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Investigation of Knowledge Sharing Behavior in Global Software Development Organizations Using Social Cognitive Theory

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ABSTRACT Software development is a cooperative process, which relies upon the integration of knowledge spread across various domains. The shift from the industrial economy toward a decentralized knowledge-based economy has given knowledge more value and importance for organizations, which operate globally. Management of knowledge sharing activities becomes challenging and complex, specifically when operating in a globally distributed organization. The impact of ''personal factors'' and ''environmental factors'' on software developers with regard to knowledge sharing behavior in global software development organizations is an important subject, which is still not well discussed. The social cognitive theory has been utilized in the formation of the conceptual model with a focus on knowledge sharing behavior. This paper examines the impact of key factors, including ''time zone difference,'' ''geographic distance,'' ''linguistic distance,'' ''trust,'' ''motivation,'' and ''social interaction'' on knowledge sharing behavior. Self-administrative postal and online questionnaire were used as the medium of data collection. It was found that ''social interaction'' had the strongest impact on knowledge sharing behavior.

INDEX TERMS Knowledge sharing behavior, global software development organization, social cognitive theory, personal factors, environmental factors.

I. INTRODUCTION

Knowledge sharing is *''the willingness of individuals, groups or institutions to convey or spread knowledge to others''* [1]. It is the process in which individuals share the knowledge with each other [2] Global software development (GSD) is generally defined as *''software work undertaken at geographically separated locations across national boundaries in a coordinated fashion involving real time synchronous and asynchronous interaction''* [3]. Multiple interconnected teams work together in large sized global software development organizations (GSDOs). Successful management of individual's working in multiple interconnected teams requires massive knowledge and skills [4]. Many software firms across the globe have opted for GSD because of cost effective solutions for software development, increased product quality [5] and significant return on investment [6]. GSD is a ''*knowledge intensive activity*'' which is directly dependent upon knowledge sharing behavior (KSB) among distributed software teams [7]. GSD has brought many advantages to the software industry such as cheap resource utilization, follow the sun approach, opportunities for merger, utilization of expert talent from various regions [8]. But at the same time GSD faces many challenges [8], [9] such as such as managing diverse social and cultural identities of team members, overcoming coordination challenges, creating homogeneous teams with shared understanding and motivating individuals to share knowledge with development teams [10].

The remainder of the paper is organized as follows: Section II discusses previous literature and research gap Section III discusses hypothesis formulation of constructs used from social cognitive theory (SCT). The proposed conceptual research model is also presented in section III. Questionnaire development is discussed in section IV.

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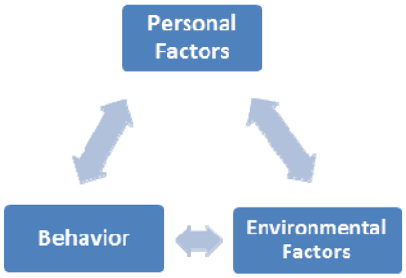

FIGURE 1. Social cognitive theory Bandura, A. (2002).

Sampling and data collection are discussed in section V. Section VI and VII presents the data analysis and results respectively. Section VIII discusses conclusion and the research contribution. Section IX discusses research implication, limitations and future work.

II. PREVIOUS RESEARCHES USING SOCIAL COGNITIVE THEORY

In social cognitive theory, ''personal factors'', ''environmental factors'' and ''behavior'' act as interrelating contributing elements which impact each other [11] as shown in figure 1.

Previous researchers have proposed frameworks for KSB using psychological theories with regards to the software industry. Tsai & Cheng (2010) used social cognitive theory to determine knowledge sharing behavior (KSB) of programmers. Data was collected from software programmers and software workers in Taiwan (Tsai & Cheng, 2010). KS ''*self-efficacy*'', ''*outcome expectancy*'' and ''*organizational climate*'' had positive influence on individual's intentions to share knowledge (Tsai & Cheng, 2010). Table 1 presents review of relevant studies which used SCT along with the research gap. It can be seen that most of the studies. incorporated only ''*personal factors*'' while mapping SCT to the respective frameworks while less attention was paid to environmental factor which is equally important because in SCT, both ''*personal*'' and ''*environmental*'' factors predict ''*behaviour*'', therefore the aim of the current study is to map both factors to determine the KSB. SCT emphasizes on the significance of ''*emotional states*''. People's self-beliefs of efficacy affect ''*how much stress and depression they experience in threatening situations, as well as their level of motivation''* [12]. But in the previous studies it can be observed that there is less focus on incorporating ''*emotional factors*''. The aim of the current study is also to explore that impact of emotional factor (motivation) on KSB.

III. MAPPING THE SOCIAL COGNITIVE THEORY FACTORS TO MEASURE KNOWLEDGE SHARING BEHAVIOR

Ever since its introduction, SCT has been widely used in the context of computer/software training and use [27], [28] in general Internet use [29] electronic-commerce-related issues [30], [31] and e-learning [21]. This study used SCT to measure KSB and there are various reasons to opt for this theory. i) SCT proposes a continuous reciprocal interconnection exists between environmental factors, personal factors, and human behavior [12]. As this study is also analyzing above-mentioned factors therefore SCT is well suitable for this study. ii) SCT also integrates motivational factors and social characteristics to get in depth understanding of individual behavior [26] which again are important part of this study as well. iii) SCT allows observation of human functioning from an encompassing perspective. iv) SCT can be considered as a ''meta-level framework'' in which other theories (which focused on individual behavior) can also be mapped according to the subset of SCT components. Based on all the reasons mentioned-above, adoption of SCT will help us gain in depth understanding of individual behavior [26]. Further, it will contribute to the development of a framework for the enhancement of KSB within the GSDOs.

The motivation behind the adoption of SCT in this study will be of great importance when it comes to answer the below-mentioned questions which will be used to fill gaps in knowledge related to:

(1) how software developers KSB is impacted from ''personal factors'' (including ''trust'', ''motivation'' and ''social interaction'') that support or hinder the KSB?

(2) how software developers KSB is impacted from ''physical environmental factors'' (such as ''linguistic distance'') that support or hinder the KSB?

(3) how software developers' KSB is impacted from ''physical environmental factors'' (such as ''time zone difference'' and ''geographic distance'') that support or hinder the KSB?

A. ENVIRONMENTAL FACTORS OF SOCIAL COGNITIVE THEORY

Environmental factors of SCT include the ''social and physical'' environment [32]. The environment is mainly composed of ''physical'' and ''social'' dimensions. Figure 2 presents the environmental factors of SCT.

B. MAPPING OF PHYSICAL ENVIRONMENTAL FACTORS OF SOCIAL COGNITIVE THEORY

Physical environment constitutes of sum of all physical entities all over the organizations [33]. The impact of global distance comprising ''geographic and temporal distance'' introduces numerous complications between individuals. These 'distance' factors impede global software development projects [34]. Previous literature suggest that the behavior of organizational members gets influenced by the physical layout of workplaces [35]. The outcome of constant interaction between social and physical environment contributes in the overall formation of any environment [36]. To achieve mutual goals various professionals, work together from different geographic physical locations in GSDOs. Due to ''geographic distance'' individuals face communication issues as face to face communication is not easily not possible. Similarly ''time zone difference'' creates obstacles in real time communication because of difference in working hours of distributed

TABLE 1. Review of Studies Using Social Cognitive Theory.

Study	Context	Sample	Environmental Factors	Personal Factors		Others	Behavioural Dependant Variables	Research Gap
				Self Efficacy	Outcome Expectancy			
[13]	Computer use	310 Navy students		General computer self-efficacy and application-specific self-efficacy	–	Anxiety, affect, declarative knowledge	Overall computer competence, domain- specific competence (performance measure)	Research did not explore the impact environmental factors
[14]	Computer learning	151 students	-	Computer self-efficacy	-	Computer attitudes, computer experience	Learning performance	Research did not explore the impact environmental factors
[15]	Web-based learning system	280 teachers and students	–	Computer self-efficacy and perceived ease of use	Perceived usefulness	Attitude	Intention to use	Research did not explore the impact environmental factors
[16]	Online banking	133 individuals	–	Computer self-efficacy and perceived ease of use	Perceived usefulness	Prior computing experience	Behavioural intention	Research did not explore the impact environmental factors
[17]	Computer training	78 undergraduate students	–	General computer self-efficacy, system-specific computer and self-efficacy, perceived ease of use	Perceived usefulness	–	Training effectiveness	Research did not explore the impact environmental factors
[18]	Computer training	78 undergraduate students	–	General computer, self-efficacy, software-specific computer, self-efficacy and perceived ease of use	–	Computer anxiety	Training effectiveness	Research did not explore the impact environmental factors
[19]	Editing application training	96 undergraduate students	–	Computer self-efficacy and ease of use	Usefulness	Attitude, perceived complexity	Intention	Research did not explore the impact environmental factors
[20]	Software use	324 students	–	Software self efficacy	–	Computer anxiety, computer experience, gender, ACT score	–	Research did not explore the impact environmental factors
[21]	E-learning system	110 undergraduate students	–	Computer self-efficacy and perceived ease of use	Perceived usefulness	Satisfaction, confirmation	Continuance intention	Research did not explore the impact environmental factors
[22]	KSB of software programmers	225 software engineers	Organizational climate	Self-efficacy	Outcome expectancy	-	Intention to share knowledge and knowledge sharing behaviour	This research considered knowledge sharing to be an individualistic behaviour, and only explored "personal aspects" aspects of SCT which affected behaviour towards knowledge sharing
[23]	Knowledge Sharing in Virtual Learning Community	250 students	Members' a sense of community and community Trust	Self-efficacy		Social interaction	Knowledge Sharing and perceptual learning	Research did not explore the relationship between self-efficacy and outcome expectations and their interaction in predicting individual behaviour
[24]	Prediction of digital piracy	257 unique studies	Environmental and other factors	Self-efficacy and self-regulation	Outcome expectancies	Social learning	Moral disengagement	Research only provided-analysis of previous studies which utilized SCT to predict digital privacy. A possible new framework could have been suggested after analyzing the shortcomings of previous studies
[25]	Social media use for political purposes	227 social media users	-	Social media political efficacy		Social media political expression, offline political participation, social media use, social media network political expression and successful enactive experience		Research did not explore the impact environmental factors (such as demographic characteristics and network diversity)

* Table I has been adapted from [26] with some modifications.

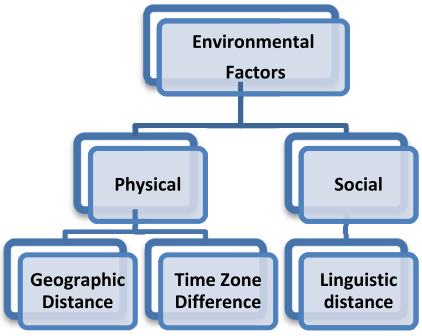

FIGURE 2. Environmental factors of social cognitive theory.

employees [37]. Therefore, in this research "geographic distance" and "time zone difference" have been included in the "physical environmental" factors of SCT.

1) TIME ZONE DIFFERENCE

"Time zone difference" makes communication difficult and challenging between distributed employees [38]–[41]. Difference in time zone decreases the mechanisms of KS and creates communication gaps between distant workers [8], [42]. Time zone variance is found to negatively impact knowledge transfer and overall success of any project [9]. Delays in overall project execution and delivery occur due to absence of synchronous collaboration because of difference in time zone [43]. Based on this literature "time zone difference" has been included in the "physical environmental factor" of the SCT, leading to the following hypothesis:

H_1: *Time zone difference is negatively related to KSB of software developers working in GSDOs*

2) GEOGRAPHIC DISTANCE

The distance between geographically dispersed members acts as a barrier [40] and causes communication issues [44] The physical distance between subproject participants prevented informal communication [45]. Study [45] found that 23% of the team members considered "far distance between work locations" as a barrier for KS [46]. KS process

becomes easier when individuals meet casually, which happens when the distance between individuals is not a concern. However in case of growing software development organizations, the growing distance between distant members hinders KS [47]. Face to face communication is also difficult when large distance is involved, and hence communication becomes difficult as compared to nearby employees [9], [44]. Distance was also mentioned as barrier by an interviewee as it limits the connectivity to the right resources [42]. Distanced members also face misunderstanding and project visualization challenges [39]. Therefore, *"geographical distance"* is found to negatively affect KSB of software developers working in GSDs, leading to the following hypothesizes:

H_2: Geographical distance is negatively related to KSB of software developers working in GSDOs.

C. MAPPING OF SOCIAL ENVIRONMENTAL FACTORS OF SOCIAL COGNITIVE THEORY

1) LINGUISTIC DISTANCE

The "*social environment*" is composed of the groups to which humans belong, the workplaces and the relevant strategies formed to direct lives [36]. Social environment also comprises of "*cultural surroundings*" in which people interact with each other [48]. It is commonly believed that "*language*" is a part of culture, and it plays a very significant part in it. In study [48], it is stated that *"A language is a part of a culture and a culture is a part of a language; the two are intricately interwoven so that one cannot separate the two without losing the significance of either language or culture"* [49]. Globalization of software projects has increased cultural diversity which obstructs smooth functioning [50]. This diversity appears in various forms such as "*linguistic distance*" [37]. Many studies have reported difference in language as one of the top most barrier for KS in GSDOs [9], [38], [39], [42], [47], [51], [52]. Based on this literature it is vital to include "*linguistic distance*" in the "*social environmental*" factor of the SCT.

In today's era Software teams comprise of individuals with various cultural backgrounds and face cultural differences such as difference in language, traditions, values, and norms of behavior which may cause misunderstanding and clashes [53], [54]. Linguistic distance also creates significant communication gaps between distant colleagues [8]. Globally distributed team members found it very difficult to share and absorb knowledge due to language difference [8]. Having individuals with heavy accents also made communication very difficult [9], [42]. Individuals whose native language was not English e.g. German [9] or Chinese [51] suffered from communication issues which resulted in improper flow of knowledge and information exchange. Additionally, when the native language was not found to be same, the diversity in terms of a common language (usually English) also lead to various problems and misunderstandings [43]. Based on this literature following hypothesis is proposed:

H_3: Linguistic distance is negatively related to KSB of software developers working in GSDOs.

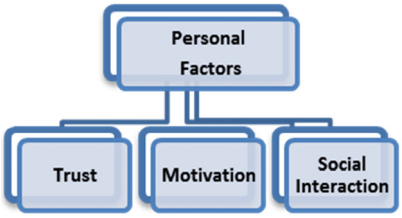

FIGURE 3. Personal factors of social cognitive theory.

D. MAPPING OF PERSONAL ENVIRONMENTAL FACTORS OF SOCIAL COGNITIVE THEORY

Three factors namely "trust" "motivation" and "social interaction "have been included in the "personal environmental factors" of SCT.

1) TRUST

Trust significantly impacts both tacit and explicit KS [10]. In order to facilitate KS between globally distributed individuals, "trust" plays a significant role [8]. Interpersonal trust positively effects KS. Trust between remote sites can be enhanced by promoting visits between globally distributed teams which can eventually build up "trust" [55]. Individuals with greater reliability transfer knowledge frequently to their trusted peers [8]. Therefore, "trust" has been included as a "personal environmental factor" in the proposed model with the following hypothesis:

H_4: Trust has a positive relationship with KSB of software developers working in GSDOs

2) MOTIVATION

Motivation is not a simple concept. and motivating factors vary from individual to individual [56]. A person who has no urge to act for a particular action is characterized as "unmotivated" whereas as someone who is eager toward an action is considered as "motivated" [57]. Individual "motivation" is the key factor which strongly influences KS. In [52], it is found that individual's 'motivation" impacted KS process. The study also reported that "motivation" to share knowledge is influenced by the quality of management [52]. In *"Self-Determination Theory"* two types of motivations have been defined based upon different reasons or goals that give rise to an action. The division is between intrinsic motivation, *"which refers to doing something because it is inherently interesting or enjoyable"*, and extrinsic motivation, *"which refers to doing something because it leads to a separable outcome"* [57]. Previous literature considers "motivation" as a personal factor [58]. Based on this literature the proposed model includes "motivation" as a "personal environmental factor", with the following hypothesis:

H_5: Motivation has a positive relationship with KSB of software developers working in GSDOs.

3) SOCIAL INTERACTION

Social interaction is defined as "any relationship between two or more individuals" [59]. Strong social interactions and

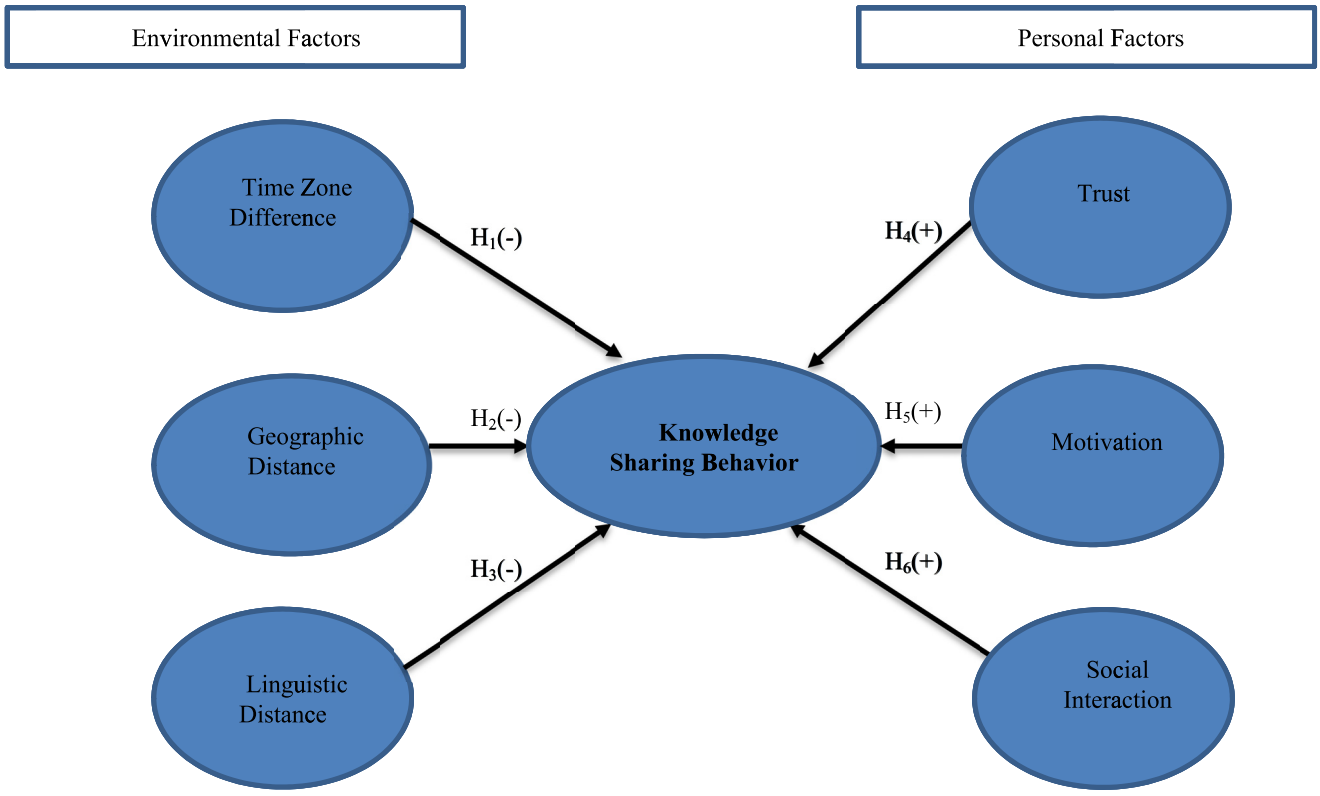

FIGURE 4. Conceptual model for knowledge sharing behavior in global software development organizations.

relationships have been found to positively aid the knowledge sharing [51]. Authors suggested that stronger social interactions between individuals allowed faster information exchange [8] and can play an important role in KS [60]. A survey comprising of 150 software developers was conducted to determine voluntary KS mechanisms in software project teams in Sri Lanka. It was found that personal interactions positively impacted KSB [61]. The proposed conceptual model includes ''social interaction'' as a ''personal environmental factor'' with the following hypothesis:

H_6: Social interaction has a positive relationship with KSB of software developers in GSDOs.

Based on the discussed hypotheses, the proposed model is given in figure 4.

IV. INDICATORS VALUES AND QUESTIONNAIRE DEVELOPMENT

Questionnaire design is the most vital component in the research which has great influence on the data selected [64]. The questionnaire items were adapted from the existing literature. Appendix A presents the questionnaire used in this study. Table 2 presents the source of variable items used in this study.

TABLE 2. Indicators design.

Indicators	Source
Geographic Distance (GD)	[65, 66]
Knowledge Sharing Behaviour (KSB)	[67]
Linguistic Distance (LD)	[65, 68, 69]
Motivation (MOT)	[70, 71]
Social Interaction (SI)	[72]
Time Zone Difference (TZD)	[66, 69]
Trust (TR)	[73]

V. SAMPLING AND DATA COLLECTION

In this study, probability sampling was done at two stages. At the first stage, list of software development companies was obtained. There are around 3,000 companies registered with Malaysia Digital Economy Corporation (MDEC) [74]. From these 3,000 companies, 100 were selected by using Simple Random Sampling (SRS) technique. When contacted, 70 companies agreed to participate in the study. These companies were asked to provide the employee name and then a master list was developed of all employees from participating companies. Total employees in the list were 789. From this list, 500 people were selected using SRS. Questionnaire was sent to these selected employees. Out of 500, 320 questionnaires were returned. Eighteen questionnaires were incomplete and were not used. Remaining (302) questionnaire were used for further data analysis. This research used self-administrative questionnaire as it is mostly used by cross-sectional studies [75].

TABLE 3. Demographics.

	No. of Respondents	Percentage
Gender		
Male	236	78.15%
Female	66	21.85%
Total	302	
Age Group		
Less than 25	51	16.89%
25 to 35	176	58.28%
26 to 40	34	11.26%
Above 40	41	13.58%
Education Level		
Diploma	72	23.84%
Bachelor	171	56.62%
Masters	54	17.88%
Doctorate	5	1.66%
Others	0	0%
Work Experience		
Less than 5 years	217	71.85%
5 to 10 years	56	18.54%
More than10 years	29	9.60%
Organization Size		
Less than 50	237	78.48%
51 to 100	28	9.27%
Above 100	37	12.25%

Various studies have recommended different minimum sample size such as [76] and [77] recommended a minimum of 100 as sample size. Hutcheson and Sofroniou (1999) recommended 150 [78], Guilford (1954) recommended 200 [79]. Generally, 100 is recommended as the ''practical minimum sample size'' while using SEM [78]. However, this research used 300 sample size, which exceeds the minimum sample size mentioned in the literature. Table 3 presents the demographic details:

VI. DATA ANALYSIS

To test the hypothesis, SmartPLS 3.0 software was used [80]. Structural equation modeling approach was selected in this research to assess the ''measurement model'' and ''structural model''. PLS has been used as it is considered suitable to investigative complex ''cause-effect-relationship'' models [80] and it also does not impose large sample size restriction and data distribution [81].

4) CONSTRUCT RELIABILITY

The suggested value for construct reliability is 0.7 [26]. Based on the above mentioned [82] recommended value, one reflective indicator from, ''*time zone difference*'' was removed. Two reflective indicators from ''*geographic distance*'', ''*linguistic difference*'' and ''*trust*'' were removed respectively. Six reflective indicators from ''*knowledge sharing behavior*'' were removed. The ''outer loadings'' values of the latent variables are presented in Table 4 (only those which are greater than 0.7).

TABLE 4. Outer loadings after item purification.

Construct	Items	Outer Loading
Time Zone Difference (TZD)	TZD1	0.885
	TZD2	0.881
	TZD3	0.898
	TZD4	0.772
Geographical Distance (GD)	GD1	0.820
	GD3	0.892
	GD4	0.889
Knowledge Sharing Behavior (KSB)	KSB4	0.855
	KSB5	0.888
	KSB9	0.793
Linguistic Distance (LD)	LD2	0.855
	LD3	0.797
	LD4	0.874
	LD5	0.750
Trust (TR)	TR1	0.852
	TR3	0.821
	TR4	0.806
	TR5	0.802
Motivation (MOT)	MOT1	0.773
	MOT2	0.767
	MOT3	0.817
	MOT4	0.793
	MOT 5	0.812
Social Interaction (SI)	SI1	0.795
	SI2	0.705
	SI4	0.769
	SI5	0.730

TABLE 5. Average variance extracted.

Constructs	CR	AVE
TZD	0.919	0.741
GD	0.901	0.753
KSB	0.883	0.716
LD	0.891	0.673
TR	0.892	0.673
MOT	0.894	0.628
SI	0.837	0.563

5) CONVERGENT VALIDITY

In this research ''average variance extracted (AVE)'', ''composite reliability (CR)'' was calculated to determine the convergent validity The recommended minimum value for Average variance extracted (AVE) is 0.50 and for composite reliability (CR) is 0.6 [83]. Table 5 presents convergent validity results which reveal that AVE and CR criteria were fulfilled.

6) DISCRIMINANT VALIDITY

In this research Fornell & Larcker [84] criterion for cross-loading scores were used to establish discriminant validity. Authors suggested that the squared root of ''*each constructs'*

TABLE 6. Construct validity and discriminant validity – fornell and lacker criterion.

Constructs	GD	KSB	LD	MOT	SI	TZD	TR
GD	**0.868**						
KSB	0.489	**0.846**					
LD	0.662	0.583	**0.821**				
MOT	0.351	0.391	0.529	**0.793**			
SI	0.63	0.666	0.616	0.459	**0.751**		
TZD	0.762	0.555	0.597	0.302	0.629	**0.861**	
TR	0.431	0.61	0.525	0.585	0.686	0.470	**0.821**

TABLE 7. Hypothesis results.

Hypothesis	t-Statistic	Decision
H1	1.895	Supported
H2	0.910	Not Supported
H3	1.788	Not Supported
H4	0.585	Not Supported
H5	2.494	Supported
H6	2.438	Supported

AVE should be higher than its highest correlation with any other construct to evidence discriminant validity'' [85]. In Table 6 the bold numbers in the diagonal row presents the square roots of the average variance extracted [84]. It can be observed that the square root of AVE for all latent variables was greater than the inter-construct correlations [79]. Further, individual loadings of all indicators were found to be higher than their respective cross-loadings [80]. This provides additional confirmation for discriminant validity.

VII. RESULTS AND DISCUSSIONS

The hypotheses were tested by calculating the significance of the path coefficients (t-values) and the results are presented in Table 7. In this study, authors investigated the KSB of individuals working in GSDOs using social cognitive theory. Out of six hypotheses, three of the hypotheses are not supported. Table 7 presents the hypothesis results.

In current study, the environmental factors of social cognitive theory were categorized into two types namely ''physical environment'' and ''social environment''. The physical environmental factors of SCT included ''geographic distance'' and ''time zone difference'' and social environmental factor of social cognitive theory included only one factor namely ''linguistic distance''. In the current study, the first factor which was included in the physical environment of SCT was ''geographic distance''. The results of current study showed that ''geographic distance'' is negatively related to KSB of software developers working in GSDOs. ''Geographic distance'' had a significant impact on the on KSB with a path coefficient of −0.190 and t-stats (2.570). This result coincides with the previous studies of [9], [42], [44], [47], [55], [86] In GSD environment the ''geographical distance'' creates physical isolation between software developers and management [87]. Effective coordination, collaboration and visibility between locations essential in GSD environment [88]. Accessing of information scattered at various remote sites such as ''updates about changes in requirements'' and ''dependencies between the products'', and ''product and technology roadmaps'' becomes a tedious task due to difference in geographic locations [89]. Prior research has shown that knowledge sharing in GSDOs encounters difficulties as ''face-to-face interaction'' is difficult due to different geographical locations [39]. ''Geographic distance'' has been cited as barrier knowledge dissemination because it reduces and sometimes totally excludes *''face-to-face interaction'' [42]*. The high value of t stats (as compared to other two antecedents of SCT) and negative path coefficient of ''geographic distance'' towards KSB suggests that software developers are more likely to engage in KS when the ''geographic distance'' is shorter. In the current study, the second factor which was included in the physical environment of SCT was ''time zone difference''. Time zone differences cause communication and knowledge sharing issues between individuals working from various distributed geographic locations [38]. The results of data analysis indicated that ''time zone difference'' had an insignificant impact on the KSB, with a path coefficient of 0.146 and t-stats (1.811). These results contradicts the result of previous studies of [44], [55], [86]. A possible explanation for this insignificance is because, GSDOs are now aware of issues related with ''geographic distance'' and have devised preventive measures to utilize the pool of resources efficiently using the various time zones. Although ''time zone difference'' is a barrier for KS, but [42] suggested that in some situations barriers can be cited as a facilitators for example, the ''time zone difference'' also acts as a facilitators for knowledge sharing because it ''increases the hours available'' to perform any activity. Reference [90] suggested different approaches to overcome ''time zone differences'' by utilizing *''time zone effectiveness'', using ''follow the sun''* approach. Reference [90] reported different approaches by various managers such as ''*We try to make time zone differences manageable by dividing work between no more than two geographical sites''* (Project manager, Intel) and

another suggestion included *"We have 'follow-the-sun' core support during Monday to Friday. Someone should be able to action a call whenever it comes in. A call can be forwarded from site to site to follow the sun..."* (Manager, HP). It can be deduced that by assigning rotational duties GSDOs can solve ''time zone differences'' related issues which eventually allows software developers to share knowledge globally. Based on these explanations it can be concluded that if management of GSDOS take counter measures to avail time zones properly knowledge sharing barriers caused by ''time zone differences'' can be reduced.

Only one factor namely ''linguistic distance'' was included in the ''social factor'' of social cognitive theory The data also did not support hypothesis H3, which was opposite to the previous researches [8], [38], [40], [47], [55], [91]. A possible explanation for this rejection might be because the study was conducted in GSDOs of Malaysia, which has a multi-cultural and ethnic society and offers home to several different ethnic groups. The statistics reveal the following breakdown: Malays, 50.1%; Chinese, 22.6%; indigenous, 11.8%; Indian, 6.7%; other, 0.7%; and non-citizens, 8.2% (2010 est.) [92]. This multi-cultural environment builds up the environment of enhancing the linguistic skills of employees which allows them to enhance their communication skills. Another possible explanation to this rejection of hypothesis is due to the introduction of *"cultural exchange programs"* by GSDOs. The cultural exchange programs help in understanding the behavior, work practices and attitudes of individuals working from different location with various cultural backgrounds [39], [55]. Lot of misunderstandings and issues occur between onsite and offshore members from the beginning of the project. In order to mitigate these issues interviewees reported that by initiating *"cultural workshops"* at the start of the project allowed individual's to share knowledge effectively [9]. Another strategy, which negates linguistic difference is by utilization *"cultural awareness"* by assigning *"cultural ambassadors"* who can interpret communication and actions of individuals working at remote sites [40]. Cultural ambassadors [55] and culturally marginal people can be assigned for mediating roles between different team members, as they have common understanding of both cultures [93], [94]. Expatriate manager are also being assigned to control and coordinate knowledge transfer and introducing corporate culture between remote sites. Nguyen, et al. (2014) suggested to overcome linguistic distance is by suing *"Information gatekeeper"* as they have skills of understanding and translating knowledge into more meaningful way for their locally oriented colleagues [93]. Thus, it can be concluded that, efficient use of cross-cultural individuals can provide an environment and baseline for organizations with an aim to enhance the knowledge sharing culture in GSDOs. Without such pre-emptive measures, knowledge sharing is destined to fail between software developers.

In the current study the personal/individual factors included *"motivation"*, *"social interaction"* and *"trust"*. The first factor which was included in the ''personal environmental factor'' of SCT was ''motivation''. The results did not support this hypothesis (H5) showing that *"motivation"* does not positively impact the KSB. Motivation had an insignificant and negative impact on the KSB with a path coefficient of -0.029 and t-stats (0.579). The path coefficient and t-stats for ''motivation'' had the lowest values as compared to other two (trust and social interaction) ''personal environmental factor'' of SCT to predict KSB. This result is not consistent with findings of [51]. It can be concluded that software developers working in GSDOs on individual level had no urge to share knowledge [51]. There could be several reasons for this insignificance, [8] stated that software developers feel unmotivated to share knowledge specially when the of sharing knowledge from senior employees to new employees [8]. To understand the impact of intrinsic and extrinsic motivation on KSB of software developers, the current research included questions related to both intrinsic and extrinsic motivation. Surprisingly, the results showed insignificant impact of ''motivation'' on KSB. Possible explanation for the insignificance of ''motivation'' can be due to the fact that individuals may become happy after getting monetary rewards, but the ''motivation'' to perform a certain action is intrinsic. No incentive can ever overshadow the power of intrinsic motivation. If individuals sense they are being controlled, they might tend to loosen their interest. Also, negative rewards like ''punishments'' weaken the intrinsic motivation of individuals. Individuals may highly desire incentives, but if acceptance of those incentives is relying on certain behaviors, individuals might get feelings of being manipulated by management with passage of time [95]. The insignificance of ''motivation'' in this study suggest that for the selected sample of software developers, intrinsic motivators (enjoyment, pleasure) and extrinsic motivators (recognition, respect) were not as important as other individual factors (trust and social interaction).

''Social interaction'' is acknowledged to be a vital construct in promoting KS [96] ''Social interaction'' had a significant and strong impact on the KSB with a path coefficient of 0.241 and t-stats (2.438). The impact of ''social interaction'' towards KSB is strongest as compared to other two (trust and motivation) antecedents for the individual factors of SCT to predict KSB. This finding highlights the importance of the ''social interaction'' in GSDOs to promote KSB. Recent studies of [8], [42], [61] have provided empirical support for the influence of ''social interaction''. The results of the current study accord with the findings of abovementioned researches. The results of data analysis affirm that ''social interaction'' can play a major role in KSB in GSDOs, therefore, it can be inferred that as the degree of ''social interaction'' increases, KSB will also increase between software developers working in GSDOs.

VIII. CONCLUSION

The purpose of the current study was to investigate the KSB using existing theory of social psychology in software developers in the context of GSD. The study investigated

TABLE 8. Instrument development.

Variable	Adopted/Adapted	Measurement Items	Source
Social interaction (SI)	Adapted	1. I maintain close social interaction with some of my co-workers. 2. I spend a lot of time sharing knowledge with some of my co-workers. 3. I have frequent exchange of knowledge with some of my co-workers. 4. I have frequent exchange of software development ideas with some of my co-workers 5. I like to share my software expertise to some members whom I know on personal level.	[72]
Trust (TR)	Adapted	1. I believe that my co-workers can be trusted completely to share knowledge. 2. I believe that my co-workers software development knowledge is reliable. 3. I believe that my co-workers software development knowledge is useful. 4. I believe that my co-worker software development knowledge is effective. 5. I believe that my co-workers would not take advantage of my software development knowledge that we share. 6. I believe that my co-workers can't be trusted completely to share knowledge.	[73]
Motivation (MOT)	Adapted	1. I enjoy sharing knowledge with my co-workers. 2. It feels good to share my software development techniques with my co-workers to solve their work related problems. 3. Sharing knowledge with my co-workers gives me pleasure. 4. Sharing my knowledge improves others recognition of me. 5. When I share my software development knowledge with my team members, my superiors respect me.	[70, 71]
Knowledge sharing behaviour (KSB)	Adapted	1. I frequently participate in knowledge sharing activities in my organization. 2. I frequently spend a lot of time conducting knowledge sharing activities in my organization. 3. I frequently share my software development knowledge with others. 4. When discussing a complicated issue, I am frequently involved in the subsequent knowledge sharing interactions. 5. I frequently involve myself in discussions of various software development topics rather than specific topics. 6. I frequently share my knowledge related to *"software construction fundamentals"* with others. 7. I frequently share my knowledge related to *"managing software construction"* with others. 8. I frequently share my knowledge related to *"practical software considerations"* with others. 9. I frequently share my knowledge related to *"software construction tools and technologies"* with others.	[67]
Linguistic distance (LD)	Adapted	1. Most people in my organization can communicate well in English. 2. Differences in language makes it difficult to share knowledge. 3. Linguistic diversity can make it difficult to communicate and collaborate across borders. 4. I believe Linguistic distance affects quality of knowledge sharing.	[65, 68, 69]

the impact of ''time zone difference'', 'geographic distance'', ''linguistic distance'', ''trust'', ''motivation'' and ''social interaction'' on KSB.

In this study, the applicability of social cognitive theory to explain the KSB was demonstrated. KSB was found to have strongest relationship with ''social interaction''. Thus, it can be concluded that ''social interaction'' plays a significant role in knowledge sharing process.

Out of the three the factors used in the ''physical environmental factors of SCT only ''geographic distance'' emerged as significant factor to predict KSB of software developers working in GSDOs. It is suggested for the management of GSDOs to resolve issues related to ''geographic distance'' to ease KS process. One solution to overcome ''geographic distance'' is *''rotation''* of individuals between distributed sites which promotes the sharing of domain related knowledge. Rotation of individual's not only supports knowledge sharing but also promotes ''trust'' and communication bandwidth [39] Rotation of individuals comes with extra cost, but to overcome the cost of frequent rotation, one line manager reported *''we rotate team members and mostly, the duration of the rotation between team members is 3-6 months''* [39]. Author suggested ''*relocation of experts*'' between remote sites, accelerated KS and technical expertise in GSDOs [10]. From the ''personal environmental factors'' ''social interaction'' had the strongest impact towards KSB, we suggest that top management of GSDOs should develop ''social interaction'' sessions such as *''group activities''* and *''common chat rooms''* where software developers can freely interact with peers. The top management may also consider ''*Pair programming''* which allows sharing of knowledge between software developers in a globally distributed project. Pair programming, allows two developers work together at one computer with a common goal [39], hence chances of social interaction will increase.

IX. IMPLICATION, LIMITATION AND FUTURE WORK

According to [56], ''social interaction'' creates a bond between members of a network, and these bonds can be considered as a major predictor of collective action. These resulting bonds are built among individuals with identical interests and resources rather than between individuals of dissimilar interests [57]. Based on this explanation we can postulate that software developers working in GSDOs develop ''social interaction'' because of similar interests in the current study. To enhance KSB, the management of GSDOs needs to provide an environment where focus should be towards building ''social interaction'' between software developers. We hope that realization of these practices can contribute to fruitful execution of KS in GSDOs. Future research could incorporate the influence of variables such as ''technological'' and ''organizational'' support impact on KSB.

APPENDIX A

See Table 8.

TABLE 8. ***(Continued.)***

		5. I believe my co-workers have to spend some time thinking about my software development knowledge to understand my real meaning. 6. Linguistic diversity in our organization opens cross-border software knowledge sharing opportunities.	
Geographic distance (GD)	Adapted	1. When working with cross-border co-workers, we incur losses due to ineffective knowledge sharing. 2. When working with cross border team, I lose time trying to figure out who to share knowledge regarding my work. 3. When working with cross border team, there have been times when I was accidently excluded from information which was shared by my co-workers. 4. When working with cross border team, it becomes difficult for me to find right people to whom I have to share my knowledge. 5. I believe geographic distance affects quality of knowledge sharing.	[65, 66]
Time zone difference (TZD)	Adapted	1. I believe time zone difference affects quality of knowledge sharing. 2. I believe time zone difference affects quality of software product development. 3. I believe time zone difference affects productivity of knowledge sharing. 4. I believe time zone difference causes communication overhead. 5. When working with cross border team, I experience difficulty in scheduling schedule common meeting times in order to share my knowledge with my co-workers.	[66, 69]

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