INVESTIGATING ICT DIFFUSION DYNAMICS AMONG SMEs THIRD-PARTY LOGISTICS PROVIDERS IN NIGERIA: AN EXPLORATORY MIXED-METHOD STUDY

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Introduction

Information and communication technology (ICT) has potential consequences for the management of supply chain and logistics operations, and the links between ICT and transformation of supply chain and logistics processes have become a subject of concern globally (Chen et al., 2007, Parasuraman and Grewal., 2000, Awoyemi and Mustakim, 2017). Hence the academic literature frequently reflects on the impact of ICT solutions on supply chain performance (Gunasekaran et al., 2015a, Prajogo and Olhager, 2012., Bharadwaj, 2000). Cheng-Min (2006) suggests that the use of ICT tools strengthens coordination of the flow of physical goods and services. Also, application of ICT solutions can reduce the role of distribution channels and intermediaries such as wholesalers (Martínez Sánchez and Pérez, 2005). However, there is little information regarding the mechanisms that influence ICT diffusion among 3PL SMEs (Gunasekaran and Ngai, 2003, Evangelista, 2011), especially in developing countries such as Nigeria (Tob-Ogu et al., 2017). This current study responds to this gap by examining how locally evolved conditions factor into ICT diffusion challenges among 3PL SMEs in Lagos State, Nigeria. Our goal is precisely to explore how contextual factors interact with the utilization of the available ICT tools among the 3PL SMEs in the study site, as such businesses are mainly responsible for logistics activities in the region (Tob-Ogu et al., 2017). We addressed the following research question to achieve the objective of the study: How do context-specific factors influence ICT diffusion among the logistics operators in Lagos State, Nigeria and what are the effects of the causal interrelationships among the affected factors?

The study was carried out in two phases. Phase one explored the problems through scoping field meetings with the relevant stakeholders, while Phase two centred around a questionnaire survey of the 3PL SMEs in the study site which we used to substantiate the findings from the phase one study. Here, 3PL refers to 'the activities carried out by logistics providers on behalf of the shippers, consisting of at least transportation and other activities such as warehousing, and inventory management activities' (Berglund et al., 1999, p.51). Lagos state was selected for the study based on its socio- economic importance in Nigeria and Sub-Saharan Africa. The rest of this paper article is structured as follows; brief literature review and theoretical framework; the research methodology and results; the discussion and finally the conclusion of the study.

Literature review and theoretical framework

Our knowledge of ICT adoption among the 3PL SMEs has benefited from a number of research papers in recent years, including evidence from Kilpala et al. (2005) that 3PL SMEs are reluctant to adopt relevant ICT tools in the Barents Region. Kwok and Haibo (2012) affirm that 3PL SMEs in China tend to utilize less expensive ICT at a tactical level, mainly to cut cost and reduce errors. Gunasekaran and Ngai (2003) suggest that 3PL SMEs in Hong Kong are flexible and innovative towards ICT adoption but constrained by financial and human resources. Similarly, Pokharel (2005) showed that 3PL SMEs in Singapore adopt primary ICT tools such as computers, internet connections and electronic data interchange (EDI), with large companies having more motivation to adopt ICT than their small logistics operator counterparts. Also, 3PL SMEs in Italy are mainly motivated to adopt relevant ICT tools due to service customization. Evangelista et al. (2013) found 3PL SMEs in Italy invest a relatively small proportion of their income on ICT tools. Evidence from Tob-Ogu et al. (2017) reveals that small and medium freight operators in Nigeria are more likely to adapt ICT tools other than those intended by the original equipment manufacturers (OEM) to overcome operational challenges. This review confirms the findings of previous studies are not always consistent and hence there is a need to examine the causal relationships among the relevant factors.

The theoretical framework underlying the work reported in this paper is based on the Hart et al. (2015) assertion that an integration of the Technology Acceptance Model (TAM) (Davis, 1993), the Technology-Environment-Organization (T-O-E) model (Tornatzky and Fleischer, 1990) and the Theory of Planned Behaviour (TPB) (Fishbein and Ajzen, 1975) would enhance our ability to predict of e-commerce adoption among SMEs. This is partly because it is argued that SMEs can exhibit the characteristics of both individuals and firms, due to the possible overbearing influence of their owner- managers on overall operations. Specifically, TAM depicts ICT adoption at an individual level, predicated on the perceived usefulness and ease of use of systems. TPB reflects the influence of the external variables on adoption behaviours, while T-O-E connotes ICT adoption at the firm level. Correspondingly, we envisage that examining the interrelationship of TAM, TOE, and TPB may well offer improved insight into the influences of the locally evolved issues on ICT acquisition and decision quality of firms of 3PL SME firms in Nigeria.

Methodology

Data collection: we conducted the data collection in two stages as follows. In Phase one, around 120 participants were involved in a scoping field study. Public administrators constituted about half of the attendees (52.5%), followed by logistics operators and researchers each constituting a quarter of the attendance (25.5%, 25.0%). Once the research objectives and themes had been explained, participants were grouped into fifteen mini groups, each comprising about eight persons. Participants were encouraged to talk openly about issues affecting ICT diffusion among 3PL SMEs in Nigeria, and their coping strategies. The participants reached a consensus statement at the second gathering which reflected the various dimensions in which locally-evolved conditions influence ICT diffusion among the 3PL SMEs. This consensus then formed the basis for creation of a questionnaire survey to gather information from operators. Phase two started with the research supervisors, collaborators, and other stakeholders amending the wordings of the questionnaire phrasing to ensure ease of understanding which would assist in survey response. We then piloted the survey instrument with the sample of fifty 3PL SMEs. The survey was then administered to a sample of Nigerian 3PL SMEs. After data screening, this process realized 295 usable survey responses. The respondents include the owner-managers (5.4%), Assistant General Managers (10.8%), Operation Managers (10.8%), other management staff (68.5%), and other undisclosed staff (2.4%).

Methods of data analyses: We used the interpretive method of qualitative analysis for the phase one study while covariant-based Structural Equation Modelling (SEM) with AMOS graphics software was used in the phase two study for the analysis of the questionnaire data. Precisely, the SEM analysis involves the following: (i) interaction effects with 'stat tool package.Xls.' (ii) Mediation effects using the Baron and Kenny (1986) approach/ bootstrapping and (iii) moderation effects using the invariant tests procedure for the designated variables. Accordingly, the interaction analysis was determined by strengthening (+) or dampening (-) effects of the respective interacting variables. Also, partial mediation occurred if the regression weights (β) reduce after the introduction of the mediator variables. Full mediation occurred when the significant causal relationships between the proposed variables turned insignificant after the introduction of mediator variables. On the other hand, there were no mediation effects if the concerned variables to be mediated were not significantly causally related. Further, the moderation analysis was interpreted according to the high or low effects of the moderator variables (regression weight scores) on the proposed causal relationships. Z score was used to denote if there were significant differences among the sampled respondents.

Causal model and hypotheses development: The research variables include the predictor variables; consumer readiness (CR), the scope of business operations (SBO) and facilitating conditions (FC). The mediator variables entailed perceived usefulness (PU) and perceived ease of use (PEOU) of ICT, while the moderator variables relate to ICT experience and education status respectively. Additionally, the controlled variables were gender, age, and frequency of ICT use (see Figure 1). Consequently, twenty hypotheses were developed for the study, thus:

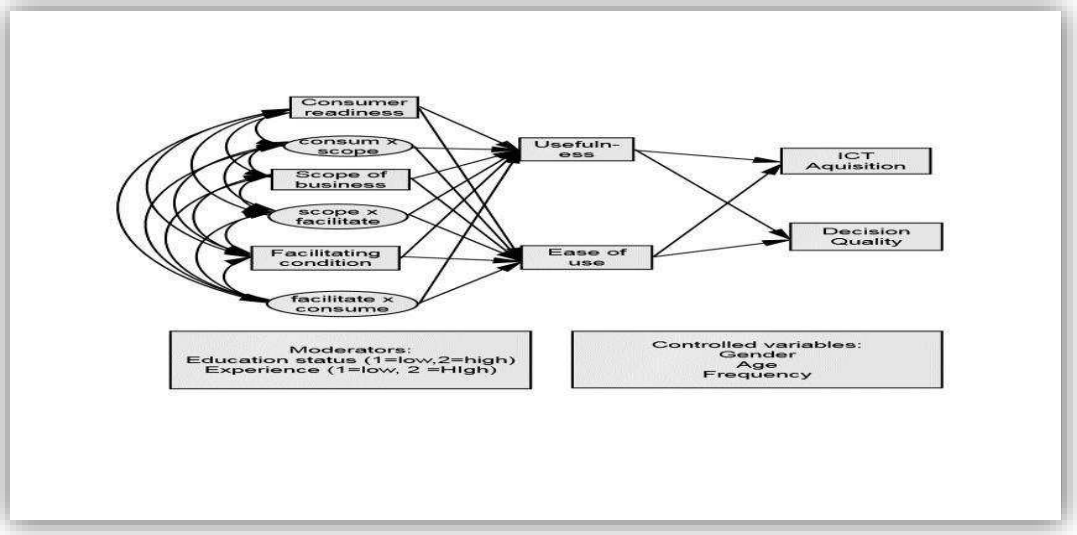

Figure 1: The causal model (Adapted, Lowry & Gaskin, 2014)

Predictor variables: According to Zhu et al. (2002), there is a causal relationship between CR and internet penetration. Ayo (2008) links limited CR to adopt ICT in Nigeria to reduced online businesses, rigours of the system, and lack of security of online transactions in the area. Sawhney and Prandelli (2000) suggest that consumer CR can attain improvement through the development of a common language or technological network which can enhance learning capability, trust, and motivation. Hitt (1999) argues that SBO is causally related to ICT acquisition and decision quality especially concerning the diversification of services. (EC). Zhu et al. (2002) suggest that ICT adoption is causally influenced by the SBOs on three grounds: (i) Computerization of business activities lessens internal coordination expenditure, harmonizes administrative complexities, and enhances information processing. (ii) Business establishments with substantial SBO are attracted to e-commerce (EC) as it reduces searching costs for buyers and raw material sellers (Bakos, 1991) and also improves inventory control (Chopra and Meindl, 2001). (iii) Large firms tend to gain more from the alliance of the EC and regular business activities as the combination of the two enables firms to compete favourably. The next predictor variable, FC includes those external factors that must be met to avert firms from facing extinction as highly functional establishments display enterprising creativity, novelty, and collaborations which allow them to remain competitive (Triandis, 1980, Thompson et al., 1994). Mische (2001) and Piater (1984) propose that FC include government regulations, antitrust measures, and policy actions. In the light of these, we developed the following six hypotheses to test the interactive effects of the predictor variables on the mediator variables as follows: H1/ H2: FC strengthens the causal relationships between CR and PU/PEOU of IC. H3/ H4: SBO strengthens the causal relationships between CR and PU/PEOU of ICT. H5/ H6: FC strengthens the causal relationships between the SBO and PU/PEOU of ICT respectively.

Mediator variables: According to TAM, PU and PEOU mediate the impact of system design features on usage (Davis, 1993). It suggests that system characteristics influence adoption behaviour via motivational variables such as PU and PEOU. According to Lu et al. (2003), PU explains potential users' intuitive expectations that utilizing a particular ICT tool enhances performance. ICT tools with less mental effort attract more users than otherwise (Opia, 2008). Further, Clarke (2000) through a survey of 800 professionals, identified ease of use among five other factors as a major influencing factor for the use of wireless handheld devices. Accordingly, we proposed the following twelve hypotheses to test the mediating effects of the PU and PEOU on the relationship between the predictor variables and response variables as follows: H7/ H8: PU/PEOU of ICT mediate the causal relationships between CR and ICT acquisition. H9/ H10: PU/PEOU ICT mediate the causal relationships between the SBO and ICT acquisition. H11/ H12: PU/PEOU of ICT mediate the causal relationships between the FC and ICT acquisition. H13/ H14: PU and PEOU of ICT mediate the causal relationships between CR and decision quality. H15/ H6:

PU/PEOU of ICT mediate the causal relationship between SBO and decision quality. H17/18: PU/PEOU of ICT mediate the causal relationship between the FC and decision quality respectively.

Moderator variables: Hambrick and Mason (1984) propose that the peculiarity of every organization reflects the characteristics of their decision makers. Hence e-commerce adoption among the SMEs depends on the individual difference factors (IDF) of the owner-managers which comprise education, age, gender, and experience (Hart et al., 2015). According to Zmud (1979), experience ranks top among other IDF in technology adoption research and more precisely, internet users' experiences influence the actual use of a specific system (Agarwal and Prasad, 1999, Chau, 1996). Similarly, education status affects individuals' abilities to innovate, comprehend, and accept change (Hambrick and Mason, 1984). Therefore, we hypothesized that ICT experience and education status significantly moderate the causal relationships among the proposed causal relationships, thus: H19: ICT experience moderates the causal relationship between the SBO and PU of ICT. H20: Education status moderates the causal between CR and ICT adoption.

Construct validity: The construct validity for the Structural Equation Modelling (SEM) was confirmed via exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) as follows: EFA was performed to extract the appropriate items for the SEM analysis. The result of the EFA analysis reveals that the pattern matrix loading was adequate. The factor correlation matrix was also suitable as there was no significant correlation between the observed variables. The rotation method was Promax with Kaiser Normalization, and the iteration converged in 7 iterations. The KMO (0.94) and Bartley (7092.45) tests were significant respectively. The cumulative variant test was also significant (0.65) as was the non-redundant residual test (0. 20). Further, the goodness of fit ($\rho<0.001$) and adequacy of the EFA analysis was confirmed adequate as the Cronbach Alpha values were above 0.80 for all the variables.

The result of the CFA shows that the model was fit for the Structural Equation Modelling - the RMSAE and PCLOSE scores were 0.037 and 1.00; CFI and CMNIDF were also within limits (0.97, 1.41.2); the observed variables were not significantly different between groups. Hence we did not further refine the model. Also, the average variance extracted (AVE), composite reliability (CR) of the observed variables, and the curve estimation tests are significantly linear ($\rho<0.001$). The F-values were within proper limits, and there were no multi-collinearity issues among the variables as the VIF values are within usable ranges (<3.00). However, the common bias test revealed that one of the items in the decision quality variable was abnormal and this was resolved by placing a constraint on it. Finally, we confirmed the SEM, as the CMIN/DF (1.196), CF (0.978), PCLOSE (0.298), and RMSEA (0.057) were within reasonable limits respectively.

Results

Hypotheses	Results	Remarks
FC strengthens the relationship between CR and PU/PEOU	- /-	H1/ H2, not supported
SBO strengthens the significant relationship between CR and PU/PEOU	-/-	H3/ H4, not supported
FC strengthens the relationship between SBO and PU/PEOU	-/+	H5/ H6, not supported an supported

*- / + signs denotes dampening and strengthening effects of the predictor variables

Table 1: Two-way interaction effects of the predictor variables

Hypotheses	Direct without mediation	Direct With mediation	ndirect effects	Results	Remarks
PU and PEOU mediate the relationship between CR and ICT acquisition	β=0.357; 0.350,	β=0.128; 0.148,	ρ<0.05	Partial mediation	H7/ H8, partially supported
PU and PEOU mediate the relationship between SBO and ICT acquisition	ρ<0.05	P = 0.158; 0.157	ρ<0.05	Full mediation	H7/ H8, fully supported
PU and PEOU mediate the relationship between FC and ICT acquisition	ρ = 0.063; 0.067	ρ =0.358; 0.356	=0.110; 0.140	No mediation	H9/ H10, not supported
PU and PEOU mediated the cl relationship between CR and decision quality	ρ<0.01	=0.745; 0.764	ρ<0.05	Full mediation	H11/ H12, fully supported
PU and PEOU mediated the relationship between SBO and decision quality	ρ =0.439; 0.410	ρ =0.116; 0.115	=0.160; 0.212	No mediation	H13/H14, not supported
PU and PEOU mediated the relationship between FC and decision quality	ρ =0.063; 0.164	ρ =0.059; 0.254	=0.130; 0.321	No mediation	H15/ H16, not supported

* R2 = (CR = 0.57; SB0 =41; FC = 51)

Table 2: Mediation effects of the PU and PEOU of ICT

Hypotheses	Effects: low; high (β)	z-score	p. value	Remarks
ICT experience moderates the relationship between SBO and PU of ICT	0.178; 0.387	1.706	<0.05	(H19= supported)
Education status moderates the relationship between CR and ICT acquisition	0.012; 0.143	2.383	<0.050	(H20=supported)

Table 3: Multi-group moderation effects of the ICT experience and education status

Study one: We found in the phase one study that the ICT use by 3PL SMEs in Lagos State, Nigeria is largely limited to the use of primary ICT tools such as mobile phones and emails for their operations, due to lack of enabling environment in the region. The lack of enabling environment related to inadequate road networks, lack of steady electricity, and technological platforms. Besides, the informants linked the situation to political corruption which they said has persisted over many years.

Study two: The results of the stage two study are represented in the Tables 1, 2, and 3 as follows: (i) Two-way interaction results indicated that FC and SBO dampened the causal relationships between CR and PU/PEOU of ICT. FC also dampened the causal relationship between SBO and PU of ICT.

Alternatively, FC strengthened the significant causal between SBO and PEOU of ICT. (ii) Mediation analysis revealed that PU and PEOU of ICT mediated the causal relationship between CR and ICT acquisition. On the other hand, there were no significant causal relationships between FC and ICT acquisition and decision quality. Likewise, there was no significant causal relationship between SBO and decision quality. Hence, there were no significant mediation effects of PU and PEOU of ICT among those relationships. (iii) Multi-group moderation analysis showed that ICT experience and education status significantly moderated the causal relationship between SBO and PU of ICT, and CR and ICT acquisition. Additionally, there were significant differences in ICT experience and education status among the owner-mangers of the firms as revealed by the Z scores.

Discussion and conclusion

Drawing evidence from our findings in the stage two study, we have demonstrated that inability of the firms to acquire relevant advanced ICT tools does not lie only with the non-significant causal relationships between FC/SBO and ICT acquisition/decision quality but also with their dampening effects on the causal relationships between CR and PU/PEOU. These revelations may help to address the conflicting reports concerning ICT diffusion challenges among 3PL SMEs and also validates the phase one study. For example, the dampening effects of the FC and SBO may relate to the impact of the lack of enabling environment in the study region. Notwithstanding, the results indicated that CR was not significantly affected by the unfavourable business environment which demonstrates the resilience of the operators. This is in line with the previous studies that 3PL SMEs are innovative and flexible (Gunasekaran and Ngai, 2003, Tob-Ogu et al., 2017). Alternatively, the dampening effects of the FC on the causal relationship between SBO and PU of ICT may account for the reluctance of 3PL SMEs to adopt advanced ICT (Kilpala et al., 2005, Pokharel, 2005, Cephus, 2016). It could also be likened to the inability of the firms to maximize the potential causal relationship between SBO and e-commerce such as diversification of services (Hitt, 1999). Again, the result confirms the vulnerability of the 3PL SMEs in Nigeria regarding ICT adoption as the majority of them have resorted to the inappropriate adaptation of ICT primary ICT tools to remain competitive (Tob-Ogu et al., 2017). The findings align with Fishbein and Ajzen (1975) proposition that external variables influence adoption behaviours according to the prevailing circumstances. Additionally, the significant moderating effects of ICT experience and education status on the causal relationships between the SBO and PU of ICT, and CR and ICT acquisition confirmed the resilience of logistics operators which may be connected to their ICT adaptation capabilities (Tob-Ogu et al., 2017). Overall, lack of adequate FC was the primary inhibitor, followed by the limited SBO. Alternatively, CR was the enabling factor.

The implications of the study suggest that engaging with context-specific issues can help unpack the problems affecting ICT diffusion among 3PL SMEs. Around these findings, we discovered why the 3PL SMEs in the study site are not willing to acquire relevant advanced ICT to enhance their operations. Hence the study may represent a useful point of entry by relevant stakeholders to assess the circumstances surrounding ICT diffusion challenges among the 3PL SMEs in the study site and similar environments. More precisely, the information from the study may be useful for developing intervention schemes and sustainable long-term strategies to mitigate the problems. Also, ICT vendors and OEM may tap information from the study to assess innovative ways to cover the digital gap. Besides, relevant entrepreneurs may also find the information from the research useful for their investment decisions.

In conclusion, our findings suggest that it is misguided to focus on individual factors to address ICT diffusion challenges among the 3PL SMEs, especially in the developing logistics environments where effects of the locally evolved conditions are complex and conflicting. Therefore, it is critical to focus on all relevant factors such as environmental, organizational and technological factors. The limitations of the study include the limited sample size and population in the phase two study. We recommend that further studies should focus on assessing the customers' perspective of the ICT diffusion challenges in the study site to create a potential avenue to address the problems holistically.

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