Evolution of situational factors in blended learning systems interfaces during COVID-19: An analytical study

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ABSTRACT

The world has been undergoing tremendous transformation since early 2020 with the occurrence of a global pandemic of COVID-19. While it will take several years of study and research to understand the true effect of this pandemic on society, it is worthy of noting that it has already transformed our methods of leading lives. One of the areas, highly impacted by a pandemic is education. In order to deliver education in a distance learning manner, more and more academic institutions have been acquiring IT systems to deliver education to the students in the confines and safety of their homes. Saudi Electronic University (SEU) has been pioneering the application of online systems for blended learning in not just Saudi Arabia but the whole middle east and north Africa region. The reliance on systems at SEU for maintaining education standards during pandemics has increased. This has provided the opportunity to researchers in various fields of IT and computing to study evolving role of such systems in traditional and blended models of education. Situational Factors (SFs) are key elements that affect the acceptability of systems by stakeholders. This paper describes the outcome of the study that was carried out to identify critical Situational Factors that play a major role in the acceptance or otherwise of systems in the academic sphere during pandemic times. The results have shown that knowledge, communication, and trust are the most important situational factors for blended learning applications. The case studies and findings are presented followed by a brief analysis of results.

1. Introduction

Software systems and services play a critical role in the efficient and smooth operations of any organization in modern times. IT and software systems are more and more penetrating academic institutions.

During the last few months of 2019, the first patients of a new infection caused by a novel coronavirus disease (coronavirus disease 2019, COVID-19) was recognized in Wuhan, China (Albahri et al., 2020a). Coronaviruses (CoVs) are a large family of viruses that are common in many animal species, including camels, cattle, cats, and bats (Albahri et al., 2020b). This disease has caused insufferable damage all over the world with hundreds of millions of infections and millions of unfortunate casualties (Alamoodi et al., 2020).

The need of having qualitatively superior and efficient systems has only increased with the arrival and ravages caused by the current COVID-19 pandemic. Academic institutions all over the world are on the hunt for better and more reliable systems to ensure that academic standards are not compromised. The pandemic has affected all areas of life equally and even after a year of its inception, its effects are yet to be fully understood. While the rush and urgency for finding good systems to facilitate education in such times is understandable, we have to realize that all systems cannot be of equal use and benefit to each organization. Software by its nature is complex and involves a lot of investment in terms of capital and time from its users. Due to any number of factors, such investment can be in danger if the software system is not of desired satisfaction for its users. Many reasons have been cited by researchers for such problems creeping up in software systems due to development process issues (Herbsleb, 2007; Lanubile, 2007). However, it has to be understood as well that another major factor that can equally

contribute to dissatisfaction with the system is the discomfort it causes to the users because of its functionality or interface.

Software analysis has assumed greater significance in such situations as it is the most reliable approach to understanding and identifying user needs and constraints. Over the period of time, we have realized that such needs and constraints posed by the users are greatly impacted by situational factors (SF) which can vary from one set of users to other sets of users depending on their particular environments. Any successful acquisition of systems can only be ensured if such situational factors are thoroughly studied (Holmstrom et al., 2006). We have to be mindful of the fact that in any given situation software development as well as software acquisition will face several (Herbsleb and Moitra, 2001; Niazi et al., 2017).

Traditionally the role of Requirement Engineering has been to understand the needs and wants of the users of the proposed system (Hofmann and Lehner, 2001). In this respect, the role of RE is closely aligning with usability engineering where we like to see the aspects most significant to the user from usability perspectives. RE strives to fulfill user expectations and demands in a rapidly evolving business environment. In a rapidly changing business environment, requirements change continuously to fulfill a user's demands, depending on their location. As such the role of RE becomes that of ensuring meeting user needs while preserving business expectations of the stakeholders (Passos et al., 2013). For this purpose, such requirements that fit the business model of the stakeholders are identified and incorporated into the system by the engineers (Subramanian et al., 2009). So we can see that finding and incorporating relevant requirements if deeply integrated with the development successful business model for the subsequent development. Whereas on one hand, no system can be deemed successful if it doesn't meet the needs of the users, on the other hand, software can't be successful if it isn't developed in time and within budget (Khan et al., 2014; Chatzoglou, 1997; Prikladnicki and Audy, 2012). This we need to develop a balance between user needs and business needs for successful software development and operations. This balance is dependent on certain factors critical for the success of any IT system. These factors are observed to have a strong influence on software development and may be linked to the organization management, human capital, techniques/tools, and social and economic aspects. In the literature, these factors are termed "situational factors" (SFs).

As already mentioned, every organization's needs are unique. The environment in which an organization operates dictates its needs. Literature is replete with information about various situational factors (SFs) that affect the software development process as well as their applications (Clarke and O'Connor, 2012). That is why it is imperative that SFs must be evaluated before making any decision about the best software systems to be deployed in any organization (Dallman et al., 2005). Commonly observed results from the previous literature indicate that situational factors have a strong impact on the acceptability of the systems. It is also to be understood that one situational factor may not hold equal significance in different circumstances. Most of the studies carried out so far have limited themselves to merely listing various SFs without providing any framework for measuring their importance. In one of our previous works (Gulzar et al., 2018), we proposed and implemented an intelligent framework to prioritize situational factors in Global Software Development environments. In this paper, we have used the situational factors identified in that framework for analyzing and identifying the most important SFs for software systems in Academic Environments by studying and processing data from faculty and students of Saudi Electronic University.

In order to conduct this study, we have based our research on the use and application of IT systems for various academic purposes. Six systems have been used as candidate applications for the study. Students from different colleges at different levels were selected and regular feedback from them was sought for each system over a period of five months starting from February 2020 to June 2020. The findings were passed through statistical systems to identify and extract the most relevant SFs for the success of blended learning education systems.

The study is motivated to examine and analyze the effect of various situational factors on Blended Learning systems. Our major challenge in this regard was to find an appropriate set of tools and their users over a sufficiently long period of time to provide us with concrete meaningful data. That can be cited as a major contribution of this work as no such detailed study has been conducted to assess the application and utility of various situational factors over blended learning systems. The significance of this work can be understood from the fact that all such systems have a huge potential for application over a long period of time.

The rest of the paper is organized as follows. Section II gives an overview of the literature on SFs. Section III provides a comprehensive understanding of the study. Section IV describes the findings and results of the study. A brief analysis of findings has been presented in section V followed by a conclusion.

2. Foundation and related works

Over the last decade and more, the significance of understanding context and situation for successful software development has been well documented (Ågerfalk and Ralyté, 2006). Ghosh et al. (2011) stated that it is imperative to understand the situational factors in today's software development. According to Hanisch et al. (2001), requirement engineering is more and more complex due to the global nature of software development.

Understanding different SFs for the successful development and operation of IT systems becomes even more significant in such a situation. This situational context provided by these situational factors leads to a project-specific software process (Giray et al., 2018). Christel and Kang (1992) emphasized three contexts: The organization, the environment, and the project to be the most important situational factors in the application of IT systems. In his study, Cameron (2002) argued that software projects can be more successful by considering various factors that subsidize the variation in projects and he pinpointed five tailoring factors.

In Xu and Ramesh (2007), the authors classified the software development environment factors into four categories: Project, Team, External Stakeholders, and Organization. They also suggested a model for the tailoring software process that laid the foundation and set the dimensions for the classification of environmental factors. Ferratt and Mai (2010) followed the work done by Xu and Ramesh (2007) and examined the factors that influence the tailoring of the software decision process. Dabholkar and Bagozzi (2002) investigated and identified the SFs within an organization. In another research work (Dede and Lioufko, 2010), the authors observed the influence of SFs from the aspects of technology-based self-service and the attitudes toward the service.

As all of this literature shows, the effort has been made so far to list as many potential situational factors as possible that can have any impact on the success of IT systems. Researchers have suggested that it is necessary for scholars and experts alike to focus on improving the understanding of the situational context while developing software projects (Clarke and O'Connor, 2015). These studies offered various situational factors but none of the studies had attempted to present all divergent SFs in one cohesive framework. In one of our previous papers, we have attempted to do that apart from presenting a framework for intelligently prioritizing these factors as well.

Saudi Electronic University has been in the operation of Blended learning since 2011. The university deploys state-of-the-art IT systems for academic purposes. The reliance on such systems and more has increased significantly with the arrival of the COVID-19 pandemic. Blended learning has been gaining a lot of traction during the last decade. A study conducted in 2011 showed that applying blended learning can effectively reduce student attrition rate and increase their grasp of concepts resulting in better academic grades (López-Pérez et al., 2011). Blended learning can be viewed as a combination of traditional face-to-face learning with distributed learning (Williams et al., 2008). Although students still find it challenging to some level adopting between online and face to face classes alternatively (Owston et al., 2019), using distributed learning as a medium of education allows efficient interaction between faculty and students across different locations while retaining features of traditional face to face learning maintains a physical contact essential for effective and immediate guidance. There are definitions of blended learning that focus on the percentage of time allocated to both face-to-face as well as distributed/online learning. For example, Bernard et al. (2014) gave an equal 50% contribution to both face-to-face and distributed learning. In Yen and Lee (2011) they emphasized that "blended learning, thoughtfully combining the best elements of online and face-to-face education, is likely to emerge as the predominant teaching model of the future." However, it has been observed that existing blended learning models fail to provide desired results especially in practical or programming courses (Alammary, 2019). Blended learning provides a personalized and adaptive learning approach to students that can be easily customized to suit the unique need of different students based on their unique characteristics and learning styles (Al-Khanjari, 2014).

The purpose of this brief literature review is to show all the progress that has been made in recent years in the fields of Situational Factors as well as blended learning. With the ravages of a pandemic, the emphasis on bringing in more quality systems for various purposes of the academic cycle has increased. As a result, many new systems have been incorporated into the academic processes of SEU while reliance on existing systems has increased as well. In this study, the knowledge collected from the application of these systems has been used to extract the most relevant situational factors in the educational domain. Understanding these factors can be key to qualitatively better academic experience in online and blended environments.

3. Situational factors case study

Three important components of this case study were identified in the beginning. These include:

1. Situational Factors: As described in the literature review, many researchers have presented various SFs. The purpose was to identify the most relevant situational factors.
2. Case Study Participants: SEU imparts education at both undergraduate as well as graduate levels in various disciplines. The university has in excess of twenty-five thousand students and approximately seven hundred faculty members spread across several branches inside Saudi Arabia. The challenge was to select an optimal number of participants while maintaining the required diversity.
3. Case Study IT Systems: SEU employs over a dozen IT systems to automate and facilitate the educational experience for its students. Our purpose was to identify the most relevant systems for our case study.

The first challenge before the commencement of the study was to find all relevant SFs that the literature has presented. Table 1 shows various SFs that have been proposed in different studies. Organization as an SF refers to the vendor developing the software systems. Project and Team are SFs assigned to the stakeholders who are benefitting from these applications. Knowledge sharing as a situational factor refers to the degree of expertise provided by the system and its vendors to the stakeholders. Culture, Trust, and Distance are those situational factors that primarily deal with assessing the readiness of application for universal usability. Stakeholders are a primary and very significant SF that describes various involved participants and their level of commitment to the application. Communication as an SF describes various channels provided to stakeholders to communicate and interact through the application interface.

Table 1: SFs for IT systems

	Damian and Zowghi (2003) work only covers RE Phases	Clarke and O'Connor (2015)	Khan et al. (2014)
Organization	X	✓	✓
Project	X	✓	✓
Team	✓ As a Challenge	✓	✓
Knowledge Sharing	✓	✓	✓
Culture	✓	✓ As a Sub-Factor	X
Stakeholder	✓ As a Challenge	✓	✓
Tools in Technology	X	X	✓ As a Sub-Factor
Communication, Collaboration, and Coordination	✓	X	X
Trust	✓ As a Challenge	X	X
Distance	✓	X	X

In the first step of this study, these situational factors with their understanding were presented to the students and faculty alike. An orientation session was conducted which gave a proper understanding of the factors to participants of the study. The composition of survey participants is shown in Table 2.

Table 2: Survey participants

Survey Participants	Number of Survey in each course				Total	Response Rate
	Year 1	Year 2	Year 3	Year 4		
Students of BS (Computing)	10	15	15	10	50	71%
Students of BS (Health)	15	20	15	10	60	68%
Students of BS (Management)	15	10	20	15	60	76%
Faculty					20	72%

As can be seen from Table 2, participants were evenly distributed between various phases of the academic cycle. Moreover, the participants were selected from various disciplines. It was taken care of to make sure that a balance is maintained between students and faculty. The overall response rate was approximately 74% which is considered a healthy response.

The third major element of the study was selected IT systems for which participant perception regarding SFs was sought. In total, five IT systems were selected out of thirteen systems used by SEU in various aspects of the academic system. Five systems for which feedback regarding SFs was elicited are presented in Table 3.

Table 3: Selected it systems for case study

#	IT System	Description
1	BlackBoard System	This system serves as Learning Management System at SEU. During COVID Pandemic, the lectures have been conducted entirely using the BlackBoard system.
2	Banner System	This system is used to maintain student progress during the academic year. Students are able to receive their academic alerts using this system.
3	SwiftAccess	Due to restrictions of physical access during COVID-19, the SwiftAccess system has been used to conduct mid and final evaluations during the 2019-2020 academic year.
4	Daa'm Complaint Resolution System	This is an IT complaint resolution system where students can log any IT-related problems they face when working with any other system provided by SEU.
5	Attendance System	The system is used to track and record student attendance, All attendance-related alerts are provided to students using this system.

After the identification of SFs, case study participants, and case study IT systems was completed, the case study was carried out in two phases:

1. In the first phase, the participants were asked to rank all SFs presented to them according to their preferences. The top five SFs identified by participants were selected as candidates for the second phase.

2. In the second phase, participants were asked to rank selected five SFs in order of their significance for each of the selected IT systems. This helped us identify which SFs were

considered to be most important for different kinds of systems.

In the next section, we will present findings and brief analysis of those findings for this case study. We would like to emphasize here however that this is a preliminary study and extensive more work is encouraged to be carried out in this area. More and more useful information can be achieved by further studies.

4. Experimental results and analysis

4.1. Situational factors (SFs)

Fig. 1 shows the summary of responses received about the most relevant SFs in the academic environment during the days of COVID-19.
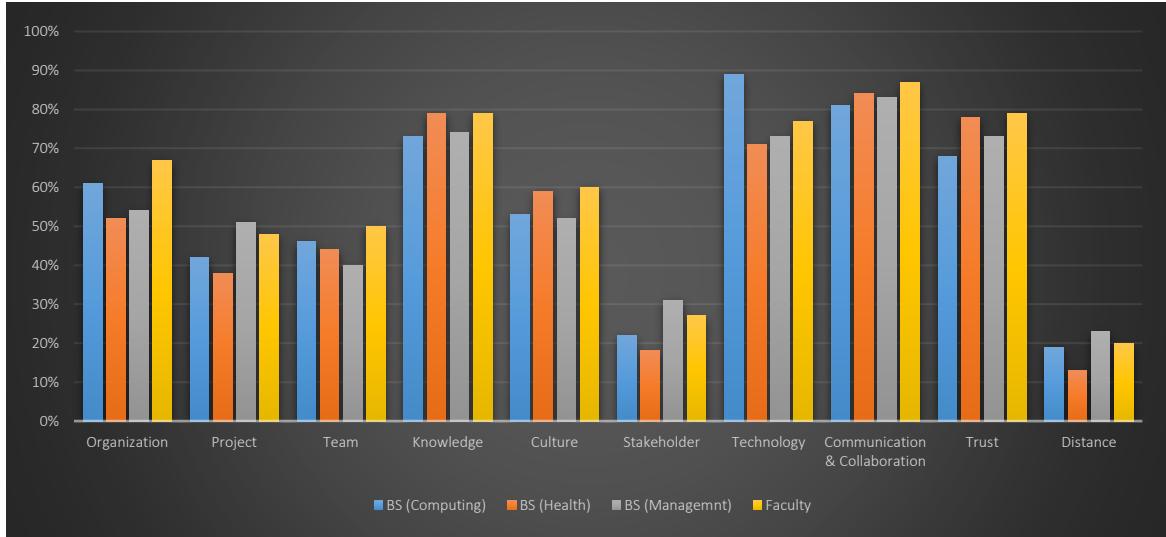

Fig. 1: Case study response for selected SFs

The study presented some interesting insights. While it was found that technology was considered to be the most important SF for students of Computing and IT, it was not the case for other disciplines and their faculty. For all other participants of the case study, communication and collaboration were considered to be the most significant situational factor. It was also found that in the day and time of COVID-19 when social distancing is a norm and distance working is now a part of regular life, distance is the least important SF for all groups of participants. In this way, it also provides an insight for researches in the domains of human-computer interaction and usability engineering to reassess the significance of this situational factor. Another situational factor very low in the perception of students and faculty alike is the Stakeholders. However, the low priority given to this SF by members of a university can be attributed to the peculiar environment of an academic institution where stakeholders have a high rate of uniformity and retention. The average significance associated with each SF by the participants of the case study is shown in Fig. 2.
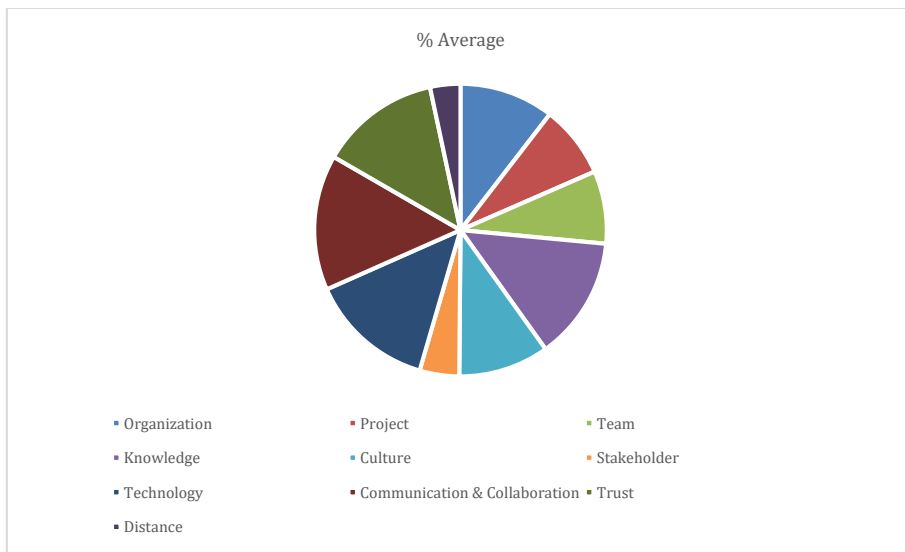

Fig. 2: Average relevance of SFs

The study showed that the most relevant situational factors in an academic environment for IT systems during pandemic days are:

1. Communication and Collaboration
2. Technology
3. Knowledge
4. Trust
5. Organization

Another important finding made during this study was that culture is very close in significance as a situational factor to determine the success or failure of an IT system as an organization that developed an IT system. It is quite possible that in certain studies, culture will become more relevant than any other factor keeping in mind contemporary environmental factors. This also showed us that understanding the environment of operations for IT systems is becoming more important with the new changes being brought upon us with this pandemic situation.

The second part of the study was dedicated to identifying which situational factors are more critical in which kind of systems. As mentioned earlier, five systems were selected. The significance of each situational factor for these systems is presented in Fig. 3.
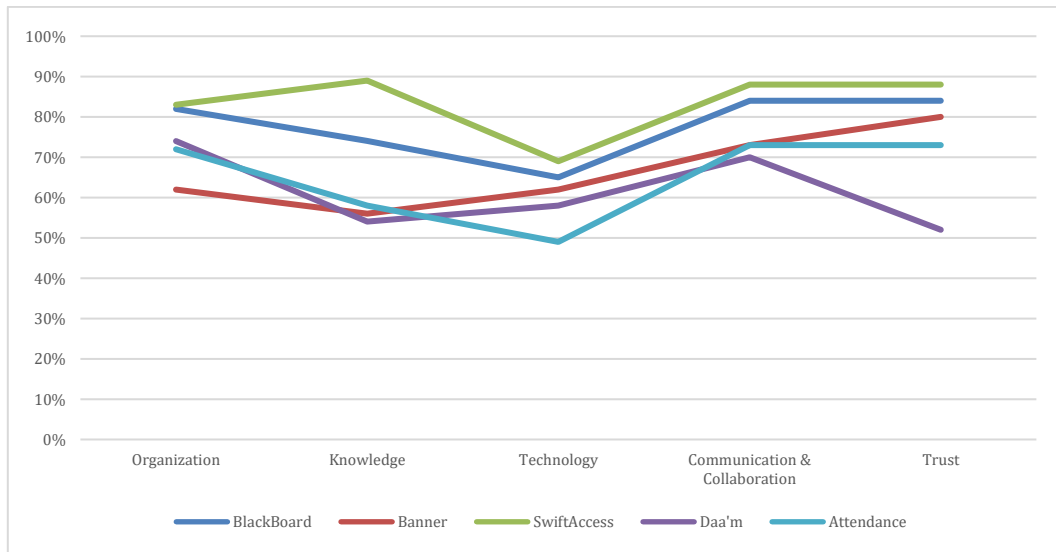

Fig. 3: Significance of situational factors for IT systems

The findings of this study were very interesting. It showed that users attach more significance to presumably important situational factors when systems being discussed deal with their core functionalities. As evident from this study, two systems i.e. BlackBoard and SwiftAccess, dealt with core responsibilities of an academic environment. Blackboard is used as a medium for delivering lectures as well as managing academic resources. SwiftAccess has been used during times of Covid pandemic to handle midterm and final evaluations and examinations. Both students and faculty attached higher significance to SFs related to these two systems as compared to the remaining three systems which dealt with peripheral academic activities of both students and faculty.

The findings of these studies as part of the case study have shown us not only the significance of situational factors (SF) in the evolving environment where reliance on IT systems is expected to grow manifolds. It has also shown us the need to identify the most relevant SFs for any particular professional domain. These results as mentioned earlier are subject to a lot of interpretation being the first study in its nature. However, they show the promise and significance of understanding the role of SFs in the successful development and deployment of UT systems. It has been observed that in the academic environment, the role of technology, knowledge, and communication is dominant as the relevant situational factors.

5. Conclusion and future works

In this paper, a comprehensive study and its findings regarding the role of Situational Factors in determining the success or failure of IT systems has been presented. This work offers even more potential and promise in current times of pandemics. The case study has explored the relevance of SFs in an academic environment, Saudi Electronic University students and faculty have been chosen as participants of the case study. The findings show that the most important SFs in an academic environment are technology, organization, communication, knowledge, and trust. The study also finds that the relevance of situational factors increases as the system becomes more relevant to the core functionalities of the stakeholders.

In the future, more work needs to be carried out in exploring the existing situational factors as some factors seem to be losing relevance in modern days of IT systems being part and parcel of our lives. More work can be done to use artificial intelligence in selecting the most optimal SFs for any professional domain. Further studies related to the application of

situational factors in other learning models can be very useful as technology penetrates further.

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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