Impact of Stress on Software Engineers Knowledge Sharing and Creativity [A Pakistani Perspective]

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Abstract— Software development involves technology as well as human efforts. Software engineering is supportive to create a quality of product by adopting the process of sharing knowledge. A lot of research was conducted on the technical side but human side of software development disregarded. Knowledge and creativity considered major factors for improving the software quality. Currently professionals working in the field of software engineering are under impressive pressure which cause stress for the Software engineers. It is highly desirable to conduct an empirical study on "impact of stress on software engineers knowledge sharing & creativity". The major motivation for this study is to investigate the impact of job stress factors which can affect the software engineering knowledge sharing capabilities and creativity. The research is based on industrial assessment. For conducting this study we developed a questionnaire based on Stress Factors. Statistical analyses are performed through SPSS tool. On the basis of the results from the survey, we proposed some strategies for those factors that have high impact on software engineers and try to mitigate their affect. These results highlight stress factors and their impact on software engineers knowledge sharing and creativity, working in Pakistani software industry.

Keywords- Knowledge sharing; Creativity; Software engineer; impact

I. INTRODUCTION

Software is a system which is developed by software engineers for the use of the people [1]. Software development is dependent on human processes [2], in which creative and innovative thinking of the human is central to the process [3]. Development of software is dependent on human knowledge and creativity [2]. Industry producing software values and relies upon human creativity [3] as a key ingredient in the matrix of the development of software and human creativity depends on knowledge sharing [4]. The process of sharing knowledge is an important part of this process because scattered or individual, knowledge has no value [5].

Rapid growth of technology and its increased use in businesses has led to increase in multiple challenges for the modern worker as compared to workers in the past. These challenges create pressure on software professionals and these pressures often become source of stress. Like any other industry the stress affects human creativity in the development of software as well. The studies on effects of stress highlights the relationship between stress and creativity; shows that employees under stress have negative impact on creativity and ultimate result decrees performance of employee [6].

A. Problem Statement

Different studies show that stress can impact creativity adversely. Stress and its impacts have been studied in different profession but a little work is available related to the software industry. Some examples where prior studies have taken pace are from Sri Lanka, Singapore and India. There is only one Pakistan based study which highlights the stress on software engineers but this study lacks to identify their impact. So there is a need to check the impact of these stress factors on software engineers knowledge sharing and creativity working in Pakistan's software industry. There is also a need to devise mitigation strategies to overcome the impacts of the highlighted stress factors.

B. Study Objectives

The objectives of this study are to identify the stress factors which relates to software engineering and their impacts on the software engineers knowledge sharing and creativity working in Pakistan's software industry. The task of this study is to empirically examine the stress factors and their effects on software engineers knowledge sharing and creativity. We proposed some mitigation techniques to overcome stress. We will share these results with the IT industry and with Pakistan software export board (PSEB) for further improvement, so they can be employed to avoid or minimize the stress factors which are the greatest source for the poor quality of work and delay in assignments. IT companies can cope up with these problems and overcome these factors by using the findings of this study.

II. LITERATURE REVIEW

A. Software Engineering& Stress

Software engineering is a profession where engineers use the technical skills in order to develop software specific to the needs and demands of the industry and the clients. As a procedure it is *"the application of an organized, restricted, quantifiable approach to the development, action, and maintenance of software"* [7]. Software is developed by the engineers using their expertise and according to the needs of their clients [8]. Stress is defined as an emotional state developed due to pressures exerted upon a person from organizational considerations and demands [9], [10]. Related to

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it there is another concept of stressor, which is a factor introducing negative feelings of stress in the people [8]. Studies have shown the negative feelings caused by stress can impacts upon health and mental conditions of the workers [11], [12].

B. Stress in software Engineering

High level of intellect is expected from people working towards the development of software [13]. This leads to this job being highly stressful [14] causing negative effects upon the health of the individual under stress. There are different types of pressure [13], one is the global pressure exerted by increased globalization, changing working environment leads pressure [15], the pressure upon the technicians to constantly update their skills in order to remain competitive [16] leads towards stress. As changes in technology are continuous, they result as high stress causing factor as well [17]. Software engineering job [18] is highly target demanding may also lead towards stress. Previous research studies conclude that stress among the professionals is not paid much importance or attention. A major proportion of the studies have been done so far have targeted the professionals working in Management Information System (MIS), instead of general professionals working in the software engineering sector. The factors investigated in this study are shown in the table I along their categories and details.

C. Knowledge Sharing & Creativity

Knowledge sharing is the process of sharing knowledge among professionals to produce creative ideas and complete the task within time [19]. General solutions and innovative approaches towards problems can be achieved through sharing of knowledge [20]. Sharing of knowledge is a social type of activity, where both the employees and engage in definite relations, whereby knowledge is shared throughout the organization (Hogel. et al., 2003) [21]. There is no fixed format for sharing of knowledge as it is sometimes shared informally in conversations and discussions which are not structured according to hierarchy. Knowledge sharing transfers experience of people to others, who then collect such knowledge with their own set of skills in order to create better skills of knowledge transfer and creation. The production of ideas or solutions is called creativity [22]. According to Cook [7] creativity is fundamental for an organization's competitive advantage since all innovations begin with thoughts which are innovative [8]. When employees think creatively, they often come up with novel suggestions and give new ideas that provide an organization with important raw material for further development [23]. Due to such advantages, creativity among employees at all levels in the organization has taken a center stage in the discussion of organizational innovation. Much of the research conducted so far focuses on factors that may foster or hamper creativity in organizations [24].

D. Knowledge Sharing in Software Engineering

Development of software is the process of sharing data. To create a quality product [25] in which no member as part of the extended team has accurate and complete knowledge of all aspects of the project [25] [26], the knowledge of an individual, unless linked to the work of the group has no value [27]. It involves sharing of knowledge among team members engaged in software development, client and other stake holders are necessary for the successful project development [25]. In case knowledge is not shared effectively, the project may fail [28] or end up being of lesser value and impact. Chieh-Peng Lin et al [29] highlighted importance of sharing of knowledge, which includes organizational commitment co-worker correspondence, received interdependence of tasks and making collective decisions.

E. Creativity in Software Engineering

Creativity is the foundation to extemporize solutions to problems for complex systems such as software development. It has been observed that software development is a knowledgeable and social activity [30] and it is carried out through cognitive processing activities [31], [32]. Creativity is cognitive feeling and it is influenced by cognitive processes like emotions and mood [33], [34]. Creativity is beneficial and important in software development [35] to develop innovative products. Programming is usually amusing because it enables creativity, although some activities such as bug fixing might not be creative at all [35].

III. RESEARCH METHODOLOGY

Methodology is very important as it defines reliability and validity of the results to generalize them. Research use single or mixed method to verify hypothesis and decide whether to accept or reject them. For this purpose, journal articles, conference papers, and books on the subject matters were reviewed and survey methods is used to collect data of quantitative nature because survey is an efficient method of data collection in order to get data from large population sample [36]. Online distributions of questionnaires were used because this method of data collection is very flexible and questionnaires are returned within period. This technique is used because it saves time and cost and is convenient [38], [39]. Due to this motive it is important to choose relevant sample and population. The target population was Software engineers. Three sections were created in the questionnaire. The first section consisted of demographic profile information of the respondent while the second section is based on questions about organizational profile, and the third section has questions relating to stress factors. SPSS tool was used to measure the effect of these stress factors on knowledge sharing & creativity.

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Table 1: Factors To Measure Software Engineer's Stress Adapted From [11], [37]

Category	Stress Factors	Details
Interactions	Individual and team interaction (ITI)	Interaction of analyst, developer and project manager
	Client interactions (CIT)	Interaction during business analysis and system analysis
	Work-family interface (WFI)	Taking work, home or working for late hours
	Work culture (WLC)	Travelling abroad and facing different cultures
	Family support towards a career (FSC)	Attitude and relation of the family towards work
Career Concerns	Fear of obsolescence (FOB)	Due to change of technology and quick learning of new technology
	Technical risk prosperity (TRP)	Risk due to using innovative technology or process
	Career concern (CCN)	Inadequate or poor quality of training no training
Hostile Working Conditions	Workload (WLD)	Excessive and diverse work
	Role ambiguity (RAB)	Lack of clarity about my roles and responsibilities and Lack of clarity about objectives and priorities in my work

Table 2: Details of Correlation Statistics

	FOB	ITI	CIT	WFI	ROV	WLC	TCN	FSC	WLD	TRP	RAB	CCN	CRE	KNS
FOB	1													
ITI	.544**	1												
CIT	-.058	.019	1											
WFI	-.033	.019	.087	1										
ROV	.657**	.661**	-.041	.031	1									
WLC	.229**	.165**	-.017	.016	.369**	1								
TCN	.121	.029	-.004	.016	.035	.254**	1							
FSC	.085	.026	-.049	.065	.053	.062	.185**	1						
WLD	-.034	-.121	.046	.010	-.176**	-.084	.023	.102	1					
TRP	-.089	-.037	.683**	.108	.000	.488**	.131*	.002	-.009	1				
RAB	.047	.039	-.128*	.036	.131*	.134*	.026	-.032	-.003	-.054	1			
CCN	.020	.124*	.051	.002	-.019	.053	.174**	.257**	.051	.095	-.017	1		
CRE	-.213**	.241**	.369**	.206**	-.270**	-.303**	-.294**	.314**	.107	.476**	.265**	.308**	1	
KNS	-.201**	.261**	.394**	.320**	-.226**	-.202**	-.233**	.279**	.128*	.472**	.225**	.252**	.698**	1

N= 260, **significant at $p < 0.01$ level; * significant at the $p < 0.05$ level

IV. ANALYSIS & INTERPRETATION

Data has been collected through web based questionnaire. The focus of this study is to investigate the stress factors and their impacts on software engineers knowledge sharing and creativity working in Pakistan software industry. From analysis we squared the effect of stress factors on knowledge sharing and creativity of software engineers. To find out the relationship between independent and dependent variables the Pearson product-moment correlation method is used. The results shown in Table II demonstrate the correlation among each of the Stress factor on Knowledge Sharing and Creativity.

Among these factors the correlation between ITI, CIT, WFI, FSC, TRP, RAB and CCN has positive and significant relationship with creativity, while WLD has positive and insignificant relationship with creativity. FOB, ROV, WLC and TCN has negative and significant relationship with creativity. The correlation between ITI, CIT, WFI, FSC, TRP, RAB, CCN and WLD has positive and significant relationship with knowledge sharing, while FOB, ROV, WLC and TCN has negative and significant relationship with knowledge sharing. Regression explain the impact of stress towards creativity and knowledge sharing, table III & IV shows regression analysis results.

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Table 3: Details of Regression (Creativity)

Variables	B	Std. Error	Beta	T	P
(Constant)	1.444	.226		6.390	.000
FOB	-.285	.051	-.265	-4.017	-.000
ITI	.043	.032	.079	1.367	.173
CIT	.063	.034	.130	1.841	.067
WFI	-.157	.019	-.128	-3.053	-.003
ROV	-.133	.051	-.179	-2.618	-.009
WLC	-.029	.026	-.074	-2.419	-.004
TCN	.079	.022	.162	3.664	.000
FSC	.079	.015	.223	5.078	.000
WLD	.040	.016	.106	2.490	.013
TRP	.157	.033	.396	4.737	.000
RAB	.089	.013	.284	6.705	.000
CCN	.084	.021	.174	3.935	.000

Note: $R^2 = .57$, adj $R^2 = .55$, $F_{(13,247)} = 28.35$

We conclude that among twelve stress factors four stress factors FOB (H1), WFI (H4), ROV (H5) and WLC (H6) were statistically significant and have a negative contribution towards creativity. Following factors TCN (H7), FSC (H8), WLD (H9), TRP (H10), RAB (H11) and CCN (H12) were statistically significant and have positive contribution towards creativity. While ITI (H2) and CIT (H3) factors were insignificant and have no contribution towards creativity.

Results show that among twelve stress factors four stress factors FOB (H1), WFI (H4), ROV (H5) and WLC (H6) were statistically significant and have a negative contribution towards knowledge sharing. The factors ITI (H2), TCN (H7), FSC (H8), WLD (H9), TRP (H10), RAB (H11) and CCN (H12) were statistically significant and have positive contribution towards creativity, while CIT (H3) factor was insignificant and has no contributed towards creativity.

Table 4: Details Of Regression (Knowledge Sharing)

Variables	B	Std. Error	Beta	T	P
(Constant)	1.661	.215		7.734	.000
FOB	-.084	.049	-.099	-1.716	-.002
ITI	.081	.030	.157	2.693	.008
CIT	.028	.032	.062	.870	.385
WFI	-.098	.018	-.235	-5.562	-.000
ROV	-.084	.048	-.120	-1.741	-.003
WLC	-.077	.024	-.210	-3.158	-.002
TCN	.060	.021	.128	2.891	.004
FSC	.067	.015	.202	4.590	.000
WLD	.044	.015	.124	2.891	.004
TRP	.191	.032	.509	6.047	.000
RAB	.077	.013	.259	6.078	.000
CCN	.053	.020	.116	2.602	.010

Note: $R^2 = .57$, adj $R^2 = .55$, $F_{(13,247)} = 28$

A. Mitigation strategies

After going thorough analysis of results, it is concluded that the 4 factors are more dominant towards creativity and knowledge sharing these are: Fear of obsolescence (FOB), Work-family interface (WFI), Role overload (ROV) and Work culture (WLC). If we control these factors, than we can reduce the impact of stress on software engineers knowledge sharing and creativity. For this purpose, we have proposed some mitigation strategies to overcome the stress of these factors.

Mitigation strategies are popularly used in software engineering for minimizing or eliminating the impact of some situation on the desired outcomes [42]. The proposed mitigation strategies for the current study along their outcomes are described in detail in table V.

Table 5: Summary of Mitigation Technique

Reasons	Mitigation Technique	Outcome
Due to rapid change in technology employees feel fear toward obsolete their knowledge. (FOB)	✓ The organization offers training and arranges meetings with the employee to discuss their needs and new emerging technology. ✓ An organization implements a proper reward system to motivate the employees. ✓ Drawl of clear career development chart [40, 41].	Enhance Employee performance and organization used emerging technology for development.
The employee meets deadline, so they have to work late nights, which disturb life. (WFI)	✓ Organizations should be in line with workers capabilities and resources. ✓ The organization mentions clearly the roles and responsibilities of each job [40, 41].	The chances of errors minimum and task completed on time and employee work in an efficient way.
Due to employee turnover work load is double on employees to complete the project. (ROV)	✓ The organization should have a contingency plan if employee resigns during the projects [40, 41].	Organization full fills their commitment regarding deliverable to the client.
Work culture is the source of stress due to the working condition of organization. (WLC)	✓ The organization provides better working condition. ✓ Organization arranges recreation trips and family get to gather. ✓ Organization offer medical facility for the employees [40, 41].	Good working condition increase performance of employees and good condition help creative ideas.

IV. CONCLUSION

Employees belonging to software industry feel higher pressure due to the nature of their job. This pressure creates high stress towards their job which affects their performance in meeting the targets and resultantly the overall performance of the organization is affected. There was significant need to identify the factors which contribute toward stress and affect the performance of software engineers working in software industry of Pakistan. In Pakistan there has been no study conducted with focus on the impacts of these stress factors and it was for this purpose that quantitative approach implemented and survey method was used to investigate the impact of stress on software engineers knowledge sharing and creativity. The analysis show that four stress factors fear of obsolescence, work-family interface, role overload and work culture are those factors that are more dominant toward stress and affect software engineers knowledge sharing and creativity. On the basis of these results some mitigation strategies are proposed to minimize the effects of these factors.

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VI. LIMITATIONS & FUTURE WORK

This study offers reminiscent implications described in the above paragraph but there are some limitations, which are described below:

- First, data was collected only from three cities Islamabad, Karachi and Lahore. Only the employees of software industry belonging to these cities were taken as population and sample for research study but some other big cities of Pakistan should also be a focus of study to determine their respective outcomes.
- Secondly, these findings are only applicable to Pakistan and should not be generalized to other countries, because there are cultural issues and working environment varies from country to country.
- Thirdly, sample size should be increased in order to get more generalized outcomes.

Furthermore, future research should be undertaken to make additional effort to validate the mitigation strategies of stress factors through survey method and validate through statistical treatment. Investigating the impact of demographic factors as a moderator will be an interesting study.

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