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**Article**

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# Using T-O-E theoretical framework to study the adoption of ERP solution

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**Abstract:** This paper provides further insight into IS adoption by investigating how 12 factors within the technology-organization-environment (T-O-E) framework explain SMEs' adoption of enterprise resource planning (ERP) software. Survey data were collected from executives of SMEs drawn from six fast service enterprises with strong operations in Port Harcourt, Nigeria. Purposive and snow ball sampling was adopted and the proposed framework was tested using the logistic regression; specifically, the likelihood ratios, Hosmer and Lemeshow's goodness of fit, and Nagelkerke $R^2$ were used. The hypothesized relationships were supported at either $p < 0.01$ or 0.05 with each factor differing in its statistical coefficient and some bearing negative values; suggesting that some factors do not pose much threat to adopters but to non-adopters. Thus, adoption of ERP by SMEs is well-explained by T-O-E framework though it is more driven by technological factors than by organizational and environmental factors. Implicit is that the proposed model will be useful to IS vendors in making investment decisions and crafting marketing programs that appeal to non-adopters since they have more adoption challenges than adopters and to cause adopters to progress in the loyalty ladder.

**Subjects: Science; Social Sciences; Technology**

**Keywords: ERP; T-O-E; SMEs; adoption determinants**

Hart O. Awa

## ABOUT THE AUTHORS

Hart O. Awa, a senior lecturer in Marketing, University of Port Harcourt, Nigeria, is well published and has presented leading papers in conferences in Nigeria, UK, US, Canada, Australia, Ireland, and Eastern Europe. His paper won the 2015 best paper award at the Imperial College conference organized by WBI, Australia and LARAP, UK. Hart is a member of the Emerald Literati network in recognition of his scholarly role in the Emerald family. Among others, Hart's interest spans co-creation, consumer psychology, and innovation adoption.

Ojiabo Ukoha is a professor in Mathematics and Computer Science, University of Maryland, USA. His interests include the infusion of technology into mathematics instruction, factor analysis in applied research, and recruiting and retaining low-income students in computer science and other STEM disciplines.

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## PUBLIC INTEREST STATEMENT

This paper provides further insight into IS domain by investigating how 12 factors within the technology-organization-environment (T-O-E) framework explain SMEs' adoption of ERP software. Survey data were collected from executives of SMEs drawn from six fast service enterprises in Port Harcourt, Nigeria. The sampling procedures were purposive and snow ball, and the proposed framework was tested using the logistic regression. Although the hypothesized relationships were supported, some factors do not pose much threat to adopters but to non-adopters. Therefore, adoption of ERP by SMEs is well-explained by T-O-E framework and more driven by technological factors than by organizational and environmental factors. IS vendors were advised to make strategic decisions and to craft marketing programs that appeal to non-adopters since they have more adoption challenges than adopters and to cause adopters to progress in the loyalty ladder.

## 1. Introduction

Enterprise resource planning (ERP) software represents one of the state-of-the-art technology innovations that manages connections and integrates business and management processes within and across the organization's basic internal systems, sub-systems, and/or processes (Hitt, Wu, & Zhou, 2002; Shiau, Hsu, & Wang, 2009). The contemporary global economy emphasizes proficient use of human intellectual capital and technology to integrate processes, support enterprise strategies, optimize resources and ultimately to build competitive advantage (Metaxiotis, 2009; Pang & Jang, 2008; Yen & Sheu, 2004). Awa, Baridam and Nwibere (2015) observe that ERP seeks strategic integration of functions and stakeholders into a customized system to streamline operations and build superior service value. Scholars (Federici, 2009; Maguire, Koh, & Magrys, 2007; Shiau et al., 2009) posit that such integration and support provide enterprises with opportunities to reduce costs and improve operational efficiencies and customer service through circle time and lead-time compression, data integration, fewer personnel, network externalities, optimal inventory holding, and search activities.

However, irrespective of the operational efficacies of ERP software to enterprises of any sizes and locations, significant number of vendors principally targets large enterprises (Kumar & van Hillegersberg, 2000; Waarts, van Everdingen, & van Hillegersberg, 2002). The operational agility of small and medium enterprises as well as their aggressive quest for globalization suggests that they are supposedly prone to offer more investment opportunities than large enterprises (Maguire et al., 2007; van Everdingen, van Hillegersberg, & Waarts, 2000). Though SMEs rarely have the cognate experience and resources to effectively implement ERP solutions (Chuang, Nakatani, & Zhou, 2009; Shiau et al., 2009), empirical evidence confirms that their dream to improve market positioning and to take advantage of governments' support programs have lately precipitated SMEs to adopt ERP in some economies (Hitt et al., 2002; Lall & Teyarachakul, 2006; Ramdani, Kawalek, & Lorenzo, 2009). The pace of diffusion of any innovation has been tracked down by the proposed adoption models. Among such models are:

- technology acceptance model (TAM; Davis, 1989);
- theory of reasoned action (TRA; Ajzen & Fishbein, 1980);
- theory of planned behavior (TPB; Ajzen, 1991);
- innovation diffusion theory (IDT; Rogers, 2003);
- stage model (SM; Poon & Swatman, 1999);
- technology-environment-organization (T-O-E; Tornatzky & Fleischer, 1990); and
- resource-based view (Caldeira & Ward, 2003).

Eze, Awa, Okoye, Emecheta, and Anazodo (2013) opine that some of these models/theories evolve from the theory of reasoned action and have their principal constructs cross-cutting though each contributes to the underpinning adoption theory. On assumption that their propositions are well known, this paper proposes 12 constructs from the T-O-E framework and uses that to explain the adoption of ERP solutions by service-oriented SMEs. ERP studies investigate different aspects of adoption ranging from implementation (Alsène, 2007; Okrent & Vokurka, 2004), financial and economic benefits (Matolcsy, Booth, & Weider, 2005; Nicolaou, Stratopoulos, & Dehning, 2003), success measurement (Wu & Wang, 2006), critical success factors (Maguire et al., 2007; Motwani & Subramanian, 2005), to extended ERP modules (Metaxiotis, Psarras, & Ergazakis, 2003). Notwithstanding these scholarly strides reported, there still exists a dearth of inquiries that sought to borrow the framework of T-O-E to study SMEs' adoption of ERP. Often rational choice models (e.g. TAM, TRA, and TPB) are accused of illusion of accumulated tradition, attitudinal, utilitarianism (Al-Natour & Benbasat, 2009; Benbasat & Barki, 2007; Eze et al., 2013), technological determinism, and techno-centric predictions (Vankatesh, Davis, & Morris, 2007); hence, technology, rather than individuals, determines adoption (Awa, Ojiabo, & Emecheta, 2015).

The theories of TAM and T-O-E specifically target technology acceptance and most popularly underpin many IS studies that explain end-user adoption at organizational level. However, the extensive focus of TAM on technology to the neglect of social and psychological parameters (Agarwal & Prasad, 1998; Venkatesh & Bala, 2008) limits its explanatory and predictive utilities, and therefore demands its integration with other frameworks (Awa, Baridam et al., 2015; Shiau et al., 2009). Rogers (2003) IDT and Ajzen's (1991) TPB sought to make-up for the neglects of TAM, but their frameworks are yet to underpin as much studies in the contemporary IS domain as T-O-E framework. IDT framework uses the constructs within organization and technology contexts to explain adoption whereas T-O-E stepped further to integrate the constructs of environment (Gangwar, Date, & Raoot, 2014). T-O-E framework is more holistic and size and industry friendly (Wen & Chen, 2010), has robust empirical support in IS field more than other adoption frameworks (e.g. TAM, IDT, TRA, SM, and TPB) (Henriksen, 2006; Hong, Thong, & Tam, 2006; Kuan & Chau, 2001; Yoon & George, 2013; Zheng, Yen, & Tarn, 2011; Zhu, Kraemer, & Xu, 2003) and meets the contemporary scholarly demand (Barrett, Grant, & Wailes, 2006; Jacobsson & Linderoth, 2010; Venkatesh & Bala, 2008) for more social interactive systems that address the ordeals of deterministic system.

Many grounded adoption theories (e.g. TRA, IDT, and TPB) find practical utility in many disciplines, but they do not specifically target ICT acceptance as much as TAM and T-O-E frameworks (Moore & Benbasat, 1991). TAM is valid, robust, and most dominant and specific in studying organizational-level adoption (Gangwar et al., 2014) because its proposed generic factors provide more meaningful lenses into studying users' opinions about specific systems, user adoption processes, and implementation; the foreseeing challenges; the technology's impact on value chain and post-adoption diffusion; and the development of organizational capabilities using the technology (Al-Natour & Benbasat, 2009; Salwani, Marthandan, Norzaidi, & Chong, 2009; Wang, Wang, & Yang, 2010). This paper contributes on the sector-specific characteristics since there is a dearth of studies that use the T-O-E framework to study SMEs' adoption of ERP; and to complement knowledge of other inquiries (e.g. Eze et al., 2013; Pang & Jang, 2008) that reported industry-specific factors that determine the adoption of ERP within the framework of T-O-E.

## 2. SMEs and adoption of ERP solution

The adoption of ERP or any other technologies defines individual and/or organization levels voluntary decision to first accept and/or use (Khasawneh, 2008; Musawa & Wahab, 2012). Most new ICT technologies turn the world flat, remove the competitive disadvantages and geographic isolation of small enterprises (Wymer & Regan, 2005), and offer the adopting enterprises the opportunity to build competitive advantages across the globe. Supposedly, SMEs are comparatively better positioned than large firms in terms of their operating agility to exploit the avowed potentials of new technologies. The government and its agencies in many economies have regularly launched programs to support the informal sector because of the mantra of small is beautiful. Previous literature (Federici, 2009; Metaxiotis, 2009; Ongori, 2009; Ramdani et al., 2009; Scupola, 2009) confirm that SMEs are the potent drivers of the informal sector as well as important sources of flexibility, local capital formation, innovations, improved living standards, and employment creation. SMEs provide approximately 80% of economic growth (Jutla, Bodorik, & Dhaliwal, 2002), 1/3 of GDP and 70% employment in Australia (Scupola, 2009), and account for between 96 and 99% of enterprises in North America, Europe, and most OECD countries (Ramdani et al., 2009; Scupola, 2009; Shiau et al., 2009).

The definition of SMEs varies across nations; most of its denominators are employment figures and sometimes sales volume and fixed assets. In many European nations, SMEs employ less 500 persons (OECD, 2000); in South Africa and Australia between 100 and 200 persons (Scupola, 2009); in Denmark 250 employees (OECD, 2002); and in Egypt based on workforce, fixed assets, and annual turnover (Rizk, 2004). Scholars (Ahituv, Neumann, & Zviran, 2002; Fisher, Fisher, Kiang, & Chi, 2004; Lall & Teyarachakul, 2006; Yusuf, Gunasekaran, & Abthorpe, 2004) propose that the need to build competitive advantage amidst changing environment calls for shopping of novel information technologies that integrate individual functional systems and support corporate strategies. SMEs are encouraged to adopt ERP on accounts that Yen and Sheu (2004) posit that it is about the most

strategic and most valuable tool used to develop and improve competitiveness. ERP defines IT-based innovation that integrates and supports functions, operations, and/or processes (e.g. supply chain, budgeting, accounting, marketing, inventory, production, and human resource) as well as the processes of outside stakeholders and streamlines them into one complete system. The process involves inter-and intra-functional alignments of operations as well as real-time sharing of information within a community; thus, information and information-based processing modules of a unit can be accessed within and across boundaries of an enterprise for building competitive advantage (Metaxiotis, Zafeiropoulos, & Askounis, 2005; Scupola, 2009).

Pang and Jang (2008, p. 100) insist that "ERP projects facilitate automation of many, if not all, basic processes in order to integrate information across an enterprise and to eliminate complex, expensive interfaces amongst computer systems." Thus, the cornerstone of ERP software is that people, processes, and the new technology should be aligned to ensure information sharing as well as business flexibility and efficiency (Davenport, 1998). The motivations to invest in the state-of-art technologies are broadly based on what Son and Benbasat (2007) refer to as "efficiency" and "legitimacy;" the efficiency motivation derived from cost, economic man, pleasure seeking, and rational choice theories; and the legitimacy motivation aligns with institutional and socio-economic theories. Scholars (Esteves, 2009; Zhang, Lee, Huang, Zhang, & Huang, 2005) collapsed the efficiency and legitimacy syndromes when they propose that successful implementation of ERP systems improves product quality, operational efficiency and consistency, customer service and customer friendliness, and ultimately market competitiveness through transparency, value-added information, and new levels of innovation from network externality and knowledge sharing. However, the demand for huge capital outlay and the associated high risk make ERP software almost a candidate for large organizations even though strategic-minded small firms still buy into its potential promises.

Scholars proposed that ERP software levels the playing field; it offers SMEs a considerable opportunity to compete more effectively with their rivals, including large ones (Gengatharen & Standing, 2005; Levy, Powell, & Worrall, 2005). SMEs are more adaptable and responsive to changes than large firms and often benefit from the speed and operational agility offered by the electronic environment (Metaxiotis, 2009; Stockdale & Standing, 2004). For these, ERP's developers and vendors had since 2004 began working hard to encourage SMEs to upgrade their legacy systems and to reposition their operations more competitively. Ahituv et al. (2002) and Huang, Hung, Chen, and Ku (2004) assert that many SMEs find it difficult to take full potential benefits of ERP solution because its implementation is technically complex and demands huge investment in internal resources. Often small size explains the inability to commit resources, to assign ERP tools to something different from short-run operating issues, and to understand ERP's benefits (Martin & Matlay, 2001; Metaxiotis, 2009). Study (Metaxiotis, 2009) shows that only about 15% of small businesses and 30% of medium-size businesses employ IT experts and/or own IT department.

Pang and Jang (2008) and Motwani, Mirchandani, Madan, and Gunasekaran (2002) conclude that a cautious, evolutionary, and bureaucratic process supported by careful change management, network relationships, and cultural readiness facilitate successful adoption of ERP. Other organizational conditions that influence ERP adoption include organizational resistance to change (Child, 1974), adoption without organizational readiness and proper change management (Motwani et al., 2002), poor implementation process (Umble, Haft, & Umble, 2003), and ineffective ERP systems (Lall & Teyarachakul, 2006). Nevertheless, Maguire et al. (2007) confirm the growing use of ERP by SMEs to gain competitive advantage.

## 3. The T-O-E framework

Tornatzky and Fleischer's (1990) T-O-E is a classic framework that proposes a generic set of factors that explain and predict the likelihood of innovation/technology adoption. The framework proposes three bits of enterprise contexts that influence the adoption and/or implementation of innovations. The contexts are technology development (Kauffman & Walden, 2001); organizational conditions, business and organizational reconfiguration (Chatterjee, Grewal, & Sambamurthy, 2002); and

industry environment (Kowath & Choon, 2001). Scholars (Al-Qirim, 2006; Awa, Ojiabo et al., 2015; Jeyaraj, Rottman, & Lacity, 2006; Sabherwal, Jeyaraj, & Chowa, 2006; Tornatzky & Fleischer, 1990; Zhu et al., 2003) opine that technology describes adoption in terms of the pool of technologies internal and external to the firm as well as their perceived usefulness, technical and organizational compatibility, complexity and learning curve, pilot test/experimentation, and visibility/imagination. The scholars explain that organization captures descriptive measures such as firm's business scope, top management support, organizational culture, complexity of managerial structure measured by centralization, formalization, and vertical differentiation, the quality of human capital, and size and size-related issues such as internal slack resources and specialization.

Environmental context relates to the operational facilitators and inhibitors; significant among them are competitive pressure, trading partners' readiness, sociocultural issues, government encouragement, and technology support infrastructures such as access to quality ICT consultants. The major issue with T-O-E framework is that some of the constructs in the adoption predictors are assumed to apply more to large organizations, where clients are sure of continuity and less complaints, than to SMEs (Awa, Eze, Urieto, & Inyang, 2011). However, the postulate of T-O-E is similar to Actor Network Theory (ANT) since it emphasizes dynamic capabilities and mutual interplay of technical and social systems. Scholarly works that explain and predict SMEs' high involvement decisions within the framework of T-O-E seems though scanty but demand conscious search effort and using the Bass model to reduce different kinds of risk (Awa, Baridam et al., 2015). Most traditional adoption theories (e.g. TAM, TRA, and TPB) imply that technology, rather than individuals, determines organization's structure and behavior (Benbasat & Barki, 2007; Vankatesh et al., 2007). Apart from Thong (1999) advancing T-O-E framework further to have the construct of decision-maker (D) and D-T-O-E adoption framework, T-O-E is about the only IS framework that emphasizes more on social and behavioral constructivism while recognizing the inter-play of technology development and organization's conditions shaped by environmental issues (Hossain & Quaddus, 2011; Ramdani et al., 2009).

The framework brings both human and non-human actors into the network; a strength that handles the illusion of accumulated traditions and techno-centric predictions of most other frameworks (e.g. TAM, TRA, UTAUT, and TPB). Recognizing that strategies are shaped by the idiosyncrasies of the decision-maker, analysts believe that ICT adoption factors encompass owner's enthusiasm and growth ambition (Fillis, Johansson, & Wagner, 2003), top management support and managerial productivity (Grandon & Pearson, 2004), managers' belief differences (Riemenschneider & McKinney, 2002), and CEO's knowledge and characteristics (Shiau et al., 2009; Thong, 1999). T-O-E framework earns substantial theoretical and empirical supports (see Eze et al., 2013; Henriksen, 2006; Hong et al., 2006; Kuan & Chau, 2001; Yoon & George, 2013; Zheng et al., 2011; Zhu & Kraemer, 2005; Zhu et al., 2003) as well as validated inventory of psychometric measurements; and hence, it is more widely used in IS domain at the organizational level than alternative models (Gangwar et al., 2014; Hong et al., 2006; Hossain & Quaddus, 2011). Scholars (King & He, 2006; Oliveira & Martins, 2011) proposed individual, group/team, and organizational levels of adoption, and posit that TRA, TPB, and UTAUT predominantly predict individual adoption while TAM and TOE frameworks study technology adoption at organizational level. TAM neglects social and psychological factors; and Rogers (2003) IDT and Ajzen's (1991) TPB incorporated such parameters though they, respectively, neglected the environmental and technological contexts.

T-O-E framework emerges as a widespread theoretical perspective specific to IS domain; therefore, its variables have been severally tested on the adoption of several other technologies–EDI, KM, e-business, RFID, e-commerce, enterprise systems, and e-procurement (Kuan & Chau, 2001; Wang et al., 2010; Zhu, Kraemer, Xu, & Dedrick, 2004). Although not specific for technology adoption, the IDT's constructs are synonymous with those of T-O-E's technology and organization (Oliveira & Martins, 2011) and thus, by integrating the constructs of environment, T-O-E framework provides a more superior theoretical analysis than IDT in studying technology adoption, use, and value creation (Gangwar et al., 2014; Hossain & Quaddus, 2011; Oliveira & Martins, 2011). Unlike most other frameworks, scholars (Salwani et al., 2009; Wang et al., 2010; Wen & Chen, 2010) opine that T-O-E provides

a more holistic insight (without minding size and industry constraints) into adoption challenges and adoption factors, value-chain activities, adoption processes and implementation, post-adoption, and development of capabilities using the technology. Therefore, by integrating environment with technology aspect of TAM and the social and psychological attributes of IDT and TPB, we believe that T-O-E would provide a theoretically meaningful adoption insight beyond the attitudinal lenses provided by TAM, TRA, and TPB frameworks.

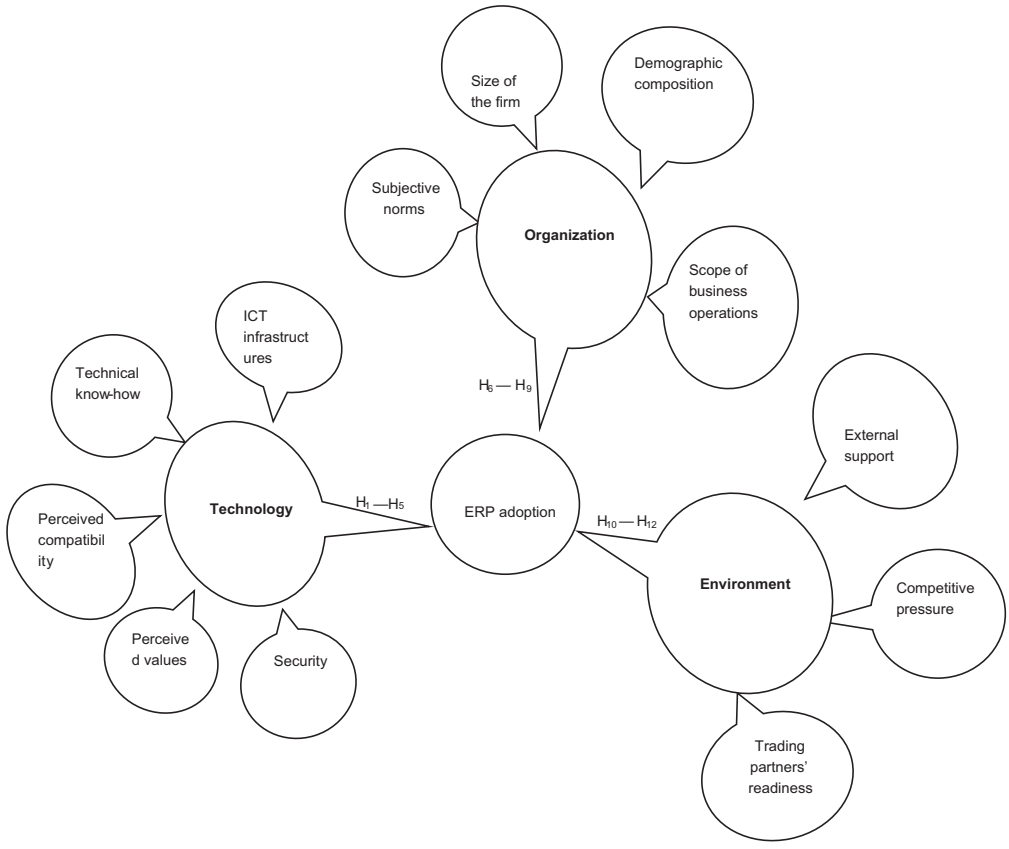
## 4. Research framework and hypotheses

Although the constructs of T-O-E framework are assumed to apply more to large enterprises, scholarly evidence (Awa, Baridam et al., 2015; Chau & Tam, 1997; Eze et al., 2013) shows that T-O-E framework has gained empirical validity across firm sizes and underpinned many ICT adoption inquiries, especially those that focus on EDI or inter-organizational information systems (IOIS). Eze et al. (2013) and Chau and Tam (1997) adopted T-O-E framework in their study and identified the innovation's characteristics, organization's technology, and external environment as quite useful in explaining and predicting adoption. Zhu and Kraemer (2005) found technology competence, firm size, financial commitment, competitive pressure, and regulatory support as critical adoption factors within T-O-E framework. Similarly, Kuan and Chau (2001) confirm the usefulness of T-O-E framework in small enterprises when they proposed a perception-based EDI adoption model with six determinants–cost structure, technical competence, industry pressure, government pressure, direct perceived usefulness, and indirect perceived usefulness. Other studies found environmental and organizational factors (Henriksen, 2006) more statistically significant determinants than technological factors even when Thong (1999) had found that adoption has significant relationship with technology and organization.

Further, Zhu et al. (2004) concluded technology readiness as the strongest adoption factor and added that financial resources, global scope, and regulatory environment significantly contribute to e-business value. Zhu et al. (2003) found higher level of consumer readiness, trading partners' readiness, and competitive pressures as critical environmental factors though relatively more technologically inclined firms reflected by greater scope of business are more likely to develop robust e-business operations. Although this review shows that there has been ample inquiry on ERP, not many of them studied ERP adoption within the framework of T-O-E. These studies differ in their contributions to knowledge but they seem to pay scanty attention on how to explain and predict SMEs' adoption of ERP within the T-O-E framework. Legris, Ingham, and Collerette (2003) note that extant inquiries considered external determining factors without a clear pattern as to how they were chosen and/or conceptually measured. For this study, the factors in the framework integrate and synthesize previous studies and the proposed framework (see Figure 1) focuses on the effects of the effects of technological, organizational, and environmental factors on adoption of ERP software. The research framework below shows 3 adoption drivers of Tornatzky and Fleischer (1990) and 12 constructs; technology-ICT infrastructure, technical know-how, perceived compatibility, and perceived value, and security; organization-demographic composition, size, scope of business operations (SBO), and subjective norms; and environment-competitive pressure, external support, and trading partners' readiness.

The choice of T-O-E framework and constructs (as earlier mentioned) was informed by their theoretical motivations as well as their specific application to ERP solution in the context of content sharing. Conceptually, we measure ICT infrastructure in terms of the number of computers owned, computers connected to the internet, and technical skills (Zhu & Kraemer, 2002; Zhu, Kraemer, & Xu, 2002). We use these because they are assumed affordable by a typical SME. Technical know-how measures the availability of proficient ICT experts and consultants who could use their knowledge to drive the enterprises' dream to competitive advantage. However, because SMEs want a resounding synergy, perceived compatibility measures consistency of ERP software with existing belief and value systems, knowledge and experience, and need potentials (Awa, Nwibere, & Inyang, 2010; Rogers, 2003). On accounts that previous studies (Davis, 1989; Lu, Yu, Liu, & Yao, 2003; Rogers, 2003; Taylor

**Figure 1. Proposed framework explaining ERP adoption within T-O-E.**




& Todd, 1995) emphasize on technology's outcomes, we measure perceived value by the SMEs' subjective probability that using ERP improves results. Security is a critical adoption issue and was measured by data security and absence of threat of yahoo-yahoo boys breaking into personal information privacy (Clarke, 1999; Swan, Bowers, & Richardson, 1999).

For organizational factors, size was conceptualized by the number of employees, level of investment in ICT, and use of ERP software and other related applications to build competitive advantage (Jeyaraj et al., 2006; Metaxiotis, 2009; Pang & Jang, 2008; Sabherwal et al., 2006). Similar measures were used in Nigeria, Egypt, Denmark, Australia, Europe, United States, and South Africa (SMEDAN, 2005; Scupola, 2009; OECD, 2000, 2002). We conceptualize demographic composition by indicators that lend support to factor analysis. The SBOs was measured by the digitalization of operations to enhance information processing and operational synergy and to reduce co-ordination costs and administrative complexities of multiple investments (Bakos, 1998; Chopra & Meindl, 2001; Zhu et al., 2003). This was informed by the fact that they strengthen the SMEs' agility to build competitive advantage amidst the contemporary digital world. Based on huge scholarship (Ling & Yttri, 2002; Marchionni & Ritchie, 2007; Rogers, 2003; Samson & Hornby, 1988) on what members want from a group, we conceptualize subjective norms in terms of the functional and/or psychological influences of other peoples' opinions, including those of superior and peer groups (Taylor & Todd, 1995; Venkatesh & Davis, 2000).

Within environmental context, competitive pressure was conceptualized by enterprise's behavior on Research and Development (R&D), domestic and overseas ICT talent, and developing related applications/services (Pang & Jang, 2008); and external support by the extent of encouragement from governments and non-governmental agencies (NGOs) such as less stringent loans, tax holidays, subsidies, grants, and provision of the facilities for uninterrupted service (Akbulut, 2002; Bingham, 1976). The value chain is a community and as such all the partners work toward a common goal of

using ERP to build competitive advantage. Therefore, trading partners' readiness measures network externalities within the value chain (Awa et al., 2010; Awa, Ojiabo et al., 2015).

### *4.1. Technology*

In the context of this study, technology aligns more to TPB's perceived behavioral control; that is, users' agility shaped by available resources to exploit the potentials of the proposed innovation(s). Scholarly review (see Khemthong & Roberts, 2006; Kuan & Chau, 2001; Kwon & Zmud, 1987; Al-Qirim, 2006; Zhu & Kraemer, 2002; Zhu et al., 2002, 2003) shows that technology factors as availability of internal and external technology resources (e.g. ICT infrastructures, internet skills, ICT technical know-how, user time, and developers), relative advantage, security, reliability, capability, cost, quality of software in the market, vendor supports, type of IT solution within the firm and their compatibility, IT objectives and assumptions, and evaluation of benefits influence adoption. Scholars propose that enterprises that possess strong and sophisticated technology and financial competences show more adoption likelihoods (Zhu & Kraemer, 2002; Zhu et al., 2004).

Although resistance to change is a normal organizational reaction (Premkumar & Roberts, 1999), studies show that perceived compatibility (Khemthong & Roberts, 2006; Premkumar, 2003; Tornatzky & Fleischer, 1990), perceived simplicity (Brown & Lockett, 2004; Khemthong & Roberts, 2006; Riemenscheider, Harrison, & Mykytyn, 2003), perceived observability (Musawa & Wahab, 2012; Wang et al., 2010), and perceived values (Grandon & Pearson, 2004; Mehrtens, Cragg, & Mills, 2001) were critical adoption predictors. Lee (2004) found that innovations perceived to have more operational values is more likely to be adopted. Whereas Grover (1993) found negative association between complexity and adoption of IS innovations, Thong (1999) found it a critical determinant in the context of small businesses. Zhu et al. (2004) conclude that the technology-driven nature of IT-based innovations precipitates that enterprises that efficiently exploit the complexities of internet technologies and exhibit technology readiness are more likely to create values with ERP faster than others, who do not have such strengths.

ICT infrastructures provide the platforms upon which community members share content real-time, internet skills offer the technical know-how, and ICT know-how provides the business and managerial skills to develop and operate the applications (Eze et al., 2013; Zhu et al., 2003). Scholars (Metaxiotis, 2009; Scupola, 2009) suggest that technology competence goes beyond physical assets; it includes intangible resources, which perhaps generate competitive advantages for innovators since skills and know-how complement physical assets and are more difficult to imitate by rivals. The proficient know-how understands the usefulness of the technology and uses his experiences to turn the complex part of the technology into mental effortlessness (Davis, 1989; Lu et al., 2003). However, when transactions in digital interactions move beyond the confines of simple concept, privacy, safety, and security become essential issues. Security defines the ability to protect consumer information and their transaction data during transmission (Hua, 2009; Salisbury, Pearson, Pearson, & Miller, 2001).

People are less likely to use the internet facilities in more advanced forms due to security concerns and access issues (Shafi, 2002); often they leave websites when their personal information is requested for (Benassi, 1999; Green, 1997). Studies found security threat the most critical adoption barrier (Belkhamza & Wafa, 2009; Hua, 2009; Limthongchai & Speece, 2003; Miyazaki & Fernandez, 2000; Yang & Jun, 2002) and others (Cho, Kwon, & Lee, 2007; Lu et al., 2003; Luarn & Lin, 2005) suggest positive relationship between security trust in web transactions and customer attitude, intention to buy, and purchase behavior. We propose the following hypothesized relationships on technology factors.

H1: There is a statistically significant relationship between the availability of ICT infrastructures and adoption of ERP solution.

H2: There is a statistically significant relationship between technical know-how and adoption of ERP.

H3: The perceived compatibility between ERP software and existing platforms makes adoption of ERP software possible.

H4: There is a statistically significant relationship between perceived values of ERP software in facilitating operations and its adoption.

H5: There is a significant relationship between perceived security and adoption of ERP.

### *4.2. Organization*

Organizational factors are descriptive and directly relate to availability and use of internal resources (Wymer & Regan, 2005). Proposed IS frameworks factored in SBOs, size and size-related issues (Eze et al., 2013; Pang & Jang, 2008); social influences (Rogers, 2003; Venkatesh & Davis, 2000), individual difference factors (Hambrick & Mason, 1984), organizations' mission (Awa et al., 2010), top management, available expertise, type of products offered, corporate culture and ownership structure (Scupola, 2009; Sheridan, 1994) and facilitating conditions (Tornatzky & Fleischer, 1990); and information sources and communication channels (Kannabiran & Dharmalingam, 2012). Our own framework limits organizational factors to subjective norms, SBOs, enterprise size and demographic composition. Size is an environmental and organizational issue (Kamal, 2006) though it measures the size of the community served and the number of services provided (Akbulut, 2002).

It is a critical adoption factor in central and local governments (Cho et al., 2007; Tornatzky & Fleischer, 1990); firms in larger cities adopt more sophisticated technologies than those in smaller cities (Norris, 1999). Other studies (Hwang, Ku, Yen, & Cheng, 2004; Zhu & Kraemer, 2005; Zhu et al., 2003) emphasize that adoption is slower among smaller enterprises because they rarely possess economy of scale advantage and the facilitating slacks as well as the resilience to bear the associated risks and to encourage community building and network externalities. Similarly, studies (Hossain & Quaddus, 2011; Ramdani et al., 2009; Wang et al., 2010) affirm size a critical factor in RFID, e-commerce, and ERP adoption and not critical in EDI adoption. Densmore (1998) found that about 95% of large enterprises adopt EDI against only about 2% of small enterprises.

Further, inquiries show that top management's demographic differences affect technology adoption (Awa, Baridam et al., 2015; Chuang et al., 2009; Hambrick & Mason, 1984; Thong, 1999; Zhu et al., 2003). Awa et al. (2011) submit that innovation adoption is influenced by group heterogeneity and cohesiveness as well as group members' functional tracks, education, age, gender, and experience. We consider demographic composition in terms of heterogeneity and/or homogeneity of decision-makers, occupational mobility, and functional tracks (Hambrick & Mason, 1984) because the measures of such dimensions as age and gender (nominal scale) rarely lend themselves to factor analysis. Similar training and experiences spill-over to related technologies on accounts of stimulus generalization and technology cluster (Awa et al., 2010). Awa et al. (2011) observe that a cohort made up of executives with integrated cost-cutting behavior, optimization backgrounds, database management and related areas influences adoption of new technologies. Social participation, group cohesiveness, and social mobility presuppose moving from functional to psychological motives and of course the adoption of untried technologies (Choudrie & Dwivedi, 2005; Marchionni & Ritchie, 2007; Rogers, 2003). Lu et al. (2003) found subjective norm to be an important determinant of intention and practically epitomizes the perception of others about adoption behavior(s).

Samson and Hornby (1988) report that in China, 73% of the executive class in big cities owned mobile phones early 1998 not solely for communications but also for social status. Further, younger users of communication interfaces are subjected to social influences because they are at social development and learning stage of life (Ling & Yttri, 2002). Thus, young users' social networks are more dynamic and exposed to more influences than other users. Scholars describe SBO as an adoption predicator; the greater the scope of business, the more likelihood enterprises invest to digitalize operations and to reduce internal co-ordination costs, administrative complexities, and information processing (Bakos, 1998; Chopra & Meindl, 2001; Hitt, 1999; Zhu et al., 2003). Enterprises with large scope of business go for e-business to reduce search costs for both buyers and sellers (Bakos, 1998)

and to achieve demand aggregation and improved inventory management (Chopra & Meindl, 2001) and have more latitude of benefiting from synergy of e-commerce and traditional business. Zhu et al. (2003) observe that web connectivity and knowledge sharing help consumers to locate physical stores.

H6: There is a statistically significant relationship between size of SMEs and adoption of ERP facilities.

H7: There is a statistically significant relationship between demographic composition of the decision-making team and adoption of ERP facilities.

H8: The relationship between demographic composition of the decision-making team and adoption of ERP facilities is statistically significant.

H9: There is a statistically significant relationship between subjective norms and adoption of ERP facilities.

### *4.3. Environment*

Strategists anticipate and respond to macro and micro environmental factors (Abell, 1978) as they often pose opportunities and threats as well as strengths and threats (SWOT) to their enterprises and shape their propensity to innovate and/or to engage in strategic and/or tactical programs (Raymond, 2001). A review of literature (see Al-Qirim, 2004; Awa et al., 2010; Pflughoeft, Ramamurthy, Soofi, Yasai-Ardekani, & Zahedi, 2003; Porter, 1996; Raymond & Blili, 1997; Sinkkonen, 2001; Tornatzky & Fleischer, 1990) reported that environmental factors that shape operational effectiveness, strategic positioning, and proactive decisions relate to marketplace forces, competitive pressures, government rules and regulations, suppliers, vendors, trading partners, and customers. On the strength of conciseness of purpose, the factors in our framework were external support, competitive pressure, and trading partners' readiness. Recognizing retaliation and actions going endless vicious circle, studies (Al-Qirim, 2004; Jeyaraj et al., 2006; Pflughoeft et al., 2003; Sinkkonen, 2001; Windrum & de Berranger, 2004; Zhu & Kraemer, 2005; Zhu et al., 2003) found competitive pressure and demands of marketplace participants as strategic necessities and critical innovation adoption drivers. Conversely, Windrum and de Berranger (2004) found that pressure from suppliers and allied firms was not statistically significant in determining the adoption of intranets or extranets.

Porter and Millar (1985) analyze the significance of competitive pressure on adoption and suggest that modern technologies alter the rules of competitive games, restructure the industry, and unravel novelty in outperforming rivals. Studies confirm that external support is not only a significant driver of ICT's success (Delone, 1988) but also a determinant of actual adoption (Premkumar & Roberts, 1999). Scholars (Pflughoeft et al., 2003; Sinkkonen, 2001; Windrum & de Berranger, 2004) captured in their frameworks network externalities with trading partners to ensure electronic interactions and transactions along the value chain. Awa, Ojiabo et al. (2015) propose that most ICT platforms transcend the digitalization of business domain of individual enterprises; there is need for integrated and electronically compatible trading systems that link the enterprises and their trading partners to provide internet-enabled services for one another.

H10: The relationship between competitive pressure and adoption of ERP solution is statistically significant.

H11: There is a statistically significant relationship between external support and adoption of ERP software.

H12: There is a statistically significant relationship between trading partners' readiness and adoption of ERP software.

## 5. Methods

The opposing intellectual traditions adopted in social science studies are positivism and anti-positivism. We adopt positivism because the study follows a realist approach to ontology backed up by positivist epistemology, relatively deterministic and nomothetic methodologies. To test the proposed framework and hypotheses, survey data were collected from a population of SMEs operating

**Table 1. Sample description**

| | SMEs | Administration | Managers/ Owners | Senior executives | Returns |
|---|---|---|---|---|---|
| 1 | ICT maintenance | 65 | 14 | 51 | 38 |
| 2 | Legal services | 70 | 28 | 42 | 41 |
| 3 | Health care services | 80 | 18 | 62 | 52 |
| 4 | Laundry and dry cleaning | 52 | 40 | 12 | 42 |
| 5 | Make-ups | 56 | 12 | 44 | 34 |
| 6 | Management consultancy | 50 | 14 | 36 | 37 |
| | Total | 373 | 126 | 247 | 244 |

in six fast growing service enterprises with strong operations in the city of Port Harcourt, Nigeria. Table 1 reports on sample description by firms and number of respondents. The study relied on documents from Small and Medium Sized Development Agency of Nigeria (SMEDAN, 2005) to focus on enterprises that employ at least 10 employees and have huge investment in ICT and annual turnover of five million naira or less. The peculiarity of Nigeria and the need to avert the more stringent estimates (between 100 and 500 employees) of developed and emerging nations (see OECD, 2000, 2002; Scupola, 2009) informed the criterion of 10 employees. Other criteria used to define the population were that the SMEs must use ERP to integrate operations and be duly registered with Corporate Affairs Commission and other relevant government approved bodies.

Our sampling frame spans 373 owners and executives of SMEs and the cluster of federal and state ministries and parastatals as well as huge oil deposit and commercial activities in the city of Port Harcourt makes her to play host to expatriates and different tribes of Nigeria. Further, we relied on critical mass theory (see Bingham, 1976; Bouchard, 1993) and the assumption that cities with higher socio-economic status are in close proximity and show are more prone to amenity-based values than low socio-economic cities, who often emphasize necessity-based (e.g. innovations designed to correct some specific deficiencies). The sampling modes of were purposive and snowball; we use our experiential knowledge and judgment to choose the first few cases whose opinions best represented that of the community and then relied on referrals for further guide. In order to minimize the fear of bias associated with non-probability samples; we rely on Chein (1981) to restrict and precisely define the population.

## 6. Data analysis and results

The test statistic for analyzing the framework and the hypothesized relationships involves logistic regression and Wald statistics; logistic regression uses the likelihood ratios, Hosmer and Lemeshow's goodness of fit, and Nagelkerke $R^2$ to estimate the explanatory strength of the latent variables, whereas the Wald statistics test the significance of the regression coefficients of the proposed hypotheses. Such multivariate analysis is often preferred to multiple regression tests when the dependent variable is dichotomous—adopters vs. non-adopters (Pang & Jang, 2008). Pallant (2013) posits that logistic regression assesses the impact of a number of factors on the likelihood that the respondents report adoption or non-adoption of ERP software.

### *6.1. Measures*

Content and construct validities were assessed. The former explains the subjective and judgmental opinions that support the adequacy with which a specific domain of content has been sampled or the extent to which an instrument is truly a comprehensive measure of the area under study (Nunnally, 1978; Shah Alam, Ali, & Mohd. Jani, 2011). And then the latter deals with the extent to which the statement items in a scale measure the same construct. The constructs of this study are well-researched and have well-developed measures in literature; thus, their scales have some

measures of content validity. We drew the measures for the constructs from the relevant literature (see Table 2 for the measures and their sources) and asked the respondents to rate their level of agreement to the batteries of statements on a five-point scale (from 5 = strongly agree to 1 = strongly disagree). Factor analysis of the multi-item indicators was performed to only test the validity and reliability of instruments. Hair, Anderson, Tatham, and Black (1998) propose using convergent and discriminant validity to further assess measurement model.

Table 2 confirmed convergent validity for three reasons––the composite reliability (CR) values are greater than 0.7 for a reliable construct (Hair et al., 1998); the AVE for every statement item was greater than 0.5 (Fornell & Larcker, 1981); and the degree of association between the underlying latent factors and each item were statistically significant at greater than 0.7 (Gefen, Straub, & Boudreau, 2000). Further, the observed components met Kaiser-Meyer-Olkin's (KMO) benchmark (Kaiser, 1974) and the eigen-values of greater than one. The Bartlett's Tests of Sphericity ($\chi^2$) were significant at $p < 0.001$. The discriminant validity describes the extent to which a given construct shares more variance with its measures than other latent variables in the model (Hinkin, 1995; Sanchez & Roldan, 2005); thus, the square root of a construct's AVE must be larger than the inter-construct correlations to ensure discriminant validity (Fornell & Larcker, 1981). Discriminant validity is confirmed because the square roots of the AVE in the diagonal exceed the correlation between other constructs; and therefore, indicators loaded onto separate factors in the expected manner and show no oblique but orthogonal relationships among themselves.

Our framework has many exogenous variables; therefore, we rely on Kleinbaum, Kupper, and Muller (1988) and Bowerman and Connell (2001) to clear threats of multi-collinearity using the Tolerance test, Variance Inflation Factor (VIF), and Durbin–Watson range of 1.5–2.5. Table 3 reports that multi-collinearity was yet to be reached by the measures of the predictors because the collinearity diagnostics showed that VIFs were less than 10 and the tolerance levels were above 0.4. The Durbin–Watson value of 1.645 confirms absence of auto-correlation in the data-set. Further psychometric assessment of survey instruments and scales confirmed internal consistency (Kim & Cha, 2002; Zhang et al., 2005) through inter-item consistency measure of Cronbach's coefficient. The Cronbach's α values ranging from 0.708 to 0.881 suggest that the multi-item scales observed were satisfactory in describing the relevant latent variables.

Table 5 shows that at LR = 99.400, the logistic likelihood regression reports strong interactions between the dimensions of T-O-E framework and ERP adoption and attempts to test the proposed framework and hypotheses. The goodness of fit test using the Hosmer and Lemeshow model shows a value of $\chi^2 = 5.670$ and the $p$-value ($p < 0.817$) confirms that the proposed model does not critically differ from a perfect one that correctly classifies respondents into their respective groupings. The table further shows that 46% variance was explained by Nagelkerke $R^2$. The significance of the regression coefficients as reported by Wald statistics showed mixed results; some adoption predictors have significant negative coefficients (competitive pressure, external support, subjective norms, trading partners' readiness, and SBOs) and others have significant positive coefficients (firm's size, security, perceived values, perceived compatibility, technical know-how, demographic composition, and ICT infrastructure). These results fully lend support to H1–H12 and explain that although those factors that have significant negative coefficients are significant adoption predictors, they do not currently contribute to the explanation of adoption behavior.

We measure adoption as the voluntary decision to use ERP software as a part of business strategy within and across the firm. The overall discriminating power reported in Table 4 shows a prediction accuracy of 78.70% based on the logistic regression equation. The table reports 178 adopters and 66 non-adopters; thus, guessing adoption by random choice would result in $(178/244)^2 + (66/244)^2 = 5$ 0.48%. Further, we conclude that the logistic regression model has higher discriminating power than the random choice model since the former has much higher value than the latter.

**Table 2. Factor, validity, and reliability analyses**

| Factor dimension and items measured | EVA | Eigen-value | Cronbach Alpha | CR | KMO | Bartlett's Test of Sphericity |
|---|---|---|---|---|---|---|
| **ICT infrastructures** (see Pang & Jang, 2008) | | 7.24 | 0.881 | 0.712 | 0.810 | 71.23 |
| Number of employees connected to the internet | 0.77 | | | | | |
| Number of computers connected online | 0.69 | | | | | |
| Number of computers to employees | 0.63 | | | | | |
| **Technical know-how** (see Brown & Lockett, 2004; Riemenschneider et al., 2003) | | 6.02 | 0.802 | 0.776 | 0.821 | 73.16 |
| Availability of technical/maintenance unit(s) | 0.87 | | | | | |
| The number of technical officers employed | 0.79 | | | | | |
| Regularity of staff training on ICT | 0.73 | | | | | |
| Existence of ICT consultants | 0.69 | | | | | |
| Availability of service providers and spare parts | 0.63 | | | | | |
| **Perceived compatibility** (see Grandon & Pearson, 2004; Khemthong & Roberts, 2006; Tornatzky & Fleischer, 1990) | | 4.40 | 0.711 | 0.898 | 0.804 | 76.31 |
| Fit between the new and existing technologies | 0.82 | | | | | |
| Fit between the new systems and existing work procedures | 0.78 | | | | | |
| Fit between the new systems and corporate culture | 0.70 | | | | | |
| Fit between the new systems and corporate philosophies, norms, and values | 0.64 | | | | | |
| **Perceived values** (see Al-Qirim, 2006; Beatty, Shim, & Jones, 2001) | | 2.94 | 0.784 | 0.780 | 0.871 | 78.26 |
| Reduced operating costs | 0.81 | | | | | |
| Improved operational efficiency | 0.76 | | | | | |
| Improved customer service | 0.72 | | | | | |
| Improved customer relationship | 0.69 | | | | | |
| Reaching new customers | 0.65 | | | | | |
| **Security** (see Shah Alam et al., 2011) | | 2.54 | 0.768 | 0.788 | 0.817 | 79.11 |
| Lack of confidentiality of transaction details | 0.85 | | | | | |
| Web transaction information is not private | 0.82 | | | | | |
| No confidence in web payment system | 0.79 | | | | | |
| Current laws and regulations are insufficient to protect user's interest | 0.73 | | | | | |
| **Scope of business operations** (see Chopra & Meindl, 2001; Gurbaxani & Whang, 1991; Shapiro & Varian, 1999) | | 2.34 | 0.771 | 0.891 | 0.820 | 81.10 |
| Reducing costs associated with operational expansion | 0.88 | | | | | |
| Reduction of external costs of operations | 0.82 | | | | | |
| Operations and lead-time compression | 0.73 | | | | | |
| Integration of units and independent partners at a reduced cost | 0.67 | | | | | |
| **Demographic composition** (see Awa et al., 2011; Awa, Ojiabo et al., 2015; Chuang et al., 2009; Hambrick & Mason, 1984) | | 1.94 | 0.708 | 0.712 | 0.812 | 84.13 |
| Heterogeneity of decision-makers | 0.86 | | | | | |

(*Continued*)

**Table 2. (*Continued*)**

| Factor dimension and items measured | EVA | Eigen-value | Cronbach Alpha | CR | KMO | Bartlett's Test of Sphericity |
|---|---|---|---|---|---|---|
| Homogeneity of decision-makers | 0.83 | | | | | |
| Occupational mobility | 0.75 | | | | | |
| Functional tracks | 0.71 | | | | | |
| **Size of the firm** (see Grandon & Pearson, 2004; Jeyaraj et al., 2006; Lertwongsatien & Wongpinunwatana, 2003; Tornatzky & Fleischer, 1990) | 0.76 | 1.64 | 0.801 | 0.769 | 0.832 | 85.32 |
| Resources | 0.76 | | | | | |
| Skills and experience | 0.74 | | | | | |
| Level of resilience | 0.68 | | | | | |
| Operational agility | 0.62 | | | | | |
| **Subjective norms** | | 1.45 | 0.764 | 0.786 | 0.827 | 86.03 |
| Influence by others | 0.74 | | | | | |
| Group cohesiveness | 0.71 | | | | | |
| Strong belief in group norms | 0.68 | | | | | |
| Fear of group penalty | 0.64 | | | | | |
| **External support** (see Akbulut, 2002; Bingham, 1976). Governments, NGOs and inter-governmental influences may generate: | | 1.22 | 0.790 | 0.770 | 0.911 | 74.67 |
| Grants/donations | 0.90 | | | | | |
| Transfer of technical assistance | 0.83 | | | | | |
| Soft-loans | 0.78 | | | | | |
| Loan guarantee and loan insurance | 0.76 | | | | | |
| Subsidies and tax relieve operations | 0.68 | | | | | |
| **Competitive pressure** (see Jeyaraj et al., 2006; Lertwongsatien & Wongpinunwatana, 2003) | 0.89 | 1.10 | 0.809 | 0.754 | 0.902 | 78.43 |
| Operational necessity | | | | | | |
| Strategic necessity | 0.79 | | | | | |
| Vendor or third party support | 0.73 | | | | | |
| Opponents adopt it | 0.67 | | | | | |
| **Trading partners readiness** | | 1.06 | 0.829 | 0.777 | 0.881 | 75.28 |
| Partners want integration | 0.77 | | | | | |
| Partners are buoyant | 0.74 | | | | | |
| Partners belief in the innovation's values | 0.70 | | | | | |
| Partners have the technical resources | 0.66 | | | | | |
| **Adoption** (see NSSBF) | | 7.23 | 0.752 | 0.784 | 0.929 | 84.04 |
| The use of ERP to improve customer service | 0.88 | | | | | |
| The use of ERP for inventory management | 0.79 | | | | | |
| The use of ERP for operational efficiencies and cost reduction | 0.76 | | | | | |
| The use of ERP for inter-firm funds transfer | 0.69 | | | | | |
| The use of ERP to update contents and integrate operations | 0.70 | | | | | |

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**Table 3. Discriminant validity and collinearity statistics**

| | ICT1 | TK | PC | PV | Sec | SBO | DC | SF | SN | ES | CP | TPR | AD | Tolerance | VIF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ICT1 | 0.655 | | | | | | | | | | | | | 0.458 | 2.30 |
| TK | 0.410 | 0.539 | | | | | | | | | | | | 0.608 | 3.10 |
| PC | −0.199 | −0.200 | 0.560 | | | | | | | | | | | 0.727 | 2.80 |
| PV | 0.451 | 0.360 | −0.220 | 0.622 | | | | | | | | | | 0.468 | 2.54 |
| Sec | 0.527 | 0.343 | −0.274 | 0.457 | 0.638 | | | | | | | | | 0.540 | 2.82 |
| SBO | 0.422 | 0.463 | −0.362 | 0.482 | 0.526 | 0.551 | | | | | | | | 0.470 | 2.87 |
| DC | 0.438 | 0.361 | 0.255 | 0.662 | 0.476 | 0.427 | 0.602 | | | | | | | 0.583 | 2.49 |
| SF | 0.481 | 0.517 | 0.373 | 0.477 | 0.652 | 0.362 | 0.470 | 0.610 | | | | | | 0.517 | 3.32 |
| SN | 0.525 | 0.564 | 0.367 | 0.524 | 0.713 | 0.467 | 0.640 | 0.540 | 0.510 | | | | | 0.661 | 4.20 |
| ES | 0.476 | −0.362 | 0.463 | 0.419 | −0.204 | −0.362 | 0.517 | −0.204 | 0.221 | 0.661 | | | | 0.712 | 5.40 |
| CP | 0.652 | 0.255 | 0.361 | −0.197 | 0.266 | 0.255 | 0.564 | 0.266 | 0.481 | 0.517 | 0.591 | | | 0.645 | 4.16 |
| TPR | 0.723 | 0.373 | 0.517 | 0.421 | 0.343 | 0.463 | 0.373 | 0.565 | 0.525 | 0.564 | 0.218 | 0.612 | | 0.443 | 0.541 |
| AD | 0.468 | 0.376 | 0.564 | 0.527 | 0.463 | 0.361 | 0.367 | −0.220 | 0.410 | 0.441 | 0.301 | 0.412 | 0.514 | - | - |

Notes: ICT1 = ICT infrastructure; TK = technical know-how; PC = perceived compatibility; PV = perceived values; Sec = security; SBO = scope of business operations; DC = demographic composition; SF = size of firm; SE = external support; CP = competitive pressure; TPR = trading partners' readiness; and AD = adoption.

Table 4. Classification

| | Observed total | Predicted | | Percentage correct |
|---|---|---|---|---|
| | | Adopters | Non-adopters | |
| Adopters | 178 | 155 | 23 | 87.08 |
| Non-adopters | 66 | 22 | 44 | 66.67 |
| Overall | 244 | 199 | 45 | 78.70 |

**Table 5. Logistic regression test**

| | | | |
|---|---|---|---|
| **−2 Logistic likelihood = 99.400** | | | |
| **Nagelkerke $R^2$ = 0.456** | | | |
| **Hosmer and Lemeshow $\chi^2$ = 5.670** | | | |
| **Significance = 0.817** | | | |
| **Dimension factor** | **Coefficient (S.D)** | **Wald statistic** | **Sig** |
| ICT infrastructures | 0.653 (0.314) | 7.450 | 0.070* |
| Technical know-how | 0.167 (0.331) | 2.541 | 0.072* |
| Perceived compatibility | 0.576 (0.302) | 7.331 | 0.073* |
| Perceived values | 0.459 (0.299) | 2.404 | 0.049** |
| Security | 0.686 (0.349) | 3.425 | 0.065* |
| Size of the firm | 0.103 (0.710) | 0.255 | 0.011** |
| Demographic composition | −0.483 (0.279) | 2.330 | 0.070* |
| Scope of business operations | −0.589 (0.374) | 6.377 | 0.019** |
| Subjective norms | −0.634 (324) | 3.211 | 0.062* |
| Competitive pressure | −0.495 (0.263) | 2.219 | 0.067* |
| External support | −0.480 (0.201) | 2.106 | 0.041** |
| Trading partners' readiness | −0.661 (0.347) | 3.370 | 0.059* |

*Level of significant of $p < 0.01$.

**Level of significant of $p < 0.05$.

At $p < 0.01$ the demographic composition has a significant negative coefficient and substantially affects adoption more than the other five factors (subjective norms, trading partners' readiness, and competitive pressure) with negative coefficients. When the means of each of these factors were compared between adopters and non-adopters, significant differences were noticed. Thus, these critical adoption factors pose minimal obstacles to adopters than to non-adopters. Further at $p < 0.01$, the coefficients of ICT infrastructures, technical know-how, perceived compatibility, and security, respectively, lend moderate supports to H1, H2, H3, and H5. At $p < 0.05$, size of the firm is the most critical adoption driver and lends strong support to H6. SBO would have been the next most critical factor but it has a negative coefficient though it lends support to H8; thus, it is more of an issue to non-adopters than to adopters (going by their mean differences). For perceived values, its coefficient moderately and positively supports H4 at $p < 0.05$; and finally external support has negative coefficient and moderately supports H11.

## 7. Discussion

This paper provides insight into the critical factors within the framework of T-O-E that distinguish adopters from non-adopters of ERP software. On accounts that the measures of the 12 factor dimensions were reliable and valid (see Table 2) and the goodness of fit criteria of the basic model meet the proposed thresholds, the hypothesized relationships were tested to confirm the extent to which they support the proposed T-O-E framework. The 12 hypotheses were supported at either $p < 0.01$ or 0.05 with each factor differing in its statistical coefficient. The study found that adoption of ERP by SMEs is more driven by technological factors than by organizational and environmental factors. In their study of the Danish steel and machinery industry within the context of T-O-E framework, Henriksen (2006) contrasted this finding when he reported that organizational and environmental factors are more critical adoption determinants than do the technological attributes.

### *7.1. Technology*

Five hypotheses were captured here to reflect ICT infrastructures, technical know-how, perceived compatibility, perceived values, and security. Availability of ICT infrastructures was found a critical factor in SMEs' adoption of ERP; thereby supporting H1. Similarly and in support of H2, technical know-how was reportedly found a critical ERP adoption factor. A possible explanation to these findings is that when compared to other economies (including South Africa, India, and even Ghana), modern technologies are yet to attain a relatively high level of adoption in Nigeria because very few employees/owners of SMEs have computers and integrate operations online. Whereas some previous studies (Khemthong & Roberts, 2006; Al-Qirim, 2006; Zhu & Kraemer, 2002; Zhu et al., 2002, 2003) are consistent with this finding when they emphasize that the adoption of facilities is dependent upon the availability of internal and external technology resources, others (Premkumar & Ramamurthy, 1995; Thong, 1999) contrasted the finding when they reported that adoption of IS does not depend on existing ICT infrastructures.

Further, H3 is moderately supported at $p < 0.01$; this accounts that perceived compatibility has significant direct interactions with adoption. This confirms previous studies (Khemthong & Roberts, 2006; Lertwongsatien & Wongpinunwatana, 2003; Premkumar, 2003; Tornatzky & Fleischer, 1990) that found perceived compatibility a critical adoption predictor. With a significant positive coefficient at $p < 0.05$, the interaction between perceived values and adoption is moderately critical and supports H4. Previous studies (Grandon & Pearson, 2004; Mehrtens et al., 2001) suggest that innovation adoption is largely dependent upon its relative advantage over current practices. The result of security significantly supports H5 at $p < 0.01$ and confirms that security issues are critical adoption factors, especially from customers' perspective. Previous studies (Benassi, 1999; Cho et al., 2007; Green, 1997; Lu et al., 2003; Luarn & Lin, 2005) support this finding when they found that security significantly influences online purchases.

### *7.2. Organization*

The demographic composition, SBOs, subjective norms, and size of the SMEs were captured in the organizational dimension. First, size of the firm has a significant positive coefficient and substantially supports H6 at $p < 0.05$. Firm's size is a critical adoption factor in RFID, e-commerce, and ERP though non-critical in EDI adoption (Hossain & Quaddus, 2011; Ramdani et al., 2009; Wang et al., 2010). Other studies (Hwang et al., 2004; Zhu & Kraemer, 2005; Zhu et al., 2003) emphasize that smaller enterprises often lack the requisite resources to be entrepreneurial. Second, the demographic composition has a significant negative coefficient and at $p < 0.01$, it moderately affects adoption of ERP and supports H7. The demographic composition is perceived more of a critical adoption factor to non-adopters than to adopters. Inquiries (Chuang et al., 2009; Hambrick & Mason, 1984; Thong, 1999; Zhu et al., 2003) support that management's demographic differences and knowledge about an innovation influence organization's strategies.

SBO has a significant negative coefficient and support H8 at $p < 0.05$. Having a significant negative coefficient explains that SBO is a critical adoption factor though a less obstacle to adopters than to non-adopters. The role of SBO as an adoption predicator has been variously confirmed (Hitt, 1999; Thong, 1999; Tornatzky & Fleischer, 1990; Zhu et al., 2003). Studies (Bakos, 1998; Chopra & Meindl, 2001; Gurbaxani & Whang, 1991; Shapiro & Varian, 1999) show that larger scope of business demands e-business to reduce costs, to integrate demand and improve inventory management and to benefit from synergy of modern applications and traditional business. The result of subjective norms shows that it has a significant negative coefficient and supports H9 at $p < 0.01$. The negative coefficient explains that subjective norm represents adoption driver but the influence of others (e.g. opinion leaders) is yet to be strong enough to drive action among non-adopters. Adopters recognize it as a critical adoption driver, but a less obstacle than to non-adopters. This finding lends support to previous studies (Ling & Yttri, 2002; Lu et al., 2003; Samson & Hornby, 1988; Taylor & Todd, 1995) that emphasize group and other people's influence on behavior.

### *7.3. Environment*

In the context of environment, external support and competitive pressure were considered; they had significant negative coefficients and moderately support H10 and H11. Thus, the two factors are critical adoption factors, but they do not strongly pose part of adoption issue, especially among current adopters. To non-adopters who perceive these factors as more critical than do adopters, the explanation to these findings rests on two platforms; first, adoption is still at the infancy and yet to be used extensively for building competitive advantage; and second, the support programs are rarely transparent and hitch-freely delivered. Previous studies found mixed result on the influence of competitive pressure on adoption (Premkumar & Ramamurthy, 1995; Zhu et al., 2003); some scholars suggest direct (Jeyaraj et al., 2006; Zhu & Kraemer, 2005) and others indirect (Lee, 2004; Thong, 1999) effects on adoption decision with the proposition that organization's willingness to adopt an innovation is largely dependent upon her internal necessity for it (Premkumar & Ramamurthy, 1995). Chau and Tam (1997) found that the external environment has little influence on adoption decision of ERP.

Many studies recognize the strategic necessity of competitive pressure (Iacovou, Benbasat, & Dexter, 1995; Jeyaraj et al., 2006; Zhu et al., 2003; Zhu & Kraemer, 2005) in altering the rules of the games, restructuring the industry make-ups, and unraveling novelty in outperforming rivals (Porter & Millar, 1985). Others studies (Delone, 1988; Premkumar & Roberts, 1999) confirm external support as a critical adoption determinant. The result of the trading partners' readiness reads, indicating significant negative coefficient and support for H12. The factor is a critical one though it does not form strong part of adoption factor for adopters because many partners already appreciate network externality. For the non-adopters, trading partners' readiness is a major factor that influences adoption. In some economies like Nigeria, where the diffusion of ICT platforms is at its infancy, the issue of network externalities is much more associated with enterprises with large investments. The finding supports studies that propose that ERP and other related technologies demand integrated and electronically compatible trading systems (Pflughoeft et al., 2003; Sinkkonen, 2001) and disagrees

with Windrum and de Berranger (2004) who found that pressure from allied firms was not a significant adoption determinant.

## 8. Conclusion and implications

IT-based innovations are highly differentiated technologies for which no single proposed adoption model is all-encompassing; adoption takes place after many factors had been carefully considered. They are complex, risky, and integrated systems that reposition enterprises' competitive advantage subject to knowing and managing the critical success factors. Building competitive advantage via ERP systems encompasses the fundamental platforms for transaction processing (the primary focus of ERP studies) and the extended platforms (EERP) for supply chain management, customer relationship management, knowledge management, decision support systems, and strategic management. SMEs rarely take advantage of the strengths of the primary and extended functions of ERP in full because they suffer socio-economic disadvantage to adopt novel and complex software. Therefore, this paper compliments and/or extends adoption knowledge by developing a 12-factor model of ERP adoption from the 3 adoption contexts of T-O-E framework, and by testing the framework in order to ascertain the strength of the factors to adopters and non-adopters. The coefficients of the 12 factors show that they were critical adoption factors though some had negative values.

The latent variables with significant negative coefficients (SBO, trading partners' readiness, subjective norms, competitive pressure, demographic composition, and external support) were critical adoption determinants though they pose less of an obstacle to adopters than to non-adopters. ICT infrastructures, technical know-how, perceived compatibility, perceived values, security, and size of the firm were significant determinants of adoption. Therefore, adoption of ERP by SMEs is more driven by technological factors than by organizational and environmental factors. The main theoretical thrust of this paper lies on the proposed research framework and attempt test the framework in order to statistically validate and/or extend the T-O-E factors on SMEs' adoption of ERP software. Thus, the paper contributes to the theoretical and methodological discourse in the IS domain and provides specific lenses into the understanding of the relationships between endogenous and exogenous factors in the proposed framework. The 12 factors were critical for non-adopters; and for adopters, the most critical factors were the enterprises' size and platform's display of relative value and compatibility, the existence of technical know-how and infrastructural facilities, and security and top management predisposition.

Practically, the IT vendors are guided by providing support for their investment decisions and by tailoring more rigorous marketing programs that appeal to non-adopters since the outcome of the study shows that they have more adoption challenges than adopters. This holds while actual adopters are caused to progress in the loyalty ladder. State policies should offer SMEs supportive programs that encourage investment in ERP technologies since size and size-related factors are critical adoption issues. Like other studies, the findings of this study are prone to some limitations and thus, offer opportunities for further research. First, reliance on data from only ICT industry and cross-sectional data to test the proposed framework limits the generalizability of the findings on accounts that causal relationships identified definitely vary across sectors, industries, regions, and countries or may even lose weight and meaning overtime. Therefore, extended measures and/or longitudinal studies may be required to strengthen the direction of the causality; multiple samples from different populations and/or replicating the study in other settings will increase generalizability of the identified causal relationships.

Second, measures of constructs represented subjective perceptions and are prone to common error biases though some errors were unavoidable in the SPSS conversion of data; thus, future studies should extend the measures and cross-validate the scales. Third, the study focuses on pre-adoption phase and so future investigators should take up the implementation and post-adoption phases

in order to forge a more integrated and holistic adoption lenses. Fourth, other factors which most likely affect ERP adoption and are not factored into the T-O-E framework pose another strong area(s) of future inquiries. Finally and perhaps most importantly, we use PCA with varimax rotation; therefore, further researchers may reduce the scales and do CFA and maximum likelihood with an oblimin rotation or do a second-order level where a single 12 items may be fitted into the three drivers of TOE.

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