems. Most of these only have basic infrastructure such as Internet and Intranet as a way to transfer information. In some organizations they may still only use physical filing storage in filing rooms. Venues that would assist employees to interact and discuss should be provided (Cheng Sheng Lee, 2015; Cumming, 2004).

H11: Organizational Infrastructure has a positive impact on Knowledge Management in Software Crowdsourcing.

c. Organizational Strategy

Successful Knowledge Management implementation is a key strategy within an organizations' overall business strategy and a key factor for their long-term competitiveness and success. Owner-managers are usually responsible for this (Khan et al, 2016; Cheng Sheng Lee, 2015). An organization would need to predefine its needs and requirements prior to considering its Knowledge Management strategy. A clear strategy will provide focus and direction for everyone in the organization (Chang Sheng Lee, 2015). Without this, the required result will not be reachable and resources would have been wasted.

H12: Organizational Strategy has a positive impact on Knowledge Management in Software Crowdsourcing.

4.2 Failure Factors

The following failure factors categorized below includes the variables which produces negatives within Knowledge Management in Software Crowdsourcing.

4.2.1 Technology

The practical application of knowledge especially in the particular area of engineering based on how to use technology.

a. Lack of Advanced Technological Tools and Techniques

Due to the ever changing technical advancements and enhancements in areas such as computers, networks, television, fiber optics, etc., we have to adapt the way we interconnect, play and do business as it changes rapidly. This shift in technology means that organizations have an increased need to accept and adjust to the need created in the field of IT advancements. As the information age further develops we are faced with larger sources of information and organizations therefore need to mechanize themselves (Frost, 2014). Technology is therefore a key factor within Knowledge Management as a success factor and as a potential failure factor.

H13: Lack of Advance Technological Tools and Techniques has a negative impact on Knowledge Management in Software Crowdsourcing.

b. Lack of Controlling Knowledge Management Activities

Knowledge Management has revealed a more often psychological trend as supposed to a technical view (Frost, 2014). Thus knowledge has more to do with individuals, else it is only data or information. Knowledge can therefore be viewed as an activity whereas data and information are objects.

H14: Lack of Controlling Knowledge Management Activities has a negative impact on Knowledge Management in Software Crowdsourcing.

4.2.2 Planning

A basic management function involving formulation of one or more detailed plans to achieve optimum balance of needs or demands within the available resources.

a. Poor Planning and Design

Successful Knowledge Management implementation depends upon the integration of many different aspects of an organization (Frost, 2014). Indicates that "Knowledge Management provides a strategy and organizational discipline for the integration of people, processes and IT into an effective enterprise." Proper planning and continuous evaluation are needed to ensure that all aspects of Knowledge

Management are being implemented effectively and work well together. Moreover, the implementation of Knowledge Management needs to be focused on the organization's strategic business objectives and critical business problems (Khan et al, 2017). In other words, the implementation of Knowledge Management requires a long-term practical outlook.

H15: Poor Planning and Design has a negative impact on Knowledge Management in Software Crowdsourcing.

b. Poor Coordination and Evaluation

There is a positive relationship between operation control and continuous evaluation of a successful knowledge management project as per Danesh (Alan Frost, 2014). There needs to be a continuous facility in order to evaluate progress and to track the effectiveness of the program. There needs to be a continuous facility in order to evaluate progress and to track the effectiveness of the program. There needs to be proper performance indicators in place in order to evaluate progress made, else it will be a challenge for management to evaluate the effectiveness of the program. In addition there could also be a shortcoming in the approach followed during the implementation (Khan et al, 2017; Frost, 2014).

H16: Poor Coordination and Evaluation has a negative impact on Knowledge Management in Software Crowdsourcing.

4.2.3 Skills

The attributes required to perform a job which is generally demonstrated through qualifying service, education or training.

a. Inadequate Skills of Knowledge Managers

Knowledge managers and workers fulfil the entire spectrum of Knowledge Management related positions, and may include such titles/roles as Chief Knowledge Officer (CKO), knowledge broker (Frost, 2014), knowledge analyst, knowledge systems engineer (Civilian Career Path Guide), etc.

The skills required of knowledge managers and workers can be broken down into the following broad categories (KM Skills Map) (Khan et al, 2017). The skill requirements for a knowledge manager/worker could change depending on the areas of responsibility. For instance, a CKO would require very strong strategic and business skills, as well as management, learning, and communication (KM Skills Map). The CKO would not need to be as strong in IT skills as for example, a systems engineer in

charge of developing a Knowledge Management system (Frost, 2014).

H17: Inadequate Skills of Knowledge Managers has a negative impact on Knowledge Management in Software Crowdsourcing.

b. Inadequate Skills of Team Members

Lack of availability of relevant skills: The right business and technical skills must be present to sustain the project. Skills can also be developed through training, provided that it is implemented with clear, measurable goals (Frost, 2014).

Improper selection of knowledge managers. i.e. the skills must correspond to the role that the individual knowledge manager or worker will play within the Knowledge Management initiative (Khan et al, 2017; Frost, 2014), stress the importance of the middle manager, highlighting three key qualities: analytic, intuitive and pragmatic.

H18: Inadequate Skills of Team Members has a negative impact on Knowledge Management in Software Crowdsourcing.

4.2.4 Responsibility

This shows the expense at the lowest level of work for the purpose of managing cost and duration. It is a charting system that illustrates the task’s goals and the required action by each person.

a. Lack of Responsibility

Control of shared resources are part of managerial responsibilities according to Weber. There is a need for central management responsibilities according to Pettersson. For Hasanali (Frost, 2014), he views the need of stewards throughout the organization to be working below the central Knowledge Management team as well as the importance of structure and responsibility to assist with accountability (Bergman et al, 2004; Frost, 2014).

H19: Lack of Responsibility has a negative impact on Knowledge Management in Software Crowdsourcing.

b. Lack of Ownership

Ownership is the classification of when one owns up to ones mistakes as well as willingly taking up tasks. Not willingly taking up responsibility is failure of knowledge management (Frost, 2014), which is likely because of organizational culture. Culture could cause a reluctance to admit to ones mistakes due to the fear of possible consequences.

H20: Lack of Ownership has a negative impact on Knowledge Management in Software Crowdsourcing.

The Framework of this research is shown below in Figure 1.

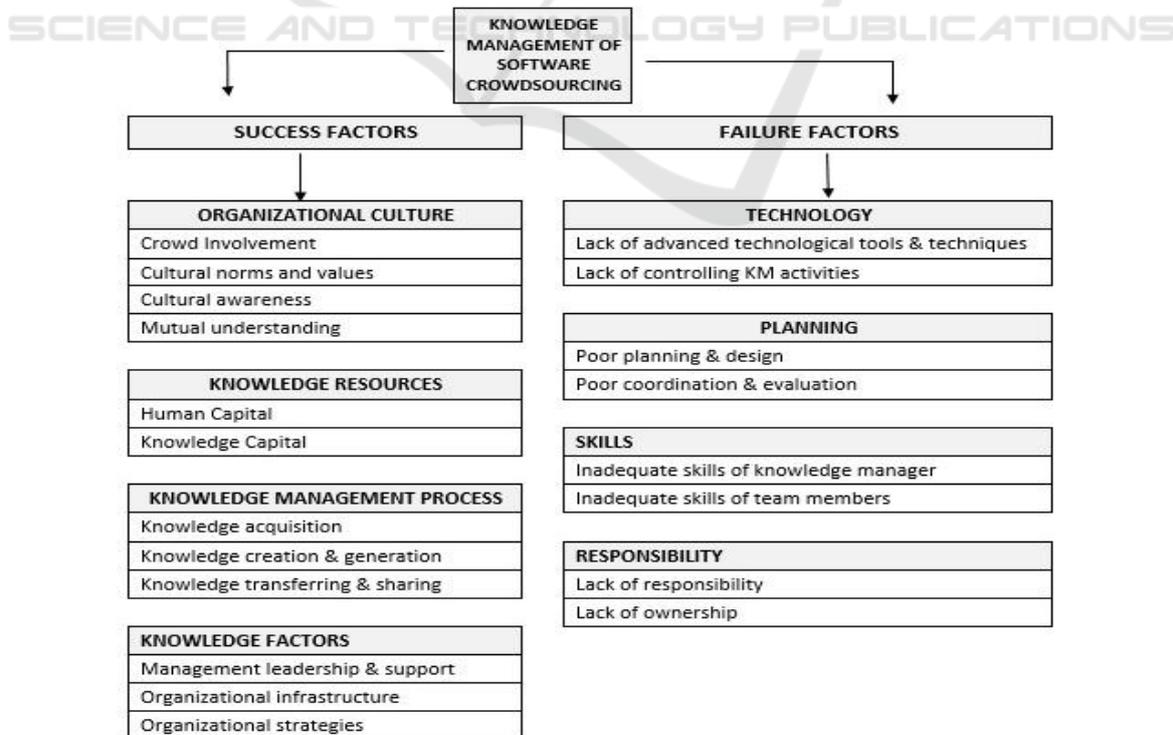


Figure 1: Proposed Framework.

5 CONCLUSION

This research places its focus on developing a framework for Knowledge Management within Software Crowdsourcing and it is based on critical success factors and critical failure factors. Literature review was performed after which a research questionnaire was sent to IT professionals in the field. After all the results were obtained, data analyses was performed by utilizing SPSS version 19. It was found that a total of twelve success factors were established out of which seven is supported. Eight failure factors were established out of which six is supported. In conclusion, a framework is presented in which the factors are further linked to the implementation of Knowledge Management in Software Crowdsourcing.

6 FUTURE WORK

During future research, the focus should be placed on conducting an empirical study in order to produce factors that will have an effect on Knowledge Management within Software Crowdsourcing implementation. This research as well as the framework it suggests will prove valuable for academics to further gain a comprehensive view of the factors that have an influence in Knowledge Management in Software Crowdsourcing.

REFERENCES

- Alan Frost, 2014. Synthesis of Knowledge Management Failure Factors www.knowledge-management-tools.net
- Aurum, A., F. Daneshgar and J. Ward, 2008. "Investigating Knowledge Management in software development organizations –An Australia experience", *Information and Software Technology*, 50 (6), pp. 511-533.
- Akhavan, P., M. Jafari and M. Fathian, 2006. "Critical success factors of Knowledge Management systems: a multi-case analysis", *European Business Review*, 18 (2), pp. 97-113.
- Alavi, M. And D. E. Leidner, 2001. "Review: Knowledge management and Knowledge Management systems: Conceptual foundations and research issues", *MIS Quarterly*, 25 (1), 107-136.
- Azeem, M. I., & Khan, S. U. (2011) "Intercultural challenges in offshore software development outsourcing relationships: A systematic literature review protocol", Paper presented at 5th Malaysian Conference on Software Engineering, Malaysia, ISBN 978-1-4577-1530-3, pp.475-480.
- Brabham, D. C., 2008. Crowdsourcing as a model for problem solving: An introduction and cases. *Convergence*, 14(1), 75-90.
- Brettell, A., & Gambling, T., 2003. Needle in a haystack? Effective literature searching for research. *Radiography* 9, 229–236.
- Bergman, J., Jantunen, A. And Saksa, J.M., 2004. "Managing knowledge creation and sharing-scenarios and dynamic capabilities in inter-industrial knowledge networks", *Journal of Knowledge Management*, Vol. 8 No. 6, pp. 63-76.
- Cheng Sheng Lee, 2015. Development and validation of Knowledge Management performance measurement constructs for small and medium enterprises Author(s): Cheng Sheng Lee (Department of Manufacturing and Industrial Engineering, Faculty of Mechanical Engineering, University Technology Malaysia, Skudai, Malaysia)
- Cummings, J. N., 2004. "Workgroups, structural diversity, and knowledge sharing in a global organization", *Management Science*, Vol. 50 No. 3, pp. 352-64.
- Ergazakis, K., Metaxiotis, K. and Psarras, J., 2006. "Knowledge cities: the answer to the needs of knowledge-based development", *The Journal of Information and Knowledge Management Systems*, Vol. 36 No. 1, pp. 67-84.
- Espinosa, J. A., Slaughter, S. A., Kraut, R. E., & Herbsleb, J. D. (2007) "Team knowledge and coordination in geographically distributed software development", *Journal of Management and Information Systems*, Vol.24, No1, pp.135-169.
- Holmstrom, H., Conchúir, E. Ó. Agerfalk, J., & Fitzgerald, B. (2006) "Global software development challenges: A case study on temporal, geographical and socio-cultural distance", *Proceeding of the International Conference on Global Software Engineering*, ISBN 0-7695-2663-2, pp.3-11
- Imsland, V., Sahay, S., & Warttinen, Y. (2003) "Key issues in Managing a Global Software Outsourcing relationship between a Norwegian and Russian firm: Some Practical Implications", *Proceeding of the 26th Information Systems Research Seminar, Scandinavia, Finland*.
- Jimnez, M., Piattini, M., & Vizcaino, A. (2009) "Challenges and improvements in distributed software development: a systematic review" *Journal of Advances in Software Engineering*, Vol.2009, No.3, pp.1-16.
- Khan, A. A., Keung, J., Hussain, S., Niazi, M., & Kieffer, S., 2018. Systematic literature study for dimensional classification of success factors affecting process improvement in global software development: client–vendor perspective. *IET Software*, 12(4), 333-344.
- Khan, A. A., Keung, J., Niazi, M., Hussain, S., & Zhang, H., 2017. Systematic literature reviews of software process improvement: A tertiary study. In *European Conference on Software Process Improvement* (pp. 177-190). Springer, Cham.
- Khan, A. A., Keung, J., Niazi, M., Hussain, S., & Ahmad, A., 2017. Systematic literature review and empirical investigation of barriers to process improvement in

- global software development: Client–vendor perspective. *Information and Software Technology*, 87, 180-205.
- Khan, A. A., Keung, J., Niazi, M., & Hussain, S., 2017. Towards a hypothetical framework of humans related success factors for process improvement in global software development: systematic review. In *Proceedings of the Symposium on Applied Computing* (pp. 180-186). ACM.
- Khan, A. A., 2016. Student research abstract: A framework for assisting software process improvement program in global software development. In *Proceedings of the ACM Symposium on Applied Computing* (Vol. 04-08-April-2016, pp. 1580-1581). Association for Computing Machinery. DOI: 10.1145/2851613.2852006
- Khan, A. A., Keung, J., Niazi, M., Hussain, S., & Shameem, M., 2019. GSEPIM: A roadmap for software process assessment and improvement in the domain of global software development. *Journal of software: Evolution and Process*, 31(1), e1988.
- Khan, A. A., & Keung, J., 2016. Systematic review of success factors and barriers for software process improvement in global software development. *IET software*, 10(5), 125-135.
- Khan, A. A., Keung, J., Hussain, S., Niazi, M., & Tamimy, M. M. I., 2017. Understanding software process improvement in global software development: a theoretical framework of human factors. *ACM SIGAPP Applied Computing Review*, 17(2), 5-15.
- Khan, A. A., Keung, J. W., & Abdullah-Al-Wadud, M., 2017. SPIIMM: Toward a model for software process improvement implementation and management in global software development. *IEEE Access*, 5, 13720-13741.
- Winkler, J. K., Dibbern, J., & Heinzl, A. (2008) "The impact of cultural differences in offshore outsourcing—Case study results from German–Indian application development projects", *Journal of Information Systems Frontiers*, Vol.10,No.2, pp.243-258
- Wong, K. Y., & Aspinwall, E., 2006. Development of a Knowledge Management initiative and system: A case study. *Expert Systems with Applications*, 30(4), 633-641.