The Impacts of Safety Climate and Computer Self-Efficacy on Near-Miss Incident Reporting Intentions

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Abstract--**Near-misses management has drawn the attention of safety specialists to reduce the likelihood of future catastrophe for improving employee safety and process reliability. Though near miss reporting systems could be implemented successfully from a technical perspective, success may depend on employees being willing to use the delivered system. This paper examined the impact of safety climate on near miss reporting intention. We defined a model of near miss reporting system usage intention by incorporating safety climate with behavioral intention theory, including theory of reasoned action (TRA) and extended technology acceptance model (TAM2) In our analysis, we found out that (1)behavioral intention to use a near miss incident reporting system was affected indirectly by safety climate and self-efficacy. And computer self-efficacy had less impact on intention than safety climate. (2)The behavioral intention was directly influenced by subjective norm, perceived usefulness and perceived ease-of-use. Subjective norm exerted almost the same impact on intentions as perceived usefulness did. Managerial implications were then discussed.**

I. INTRODUCTION

Near-miss incident was defined as an incident having potential to, but do not, result in property loss or human hurt. According to the well-known safety pyramid [2], accidents at the pyramid pinnacle result in injury loss and significant disruption of production process that usually draw the attention of the management. But much large number of near-miss incidents comprises the lower portion of pyramid, despite their limited impact; near-miss incidents provide insight into accidents that could happen [25]. Therefore, it has been recognized that increasing near-miss incident reporting rate corresponded to lost work time injuries reduction [17].

A recognized near-miss incident has only limited value, unless it is reported and analyzed with appropriate measurements to prevent its recurrence [24 and 19]. To reduce the likelihood of future catastrophe by improving employee safety and process reliability, managers need to seek and utilize near-miss incidents [19]. Near-misses management has drawn the attention of safety specialists, and many companies have built up near-miss reporting information system to collect near-miss reports. However, even though a near-miss incident is recognized, there is no assurance that it will be reported. Employees may be reluctant to report near-misses due to potential recriminations that could result from peer pressure, investigation, and unintended disciplinary actions [25]. Though near-miss reporting systems could be implemented successfully in terms of technology, system success may depend on employees being willing to use the delivered system. The current paper examined the impact of safety climate on near-miss reporting intention. We defined a model to explore the usage intention of a near-miss reporting system by incorporating safety climate with behavior intention theory, including theory of reasoned action (TRA) and extended technology acceptance model (TAM2) [29].

II. CONCEPTUAL MODEL AND RESEARCH HYPOTHESIS

A. Behavior intention of information technology (IT) usage.

Theory of reasoned action (TRA) proposed by [10] is a model to predict and explain human behavior. According to TRA, a person's specified behavior is determined by his or her behavior intention to perform the behavior, which is jointly determined by the person's attitude and subjective norm (SN) concerned the behavior in question. Subjective norm refers to the person's perception that most people that are important to him/her think he/she should or should not perform the behavior in question. Davis [8] proposed a technology acceptance model (TAM) derived from TRA, It posits that behavioral intentions to use IT are determined by an individual's attitude toward using the IT, as well as beliefs the user holds about its perceived usefulness (PU). Attitude, in turn, is determined by PU and perceived ease-of-use (EOU). *PU* is defined as the degree to which a person believes that use of a system would improve his or her performance [8], and thus taps into the instrumental outcomes a user associates with technology use. *EOU* refers to the degree to which a person believes that using a particular system would be effortless [8]. Even though both PU and EOU are significantly correlated with intentions, Davis' findings suggest that PU mediate the effect of EOU on behavioral intentions.

Venkatesh and Davis [29] extended the original TAM model to explain perceived usefulness and usage intentions in terms of social influence and cognitive instrumental processes. The extended model, referred to as TAM2, was tested in both voluntary and mandatory settings. Subjective norm (SN), which was defined as an individual's perception of social normative pressures or relevant others' beliefs that he or she should or should not perform the behavior, played the role of both direct impact to BI and indirect impact to BI by mediation of PU in model TAM2. Based on the foregoing discussion, the following hypotheses were proposed.

H1a: Subjective norm (SN) has a positive effect on behavior intention (BI) to use the information system.

H1b: Subjective norm (SN) has a positive effect on perceived usefulness (PU).

H2: Perceived usefulness (PU) has a positive effect on

behavior intention (BI) to use the information system.

H3a: Perceived ease-of-use (EOU) has a positive effect on perceived usefulness (PU).

H3b: Perceived ease-of-use (EOU) has a positive effect on behavior intention (BI) to use the information system.

B. Safety climate

Safety climate reflected employees' perception of the organization's safety efforts, Zohar defined safety climate as employees' perception of the priority that organization and supervisors placed on safety [32 and 16]. Safety climate was derived as the temporal state measure of safety culture, refers to the perceived state of safety in a particular place at a particular time, and subject to change depending on the features of the current environment or prevailing conditions. [31 and 18] Flin et al. [11] found that management commitment was the prime theme of safety climate, appearing in 13 out of the 18 research scales. Safety climate perceptions involve a process of social exchange [4 and 9], that predicts if employees perceived organization concerned for their well-being, then they will develop an implicit obligation to reciprocate by carrying out citizenship activities to benefit the organization [28].

Safety participation describes safety citizenship behaviors that do not directly contribute to an individual's personal safety but that do help to develop an environment that supports safety. These behaviors include activities such as participating in voluntary safety activities, helping coworkers with safety-related issues and attending safety meetings [22]. Reporting near-miss incidents is part of safety participation intrinsically. Some researchers suggested safety climate was the antecedent of safety participation [22 and14], that implies safety climate may affect employees' motivation to report near-miss incidents. Positive safety climate was found to maintain involvement in safety participation [21] that implied organizations with good safety climate tend to have good subjective norm of encouraging employee to concern more about others' safety. Based on the foregoing discussion, the following hypothesis was proposed.

H4: Safety climate has a positive effect on subjective norm (SN).

C. Computer self-efficacy

A key element in social learning theory is the concept of self-efficacy (SE), which refers to an individual's belief in his or her capability to perform a specific task [5]. Self-efficacy is a dynamic construct that reflects more than just an ability assessment. An individual's judgment of SE reflects an orchestration or mobilization component that includes both motivational and integrative aspects [13 and 30]. In other words, SE reflects not only an individual's perception of his or her ability to perform a particular task based on past performance or experience but also forms a critical influence on future intentions [20].

Prior research consistently indicates that computer self-efficacy (CSE) is positively correlated with an individual's willingness to choose and participate in computer-related activities, expectations of success in such activities, and persistence or effective coping behaviors when faced with computer-related difficulties [5].

A study conducted by Igbaria and Iivari [15] on impact of computer self-efficacy on computer use found that computer self-efficacy has a strong direct effect on PEU, but only an indirect effect on perceived usefulness through perceived ease of use.

H5: Computer self-efficacy (SEF) has a positive effect on perceived ease-of-use (EOU).

D. Research model

To explore how safety climate affected an individual's intention of using near-miss reporting system, we developed a model based on psychological antecedents and consequences relationship as previous discussion. The research model is shown in Fig. 1.

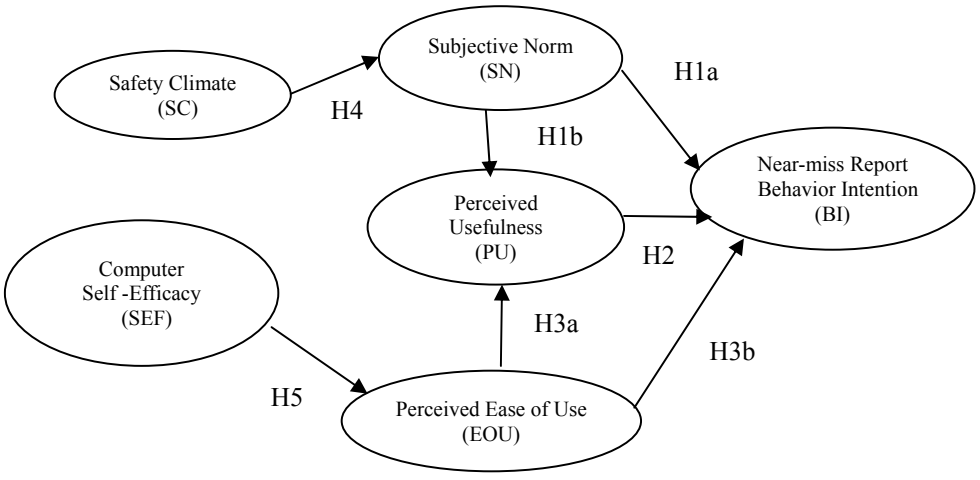


Fig. 1: Hypothesized relationships among constructs

III. RESEARCH METHOD

A. Instrument development

The survey items used to measure the constructs in our study were adapted from previous studies; each survey item was reviewed by the research team consisting of scholars and safety specialists to check its face validity, and then refined after the pilot test.

The survey questionnaire contained 23 items; all question items were measured using five point Likert-type scales ranging from "Strongly Disagree" (1) to "Strongly Agree' (5). As the survey items were gathered at the same time and by the same person, risk of common method variance might bias the result, three extra survey items were designed in reverse scoring to reduce the effect as proposed by Podsakoff et al. [26].

Survey items are adapted from previous research. Six items adapted from Zohar & Luria [32] are for safety climate. Four items adapted from Conner& Sparks [6] are for subjective norm. Four items adapted from Davis [8] are for perceived usefulness. Three items adapted from Davis (1989) are for ease-of-use. Three items adapted from Veskatech & Davis [29] are for computer self efficacy. Four items modified from Veskatech & Davis [29] are for behavior intention.

B. Sample characteristic

Cooper and Phillips [7] recommended that an organization's functional department is the appropriate level of analysis and aggregation of individual response for safety climate, so this research chose a manufacturing company with several departments for sampling. Four hundred employees having reported near-miss incidents were sampled for questionnaires, and 313 valid responds were received, yielding a valid sampling rate of 78.25%. Demographics of the study sample are shown in table 1.

IV. DATA ANALYSIS AND RESULT

A. Estimation of Measurement Model

Measurement data were analyzed in two-step methodology by statistics programs AMOS version 7. First, we checked the measurement model to investigate the relationships between the observed items and the latent constructs then we checked structure model that described the relationships among theoretical constructs. Through this procedure, the model has been adjusted to create the best measurement model, and then structure equation model was analyzed. In this study, the model effectiveness was examined by seven common model fit measurement indices and their desired values were: normed-χ^2 (<3.0), goodness-of-fit index GFI (>0.90), comparative fit index CFI (>0.9), normal fit index NFI (>.0.9), incremental fit index IFI (>0.9), Adjusted goodness-of-fit index AGFI (>0.8), root mean square error of approximation RMSEA (<0.05).

B. Confirmatory Factor Analysis (CFA)

The reliability study indicated the degree of internal consistency between the multiple variables that make up the scale, and represented the extent to which the indicators or items of the scale are measuring the same concepts [3]. Cronbach's α greater than 0.7 was considered to be adequate reliability of measurement items toward the latent construct [23]. Cronbach's α of all constructs in table 4 exceeded acceptable thresholds, and thus implied adequate reliability of measurements.

TABLE 1. DEMOGRAPHICS OF STUDY SAMPLE

Variable	Item	Number	%
Tenure	<5 y	87	27.8
	5-10 y	35	11.2
	10-15 y	25	8
	15y <	166	53.0
Position	Operators	69	22.0
	Supervisors	79	25.2
	Engineers	145	46.3
	Managers	20	6.4
Education	High School	61	19.5
	College	62	19.8
	University	92	29.4
	Graduate School	98	31.3
Work Type	Maintenance	111	35.5
	Production	154	49.2
	Administration	9	2.9
	QC & RD	39	12.5
Cases of near-miss reporting	1	26	8.3
	2~4	184	58.8
	5~10	77	24.6
	10~20	21	6.7
	21~	5	1.6

Convergent validity was assessed using factor loading (λ), composite reliability index (CR) and average variance extracted (AVE) to determine the relation between the measurement variable to the corresponding latent variable [1]. Factor loading exceeded 0.7, composite reliability index exceeded 0.7 and AVE exceeded 0.5 were supporting criterion for convergent validity [12]. In table 2, standardized factor loadings of items SEF-1(0.69) was slightly less than 0.7, all the rest factor loadings were greater than 0.7. Composite reliability indices of the items in the measurement model were greater than 0.7, and AVEs were greater than 0.5, therefore construct convergent validity are adequate.

Discriminate validity indicated the extent to which two conceptually similar concepts differ, and was investigated by estimating the 95% confidence interval of the correlation coefficient between constructs, with the aim being to ensure that no interval contains 1.0, then we can say discriminant validity was supported [27]. In table 3, no any confidence interval of the correlation coefficient contained 1.0, implied adequate discriminate validity between constructs. As correlation factors of BI-SN and BI-PU were greater than squared root of AVE of BI, discriminate validity was further investigated by assuming the correlation factor to be 1.0 then compared the significant model difference to original correlation factor [1]. The result of comparison was shown in table 4, discrimination validity of BI-SN and BI-PU were accepted.

Measurement model was examined by confirmatory factor analysis, and measurement models were revised by removing items that had large standardized residues with other items, one at a time. After dropping items with Cronbach's α less than 0.7, the measurement models exhibited overall good fit. The model fit results χ^2 (197) =280.968, Normed-χ^2 = 1.426, RMSEA=0.04, GFI =0.928, CFI =0.981, AGFI =0.899, IFI=0.981, all criteria were fitted.

C. Structure model

The structure model was examined using the cleansed measurement model, overall model fit indices are normed-χ^2= 1.82, RMSEA=0.05, GFI =0.91, CFI =0.96, IFI =0.96, NFI =0.92 and AGFI=0.88, all model fit indices suggested the structure model fit the data adequately. The standardized path coefficients are shown in Fig. 2.

The path diagram showed the causal relationship between the constructs and the standardized path coefficients, R^2, t-test was applied to examine the statistical significance. We found that SN had a significant direct positive effect on BI (β = 0.51, P < 0.001) and positive effect to PU (β = 0.47, P < 0.001), hypotheses H1a and H1b were supported. Perceived usefulness (PU) has positive effect to BI (β = 0.53, P < 0.01), hypothesis H2 was supported. Perceived Ease-of-use (EOU) has both direct positive effect to BI (β = 0.18, P < 0.01), and positive effect to PU (β = 0.41, P < 0.01), hypotheses H3a and H3b were therefore supported. We also found safety climate (SC) had positive effect to SN (β = 0.46, P < 0.01), hypothesis H4 was supported. Computer self-efficacy had positive effect to EOU ((β = 0.46, P < 0.01), hypothesis H5was supported.

V. DISCUSSION AND IMPLICATION:

A. Findings and limitations

In our analysis, we found that behavioral intention to use a near-miss incident reporting system was affected indirectly by safety climate, which also influenced the PU and SN of using the system. It was also observed that safety climate played an important role by identifying the explained variances.

The research model also showed SN, PU and EOU explained 90% variance of BI totally. They had very significant effect on near-miss reporting systems usage intention. SN and EOU together accounted for 39% of the variance in PU. Safety climate explained 21% of the variance in SN and computer self-efficacy explained 21% of the variance in EOU.

Table 6 shows the coefficients between each construct, including the direct, indirect and total effects. Intention to use near-miss reporting system is an outcome variable used to determine whether users are willing to adopt a reporting information system. The table shows that the determinant with the strongest direct impact on intention to use is subjective norm (total β = 0.76), followed by perceived usefulness (total β = 0.53). In other words, the more users feel that he was motivated and supported to report near-miss incidents, or they felt using the system is useful, the stronger will be the intention to use the information system. SN had both direct and indirect effects on BI (β = 0.51 and 0.25), EOU also had both direct and indirect effects (β = 0.18 and 0.22). EOU had less impact on BI than SN and PU did.

Another observation is the direct impact of SC on SN (β = 0.35). That implied when an organization had good safety climate, management level paid more attention to working safety, and managers showed positive perception about near-miss reporting, and developed an atmosphere of encouraging workforces to report their near-miss incidents, positive SN was created. SEF had only indirect effect factor of 0.19. That implied SEF was less important than SC concerning the perceived usefulness of a reporting system.

In many researches about adopting new information technology by applying TAM model, PU played the most significant role on BI. But in this empirical study about near-miss incidents reporting, we observed SN had stronger impact on BI than PU did (0.76>0.53). One of the possible reasons is the mental obstacle of near-miss reporting. As near-miss incident is considered to be preventable and shall be eliminated, some managers might obstruct subordinates to report near-miss incidents for the sake of organizational superficial safety performance. Sometimes exhaustive incident investigation process makes the employees hesitate to report near-miss incidents. Unlike other new technology implementation, usefulness and ease-of-use are key factors.

Building open and positive safety climate to create supporting environment for near-miss reporting maybe more critical than technology itself. This agreed with previous research conclusion "employees may be reluctant to report near-misses due to potential recriminations that could result from peer pressure, investigation, and unintended disciplinary actions "[25].

Even with the careful survey design, this study might still have limitations that circumscribe the interpretation of its findings. First, measures of all constructs were gathered at the same time and through the same instrument. Consequently, common method variance exists. Due to the cross-sectional and retrospective nature of this study, causality could only be inferred via theory; a longitudinal approach needs to be considered.

B. Conclusions

From a theoretical perspective, our study developed an integrated framework that provides a rich understanding of IT implementation. Our findings shed light on management practices. Managers need to pay attention to the role of safety climate in promoting near-miss incident reporting system implementation. Our findings emphasized the importance of managers' safety attitudes. If employees perceived that the organization concerned for their workplace safety, they will be more likely to reciprocate by carrying near-miss reporting to benefit the organization.

TABLE 2. RESULTS OF CFA DATA

Dimension	Item	Variable	Loading λ	Cronbach's Alpha	CR	AVE
Safety Climate (SC)	My direct supervisor uses explanation (not just compliance) to get us to act safely.	SC-1	0.82	0.91	0.90	0.61
	My direct supervisor refuses to ignore safety rules when work falls behind schedule.	SC-2	0.73			
	My direct supervisor insists that we obey safety rules when fixing equipment or machines.	SC-3	0.70			
	My direct supervisor says a "good word" to workers who special attention to safety.	SC-4	0.79			
	My direct supervisor spends time helping us learn to see problems before they arise.	SC-5	0.81			
	My direct supervisor frequently talks about safety issues throughout the workweek.	SC-6	0.84			
Subjective norm (SN)	My co-worker encourages me to report near-miss incidents.	SN-1	0.70	0.83	0.82	0.53
	The safety personnel of my organization encourage us to report near-miss incidents.	SN-2	0.70			
	My supervisor encourages us to report near-miss incidents.	SN-3	0.70			
	Co-workers' support for near-miss incident report system is important to me.	SN-4	0.80			
Perceived usefulness (PU)	Using the near-miss incidents reporting system enables me to have more safety information.	PU-1	0.81	0.91	0.90	0.69
	Using the near-miss incidents reporting system will enhance my safety in performing my task.	PU-2	0.82			
	Using the near-miss incidents reporting system is useful for performing my task.	PU-3	0.87			
	Using the near-miss incidents reporting system enables me to access more safety relevant information.	PU-4	0.84			
Perceived ease-of-use (EOU)	Learning to operate the near-miss incidents reporting system is easy for me.	EOU-1	0.80	0.89	0.9	0.74
	It is easy to become skillful at using the near-miss incidents reporting system for me.	EOU-2	0.85			
	I find the near-miss incidents reporting system easy to use.	EOU-3	0.93			
Computer Self Efficacy (SEF):	I feel confident using near-miss incidents reporting system if someone show me how to do it first.	SEF-1	0.69	0.79	0.78	0.54
	I feel confident using near-miss incidents reporting system if on-line help is available.	SEF-2	0.78			
	I feel confident using near-miss incidents reporting system if I have sufficient time for learning.	SEF-3	0.73			
Behavior Intention (BI)	I intend to use the near-miss incidents reporting system to report my near-miss incident.	BI-1	0.74	0.75	0.78	0.55
	When I need safety information, I intend to use near-miss incidents reporting system.	BI-3	0.75			
	I will continue to use near-miss incidents reporting system.	BI-4	0.72			

TABLE 3. CORRELATION BETWEEN EACH TWO CONSTRUCTS

	SC	SN	SEF	EOU	PU	BI
SC	0.78					
SN	0.47 (0.28-0.61)	0.73				
SEF	0.36 (0.21-0.50)	0.36 (0.21-0.50)	0.73			
EOU	0.30 (0.15-0.44)	0.46 (0.33-0.58)	0.47 (0.32-0.58)	0.86		
PU	0.32 (0.17-0.47)	0.62 (0.49-0.74)	0.44 (0.31-0.57)	0.56 (0.45-0.68)	0.83	
BI	0.36 (0.17-0.54)	0.85 (0.76-0.92)	0.36 (0.20-0.52)	0.60 (0.48-0.71)	0.87 (0.79-0.94)	0.74

Remarks: Diagonal is squared root of AVE；95% confidence interval

TABLE 4. VERIFICATION DATA OF BI-PU, BI-SN DISCRIMINATE VALIDITY

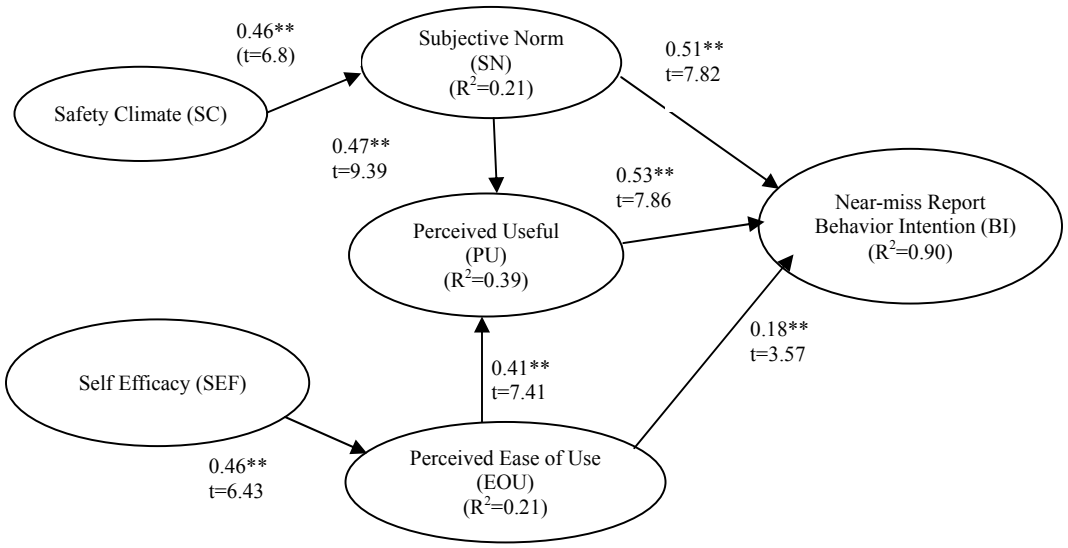
	Model	Corr.	DF	CMIN	CMIN/DF	Delta (DF)	Delta (CMIN)	p	constructs difference
BI vs PU	unconstrained	0.86	16	34.90	2.18	1	110.2	<0.01	Significant
	constrained	1.0	17	145.15	8.54				
BI vs SN	unconstrained	0.85	19	53.22	2.80	1	98.66	<0.01	Significant
	constrained	1.0	20	151.88	7.59				

TABLE 5. STATISTICS OF MODEL FIT MEASURES.

Model fit measure	Recommended value	FA model value	Structural Model value
1. χ^2/df	<3.0	47	1.82
2. Goodness-of-fit index (GFI)	>0.9	93	0.91
3. Adjusted GFI (AGFI)	>0.8	91	0.88
4. Normed fit index (NFI)	>0.9	94	0.92
5. Incremental fit index (IFI)	>0.9	98	0.96
6. Comparative fit index (CFI)	>0.9	98	
7. Root mean square error of approximation (RMSEA)	<0.05	04	

TABLE 6. THE DIRECT, INDIRECT, AND TOTAL EFFECTS AMONG CONSTRUCTS.

	EOU			SN			PU			BI		
	direct	indirect	total	direct	indirect	total	direct	indirect	total	direct	indirect	total
SC	-	-	-	0.46	-	0.46	-	0.22	0.22	-	0.35	0.35
SEF	0.46	-	0.46	-	-	-	-	0.19	0.19	-	0.18	0.18
EOU				-	-	-	0.41	-	0.41	0.18	0.22	0.40
SN	-	-	-				0.47	-	0.47	0.51	0.25	0.76
PU	-	-	-	-	-	-				0.53	-	0.53



Path coefficient between constructs (t value), **: $p<0.01$

χ^2 (71) =372.34, Normed-χ^2 =1.82, RMSEA=0.05, GFI =0.91, CFI =0.96, IFI=0.96, NFI=0.92, AGFI =0.88

Fig. 2. path diagram of structural model from SEM analysis

TABLE 6. THE DIRECT, INDIRECT, AND TOTAL EFFECTS OF EACH CONSTRUCT

	EOU			SN			PU			BI		
	direct	indirect	total	direct	indirect	total	direct	indirect	total	direct	indirect	total
SC	-	-	-	0.46	-	0.46	-	0.22	0.22	-	0.35	0.35
SEF	0.46	-	0.46	-	-	-	-	0.19	0.19	-	0.18	0.18
EOU				-	-	-	0.41	-	0.41	0.18	0.22	0.40
SN	-	-	-				0.47	-	0.47	0.51	0.25	0.76
PU	-	-	-	-	-	-				0.53	-	0.53

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