WEARABLE TECHNOLOGIES: THE IMPLICATION OF UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY IN CROWDSOURCING LOGISTICS

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Abstract. *Information communication technologies have added a tremens-dous amount of impetus to the concept of crowd sourcing and as a result organization all over the world are able to find the solution to the most current and significant problems through the general public. In this study, the unified theory of acceptance and use of technology (UTAUT) has been used to find user intention to use crowd sourcing applications and their acceptance of wearable devices for collaborative innovation and logistics performance. Data has beencollected from China through survey method. Results have empirically supported the conceptual model. The implication of this study will enhance the crowd sourcing in logistics.*

Keywords: Wearable Technologies, Crowd sourcing Logistics, Logistics Performance, Unified Theory of Acceptance and Use of Technology (UTAUT), Collaborative Innovation

1. Introduction

Crowd sourcing is an old idea which got lot of traction through the use of advanced information communication technologies (One Space, 2018). In 1714 the British government had taken the initiative of crowd sourcing project through "Longitude Prize" of amount 20,000 pounds. Then in 1783, French King awarded the prize for Soda production. In 1879, James Murray called for the Oxford English Dictionary (Thomas, 2018). So, crowd sourcing made possible many historical projects. Nowadays, the use of information communication technologies makes it possible to target specific crowd with low cost and on real-time to find organizational solutions from the public.

The previous literature has focused on the use of crowd sourcing through wearable technologies in different fields like justice (Raymond & Shackelford, 2015), emotions (Uğur, 2013), health (Amor & James, 2015) and surgical and emergency skills (Lendvay, White, & Kowalewski, 2015; Rumsfeld et al., 2016). Furthermore, crowd sourcing in logistics in terms of social crowd (Mladenow, Bauer, & Strauss, 2015, 2016), enterprise innovation (Changchun, 2010), disaster relief (Zook, Graham, Shelton, & Gorman, 2010), medicine (Ranard et al., 2014) , electronic commerce (Pan, Chen, & Zhong, 2015), last mile delivery (Esper, Jensen, Turnipseed, & Burton, 2003) and crowd sourcing applications (Alt, Shirazi, Schmidt, Kramer, & Nawaz, 2010; A Doan, Franklin, Kossmann, & Kraska, 2011; Anhai Doan, Ramakrishnan, & Halevy, 2011; Hu et al., 2015; Yan, Marzilli, Holmes, Ganesan, & Corner, 2009) has also been explored to some extent. But, how the use of crowd sourcing applications on wearable devices can enhance logistic performance? And crowd sourcing logistics through information communication technologies from the perspective of users have been ignored so far in the literature. In this study, this question has been addressed through the implication of UTAUT and use of wearable technologies in crowd sourcing to enhance logistic performance.

2 Literature Review

The unified theory of acceptance and use of technology is the technology acceptance model. This theory has focused on explaining the user intentions to use information technology for their benefits. This theory is based on PE, EE, SI, and FC to sharpen the user intention towards the use of information technology which will automatically lead to the actual use of technology (Taiwo & Downe, 2013; Venkatesh, Morris, Davis, & Davis, 2003; Williams, Rana, & Dwivedi, 2015). In this study, the complete UTAUT theory has been a focus to use of crowd sourcing applications to improve logistics performance.

Crowd sourcing system refers to the crowd of people who are actively involved in solving the specific problem (Anhai Doan et al., 2011). Also, crowd sourcing is an open call for the solution of the practical issues; which were otherwise solved within the organization or outsourced to some agencies (Howe, 2006). So, the crowd sourcing is the organizational process for open innovation through social crowd (Mladenow, Bauer, & Strauss, 2014). Crowd sourcing can improve the logistics performance and supply chain operations has been a focus area in the previous literature (Ta, 2018).

Crowd sourcing is a complete systematic process which starts from the organizational problem. In the next stage,organizations publish their problem statement in public. Then organizations target and contact with potential crowd source specific to the problem. In the next phase,organization interacts with their potential crowd to perform the task, integrate and coordinate activities. The ultimate goal is to find and report the solution and give remuneration and rewards to the solution provider (Bauer, Mladenow, & Strauss, 2014).

In crowd sourcing logistics different computerized applications have helped to improve logistics performance. One example is, BringBee (http://www.bringbee.ch/) which was launched in 2013 to improve the logistics through crowd sourcing. The purpose of this application will enable individuals to buy products from Ikea in Switzerland. There aresome other crowd sourcing applications which are there to enhance last mile logistics through reducing cost per kilometre and fleet capacity utilization(Dickinson et al., 2015).

Collaborative innovation is a process in which crowd of people get involved and contributes to improve the services, processes, products with innovative solutions. So, a large number of people get involved in collaborative innovation through crowd sourcing (Hartley, Sørensen, & Torfing, 2013; Majchrzak & Malhotra, 2013). The citizen shipper (https://citizenshipper.com/) is a form of collaborative logistics which is the best example of collaborative innovation in crowd sourcing logistics. So, collaborative innovation in crowd sourcing will enhance the logistic performance (Beliën et al., 2017; Tinoco, Creemers, & Boute, 2017).

Wearable technologies are the smart electronic devices those can be wore on body or implant into clothes. These have microcontroller and sensors to record activities through different software applications. Wearable technologies are the best example of the internet of things(Patel, Park, Bonato, Chan, & Rodgers, 2012). The use of these technologies will enable the user to store information and retrieve when it is needed. Wearable devices can have a positive effect on supply chain operations and logistics performance (Heuwinkel, Deiters, Konigsmann, & Loffeler, 2003; Wang, Lin, & Lin, 2007). Also, wearable technologies have played their productive role in crowd sourcing (Raymond & Shackelford, 2015).

3 Methodology

The methodology of this study is based on sampling, data collection, instrument, and measurement model.

3.1 Sampling and data collection

Expat students in Chinaare the population of this study. The sample has been collected through a simple random sampling method through we chat groups, and sampling size is 150 expat students; mainly focused on Dongbei University of Finance and Economics and the Dalian University of Technology. Data has been collected through an online survey method.

3.2 Instrument selection

In this study, all the instruments have been measured on a Likert scale which was adapted from previous studies. The instrument measuring UTAUT (PE, EE, SI, FC, BI, and AU) were adapted from previous literature (Venkatesh et al., 2003). Furthermore, the instrument for WT (Gao, Li, & Luo, 2015; Wixom & Todd, 2005), CI (Shin, Lee, Kim, & Rhim, 2015), and LP (Daugherty, Stank, & Ellinger, 1998) were adapted from previous literature.

3.3 Measurement model

The PLS–SEM method is based on two models: measurement model and structural model. The measurement model can measure through reliability and validity. Whilethe structural model can measure through path coefficients with their significant values.

Reliability

Reliability is the internal consistency of items. In this study, reliability of data has been measured through Cronbach Alpha and composite reliability. The minimum acceptable values for both Cronbach Alpha and composite reliability is 0.60(Hair, Ringle, & Sarstedt, 2011). Both Cronbach Alpha and composite reliabilities of each construct has been measured through PLS – SEM and interpreted in table 1. All values aregreater than the minimum acceptable values. So, data is reliable.

Validity

Validity has been measured through content validity, convergent validity and discriminant validity. Content validity showsthe logic of items, and convergent validity is the theoretical relationship among variables. Both content and convergent validity can be measured through factor loadings. The recommended factor loading value is 0.60 (Hair et al., 2011). The factor loadings of all items have mentioned in figure 1, which shows that items have content and convergent validity. Besides, discriminant validity is the opposite of convergent validity which shows how much constructs are different from each other. Discriminant validity can be measured in two ways. First, average variance extract (AVE); the recommended value is 0.50 (Fornell & Larcker, 1981). The square root of AVE has been mentioned in table 1. Second, factor loadings; recommended value 0.60 (Chin, Marcolin, & Newsted, 2003). The factor loading values have been mentioned in figure 1. All values showed that items have discriminant validity.

Table 1. *Correlational Matrix. Reliability and Validity.*

Const.	1	2	3	4	5	6	7	8	9
1. AU	**0.95**								
2. BI	0.78	**0.91**							
3. CI	0.26	0.3	**0.75**						
4. EE	0.23	0.33	0.37	**0.82**					
5. FC	-0.25	-0.24	-0.31	-0.73	**0.87**				
6. LP	0.57	0.57	0.47	0.65	-0.57	**0.7**			
7. PE	0.66	0.68	0.42	0.25	-0.21	0.61	**0.74**		
8. SI	0.77	0.69	0.24	0.16	-0.14	0.49	0.65	**0.86**	
9. WT	0.25	0.25	0.37	0.80	-0.71	0.62	0.29	0.21	**0.86**

Bold values in diagonal are the square root of AVE, Italic values in diagonal are Cronbach Alpha/ Composite Reliability. The factors loadings of each items has been calculated in Smart PLS and mentioned in the following table 2.

Table 2. *Factor Loadings of Each Items*

Item	Factor Loadings
AU1	0.952
AU2	0.95
BI1	0.885
BI2	0.943
BI3	0.892
CI1	0.78
CI2	0.858
CI3	0.592
EE1	0.788
EE2	0.853
EE3	0.801

FC1	0.819
FC2	0.899
FC3	0.898
LP1	0.735
LP2	0.752
LP3	0.65
LP4	0.655
PE1	0.683
PE2	0.655
PE3	0.851
SI1	0.795
SI2	0.922
SI3	0.902
WT1	0.824
WT2	0.878
WT3	0.861

4 Results

In the PLS-SEM method, results can be interpreted through the structural model. In this model, the variance of items R2 and their significant values havebeen calculated through path analysis. Each relationship has its path or regression values which are mentioned in the inner model of PLS-SEM path coefficient diagram in picture 1. In this study, all the paths have significant path coefficient R2 values only the paths FC to BI has non-significant path coefficient R2 value which showed expats have less FC to sharpen their BI towards crowd sourcing. All other direct paths are significant and in favour of the conceptual framework.

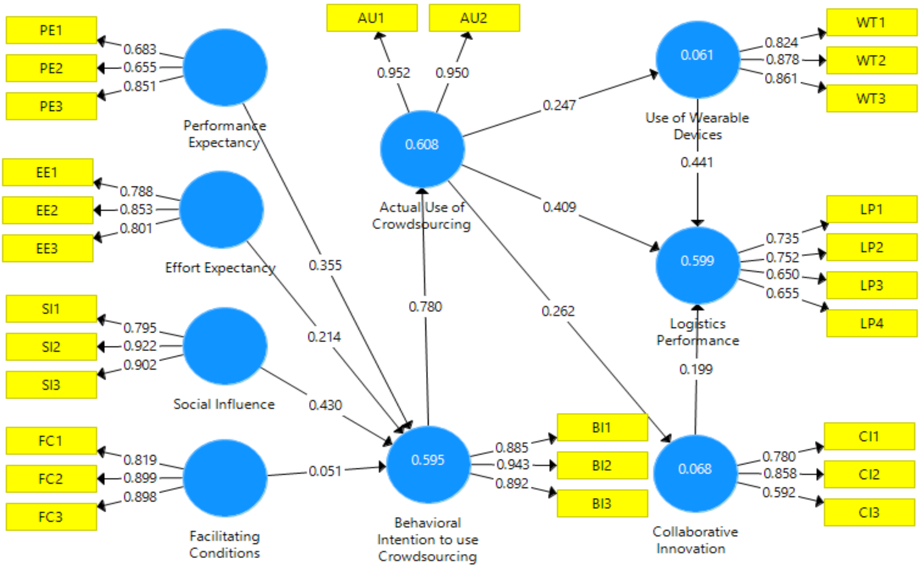

Fig. 1.Path Analysis of Crowd sourcing logistics

In Smart PLS the direct and indirect path coefficients has been calculated and mentioned in the table 3, with their t-statistics and their p values.

Table 3 *Direct and indirect Path Coefficients*

Paths	R^2	T Statistics	P Values
AU -> CI	0.273	2.797	0.005
AU -> LP	0.398	2.849	0.005
AU -> WT	0.244	2.661	0.008
BI -> AU	0.782	16.295	0
CI -> LP	0.199	2.855	0.004
EE -> BI	0.207	2.606	0.009
FC -> BI	0.043	0.601	0.548
PE -> BI	0.356	4.489	0
SI -> BI	0.433	4.999	0
WT -> LP	0.443	4.451	0
EE -> BI -> AU	0.162	2.619	0.009
FC -> BI -> AU	0.034	0.601	0.548
PE -> BI -> AU	0.277	4.924	0
SI -> BI -> AU	0.341	4.109	0
EE -> BI -> AU -> CI	0.044	1.88	0.061
FC -> BI -> AU -> CI	0.008	0.55	0.583
PE -> BI -> AU -> CI	0.075	2.426	0.016
BI -> AU -> CI	0.215	2.649	0.008

SI -> BI -> AU -> CI	0.095	1.988	0.047
EE -> BI -> AU -> LP	0.065	1.986	0.048
FC -> BI -> AU -> LP	0.014	0.573	0.567
PE -> BI -> AU -> LP	0.109	2.463	0.014
BI -> AU -> LP	0.313	2.751	0.006
SI -> BI -> AU -> LP	0.138	2.209	0.028
EE -> BI -> AU -> CI -> LP	0.009	1.482	0.139
FC -> BI -> AU -> CI -> LP	0.002	0.508	0.611
PE -> BI -> AU -> CI -> LP	0.015	1.645	0.101
AU -> CI -> LP	0.055	1.829	0.068
BI -> AU -> CI -> LP	0.043	1.823	0.069
SI -> BI -> AU -> CI -> LP	0.019	1.549	0.122
EE -> BI -> AU -> WT -> LP	0.018	1.694	0.091
FC -> BI -> AU -> WT -> LP	0.003	0.575	0.566
PE -> BI -> AU -> WT -> LP	0.029	2.318	0.021
AU -> WT -> LP	0.107	2.347	0.019
BI -> AU -> WT -> LP	0.085	2.246	0.025
SI -> BI -> AU -> WT -> LP	0.037	1.836	0.067
EE -> BI -> AU -> WT	0.04	1.776	0.076
FC -> BI -> AU -> WT	0.008	0.583	0.56
PE -> BI -> AU -> WT	0.066	2.659	0.008
BI -> AU -> WT	0.192	2.547	0.011
SI -> BI -> AU -> WT	0.085	1.995	0.047

5 Conclusion and Discussion

The use of information communication technologies has given a boost to the implementation of crowd sourcing in different fields. Some crowd sourcing logistics applications have been developed and facilitated the users to improve logistics through crowd sourcing. The crowd sourcing in logistics reduces delivery cost per kilometre and increase capacity utilization which will reduce traffic and protect the environment from pollution.

In this study, UTAUT has grounded to know the user intention and use of crowd sourcing logistics applications. The use of these applications can enhance the collaborative innovation and improve last mile delivery, supply chain activities and logistics performance (Mladenow et al., 2016). Wearable technologies also contribute to a very productive role in crowd sourcing (Heuwinkel et al., 2003; Raymond & Shackelford, 2015) and logistics performance (Heuwinkel et al., 2003). In this study, the empirical results have supported the conceptual framework. So, the use of crowd sourcing applications and wearable technologies will enhance collaborative innovation and logistics performance.

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