EXPLORING FACTORS INFLUENCING ORGANIZATIONAL ADOPTION OF AUGMENTED REALITY IN E-COMMERCE: EMPIRICAL ANALYSIS USING TECHNOLOGY–ORGANIZATION–ENVIRONMENT MODEL

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ABSTRACT

Despite positive attitudes towards augmented reality (AR) technology and the rich consumer experience that the technology offers, AR technology adoption and usage to enhance the customer experience in e-commerce is rather limited. In this research, leveraging on the technology–organization–environment (TOE) theoretical framework, we propose various factors that influence the adoption intention of AR from an organizational perspective. Analysis of organizational adoption of AR for e-commerce will bring out important factors organizations should focus on while considering the implementation of AR technologies to enhance the shopping experience of their consumers. Specifically, the study theorizes the role of technological factors (technological competence and relative advantage), organizational factors (decision-makers' knowledge, financial strength, and top management support), and environmental factors (consumer readiness and competitive pressure) in influencing an organization's adoption of AR for e-commerce. We test the proposed research model via a sample of potential adopters from Singapore, India, and the USA. Results highlight the significant roles of technology competence, relative advantage, top management support, and consumer readiness in influencing an organization's adoption intention of AR for e-commerce. Implications for research and practice are also discussed.

Keywords: Technology–organization–environment model; Augmented reality; Technology adoption; E-commerce

1. Introduction

E-commerce is growing at a rapid pace, which is evident in the statistics stating that over a billion Internet users purchased goods through e-commerce websites in 2013 [Statista 2016]. In fact, retail e-commerce sales amounted to $1.86 trillion in 2016, and e-retail revenues are projected to grow to $4.48 trillion in 2021 [Statista 2018]. This dramatic transformation of the digital retail landscape with a rapidly growing user base has evoked a strong compulsion for e-commerce firms to differentiate themselves amongst their competitors and adopt creative methods to cater to their consumers. The unique challenge for e-commerce firms is to provide their online customers with the "try before you buy" tactile experience using rich media[1]. This has increased with an increase in online customers with varied needs who are increasingly curious and demanding of visual and tactile simulation [Huang & Tseng 2015]. As a result, rich media content, such as high-resolution product images, videos, and 3D graphics, has been integrated into websites to enhance the customer experience [Gabisch & Gwebu 2011; Hassouneh & Brengman 2011; Hassouneh & Brengman 2015]. E-commerce companies are exploring the potential of the rich media and particularly immersive content offered by augmented reality (AR) to provide enhanced intuitive interface and an enriching experience to customers, thus creating a new paradigm in the space of e-commerce [Tabusca 2015].

AR is an emerging form of experience that integrates digital information with the user's environment in real time [Azuma et al. 2001]. As AR uses the existing environment and overlays new information on top of it, this technology

[1] Rich media content in the e-commerce context collectively defines any form of content that is an enhancement from normal text and static images and is designed to engage the customer visually and emotionally.

is expected to overcome the biggest hurdle of e-commerce customers by allowing them to engage in some sort of interaction with their potential purchase before buying it and determining whether the product is right for them [Chen 2016]. It is estimated that, by 2018, over 140 million new users will have used AR technology through their mobile devices [Statista 2016]. It is also estimated that the market for AR will be no less than $120 billion in 2020 [Digi-Capital 2015]. With the recent release of the AR gaming application Pokémon GO, which has been a huge success, the market value of Nintendo surged to $7.5B USD, which stands as a good example of people's acceptance and the commercial viability of the technology [Thinkwell 2016].

The applications of AR are widespread across industries, such as manufacturing, communication, health, retail, navigation, military, education, gaming, and e-commerce [Harborth 2017; Van Krevelen & Poelman 2010]. This study focuses on the application of AR in e-commerce because of the huge potential of this immersive technology in providing an in-store shopping experience regardless of location. Devices can superimpose 3D objects in various spaces, giving customers a chance to interact with digital renderings from the comfort of their own homes. Companies like IKEA and Converse are using AR to help users envision pieces of furniture in their homes or shoes on their feet in real time using smartphone apps. This increase in growth of AR applications can be attributed to the consumer's perceived benefit and positive experience [Olsson et al. 2013].

Despite this surge in AR technology usage across the industry, the responsive change expected in the adoption of AR in a firm's value chain is not adequate [Olsson et al. 2013]. In fact, even in developed and technologically advanced nations, AR technology adoption and usage for e-commerce are still in nascent stages [Tutunea 2013]. There is a practical need to investigate this topic of interest. Moreover, although the industry evolving around AR has been estimated at a volume of over $200 billion [Hyman 2013], this stream of research is quite miniscule in the field of information systems (IS) [Harborth 2017]. The bulk of AR research focuses on the technological aspects of AR with a limited focus on the behavioral aspects, which fall in the natural purview of IS research.

Substantiating the behavioral aspects of consumers, a few studies put forward that there was a considerably high proportion of consumers who became loyal to the shopping experience that had implemented AR technology compared to a normal e-commerce website [Huang & Tseng 2015]. There are few quantitative empirical studies on this subject, most of which are limited to analysis from the *consumer perspective* [Olsson et al. 2013]. Despite the positive attitude toward technology, the adoption of AR by e-commerce firms is marginal [Kumar et al. 2016; Olsson et al. 2013]. Insights into adoption of AR from a firm's perspective have not caught enough research attention. While current studies on adoption factors from a consumer standpoint can serve as an entry point to the study, it is imperative to study the specific contexts aligned from a *firm's perspective*. Motivated by the huge potential of AR in the e-commerce domain and realizing the low adoption rate of AR by e-commerce companies, the main thesis of this study is to explore the factors influencing the adoption intention of AR by e-commerce firms. Our research is predicated on this significant theoretical and managerial need. Modalities from a *firm's perspective* are divergent in terms of managerial, organizational, technological, environmental, and individual factors and require deeper examination [Ghobakhloo et al. 2011b].

The technology adoption decisions in a firm are not dependent on the characteristics of the technology alone; rather, it is also essential to examine the factors in terms of inter-organizational and environmental contexts [Kuan & Chau 2001]. Theoretically grounding our research in the technology–organization–environment (TOE) framework [Tornatzky & Fleischer 1990], in this study we analyze the factors influencing AR adoption intentions of e-commerce firms. The TOE framework is considered the complete reference model for the research, which studies the adoption of technology innovations from a *firm's perspective* [Picoto et al. 2014]. With the TOE framework as the theoretical lens, our research aims to study the following research question.

RQ: What are the key factors influencing the adoption intention of AR technology by e-commerce firms?

Our research follows a quantitative approach with a strong empirical analysis to identify the key factors influencing the adoption intention of AR by e-commerce companies. A survey questionnaire, designed with research items coined under the TOE categories, was sent to the appropriate stakeholders, including e-commerce companies, AR vendors, and industry experts, to get their responses and better understand the problem from a *firm's perspective*. Demographical items were also included to understand the responses better. The study was carried out with samples collected from India, Singapore, and the USA to avoid any geographical biases.

There are three significant contributions of this study. First, this research focuses on AR technology, which has not yet drawn enough IS research attention. As AR research in the domain of IS is sparse, this study contributes theoretically by setting the foundation for future research in this area. Second, with the TOE framework as the theoretical model, this paper shows the effectiveness of the model in analyzing the adoption intention of an upcoming technology, such as AR from a firm's context. To the best of our knowledge, this is one of the first studies to explore the factors influencing the adoption intention of AR from a *firm's perspective*. Third, by hypothesizing the effect of different identified factors, we restate the need for a thorough understanding of these antecedents for developing

adoption intention of AR technology by e-commerce firms. Holistically, by depicting the factors for adoption intentions of AR by e-commerce firms, this study will contribute to the field of e-commerce and help to understand technology adoption from a *firm's perspective*.

2. Literature Review

2.1. Augmented Reality

As an online commerce platform helps firms better understand consumer behavior compared to brick-and-mortar selling [Alpert et al. 2003], e-commerce firms are incorporating technological innovations to better segment their market landscape in terms of product and consumer preferences [Guo & Poole 2009]. The moment a product is clicked on the website, the retailer finds out there is interest shown by a customer in the product. In addition to instant information, e-commerce websites learn consumer behavior from the transaction data by simulating models and patterns. Moreover, retailers face difficulties in attracting customers' attention using existing technologies and are on the lookout for new technologies that will provide an enriching experience for their customers [Kallweit et al. 2014]. AR is one such immersive technology that facilitates virtual interaction of consumers with individual products [Pous et al. 2013]. Recently, investors poured $1.7 billion into AR technology, with several companies such as Google, Apple, and Facebook investing heavily to join the AR technology bandwagon, and other companies such as Alibaba, Microsoft, HTC, Sony, and Samsung building their AR technology in-house [Widmer 2017]. Innovative e-retailers like Zugara and LazyLazy.com have integrated AR motion capture technology in their e-commerce websites to enhance the shopping experience for their consumers [Kang 2014].

Since AR is likely to disrupt the e-commerce industry with its ability to personalize and enhance the shopping experience for consumers by visualizing their purchases, this emerging technology is drawing research attention in the domain of e-commerce [Kang 2014; O'Brien 2010]. Recent studies on AR in e-commerce have discussed consumers' perspectives, focusing on how AR facilitates consumer experiences, consumer engagement, and consumer awareness during online shopping [O'Brien 2010]. For example, some studies have discussed the role of AR in making online shopping a fun-filled experience for online consumers [Huang & Benyoucef 2013; Kang 2014]. Other studies have discussed the role of AR in enhancing consumer awareness for goal-oriented and rational consumers who visit the portal with a clear awareness of the product to be bought [Parboteeah et al. 2009]. As AR technology gives consumers an opportunity to interact with their potential purchase product, it eases out the biggest hurdle often faced by online consumers of determining whether a certain product is right for them and thus increases the positive attitude toward purchase decisions [Alpert et al. 2003; Huang & Tseng 2015; Van Krevelen & Poelman 2010].

Although AR has been shown to extend the human capabilities of perception and simulate traditional shopping activities, few e-commerce firms are actually using AR technology [Tutunea 2013]. Also, despite the huge potential of AR technology in online shopping, research on the subject is very limited (see Appendix A). Furthermore, the research on AR is generally about developing or reviewing AR technologies, rather than investigating user behavior and acceptance of AR technologies [Harborth 2017]. Notwithstanding the research on acceptance of AR technology from *consumers' perspective* and realizing the low adoption of AR technologies by e-commerce firms, this issue is broadly unexplored by researchers in the field of e-commerce. Therefore, research is needed in this area of interest. Motivated by this significant research gap and taking the TOE framework [Tornatzky & Fleischer 1990] as the theoretical basis, we explore the key factors that facilitate e-commerce firms to effectively develop adoption intentions for AR technology.

2.2. Technology–Organization–Environment (TOE) Framework

There are several theories on technology adoption used in IS research [Wade & Hulland 2004]. The most used theories are the technology acceptance model (TAM) [Davis 1986, 1989; Davis et al. 1989], theory of planned behavior (TPB) [Ajzen 1985, 1991], unified theory of acceptance and use of technology (UTAUT) [Venkatesh et al. 2003], diffusion of innovations (DOI) [Rogers 1995], and the TOE framework [Tornatzky & Fleischer 1990]. Among these theories, only DOI and TOE framework are firm-level theories, whereas the TAM, TPB, and UTAUT are at the individual level. Our study is arranged to understand the adoption intentions at the firm level, and so DOI and the TOE framework are the obvious choice of theories for our research.

Past research on information technology (IT) adoption has widely used the DOI by Rogers [1995] and TOE framework by Tornatzky and Fleischer [1990] to study the adoption of technological innovations by firms. DOI is a commonly used theory for technology adoption, as it includes several technological characteristics such as relative advantage, complexity, compatibility, observability, and trialability that may either promote or weaken the adoption of technology [Fichman 2004]. DOI is accepted by several researchers as being able to recognize the perceived critical characteristics of innovations in technology that may influence the likely adaptors or rejecters of IS [Hoti 2015]. However, it is debated that the DOI model needs to be combined with other contexts or aspects for a better understanding of technology adoption [Sila 2013; Zhu et al. 2003]. Technology characteristics alone are insufficient

to produce competitive advantage for the firm. Instead, they need to be combined and coordinated with other organizational and environmental resources to produce business value [Mata et al. 1995; Wade & Hulland 2004].

The TOE framework has been adapted by several technology adoption studies, since it provides a useful analytical framework for studying the adoption and assimilation of different types of IT innovation [Oliveira & Martins 2011]. The TOE framework encompasses *technological*, *organizational*, and *environmental* factors to study technology innovation adoption at the firm level [Sila 2013]. The *technological context* (e.g. availability of technologies and technology characteristics) deals with the appropriate technologies available to the firms, whereas the *organizational context* deals with the organizational features and resources such as hierarchy, volume, structure, type of business, etc. The third component, the *environmental context*, describes the environmental attributes such as government regulations, consumers, competition, etc. The TOE framework is consistent with the DOI theory, which emphasizes individual characteristics, and both the internal and external characteristics of the organization as drivers for organizational innovativeness. These are identical to the technological and organizational contexts of the TOE framework. In addition to the technological and organizational contexts, the TOE framework encompasses the environmental aspects, which are not considered in the DOI model. The environmental context presents both constraints and opportunities for technological innovation.

In this study, we use the TOE framework as the theoretical lens to understand the adoption intention of innovative AR technology by organizations for e-commerce. The TOE framework is a well-defined framework with a solid theoretical basis and consistent empirical support, and it provides a useful analytical framework that can be used to study the adoption of different types of IT innovations (see Appendix B); therefore, it became one of the most frequently used guiding theories in technology adoption research [Sila 2013]. The TOE framework has a robust theoretical base, making it a better choice to study the technological innovation adoption of a firm [Oliveira & Martins 2011].

Although the TOE framework has been broadly used to study organizational adoption of innovative technologies (see Appendix B), it has not yet been used to specifically study the adoption intention of AR technology by e-commerce firms. AR technology is relatively similar to other digital technologies in the sense that it is used primarily through smartphones and is highly engaging for consumers, yet it is very different from other innovative technologies used in e-commerce firms in terms of the complexity and innovation involved in effective usage and integration with e-commerce firms. It moves beyond the usage of pure data or traditional media types and incorporates the use of 3D product models, which are overlaid in the real world through the mobile device, trackers to give seamless AR experience, and constant innovation in software to compete with the current mobile AR experiences [Williams 2016]. These are created by the AR service provider. Thus, this technology differentiates itself from other innovative technologies by offering an immersive and personalized experience to customers and calls for research attention. Firms need to weigh opportunities for adoption of AR judiciously according to its benefits, relevance, and ability to embrace such new innovative technology. Since no prior IS research has examined the nuanced influence of AR technology and its adoption by e-commerce firms using the TOE framework, we intend to contribute to both IS research and practice through this study.

Even though the TOE framework has been widely used by previous researchers and has been applied to several IS innovation domains, the specific factors identified within the three contexts (technological, organizational, and environmental) may vary across different studies [Oliveira & Martins 2011; Teo et al. 2006, 2009a]. In our study, the framework was operationalized by technological competence and relative advantage under the *technological context*; decision-makers' knowledge, financial strength, and top management support under the *organization context*; and consumer readiness and competitive pressure under the *environment context* (for definitions, see Appendix C). It is vital to evaluate the above-cited parameters to determine the ability of a firm to adopt innovative technology such as AR [Chau & Tam 1997]. The rationale for selection of the factors under each context for AR adoption by e-commerce firms is specified below.

3. Research Model and Hypotheses

Figure 1 presents the proposed research model based on the TOE framework, which theorizes the role of technology, organization, and environment for the adoption intention of AR technologies by organizations and simultaneously specifies the factors associated with them.

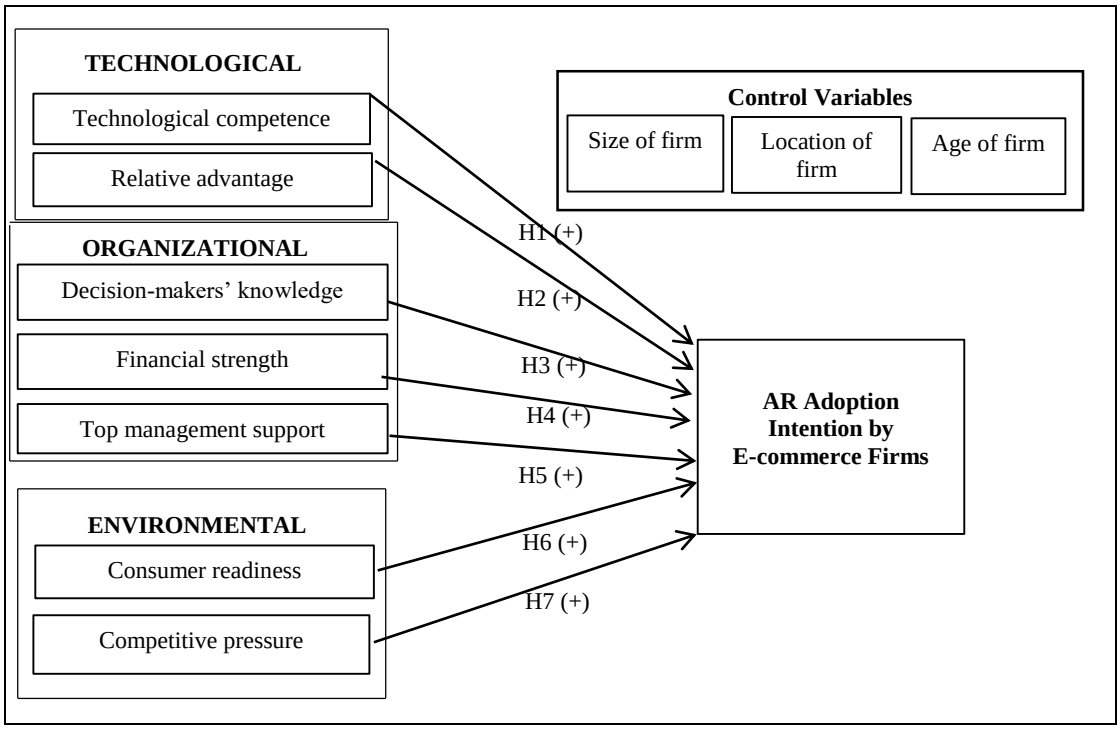

Figure 1: Research Model

3.1. Technological Context

The technological context includes the internal and external technologies relevant to the firm, thus encapsulating both the current practices and equipment internal to the firm as well as the available technologies external to the firm [Oliveira & Martins 2011]. For effective adoption of new technology from the technological point of view, the firm should consider the technologies on the market as well as the technology it is using in its operations. The present system in use will be one of important measures for considering the adoption of new technology. Innovation can be incremental, synthetic, or radically discontinuous in nature. Incremental innovation represents adding features to the existing technology landscape. Synthetic innovations are ideas that bring out a new usage pattern for existing technology, and radically discontinuous innovations are those wherein the new technology completely replaces the way in which any task was performed earlier [Baker 2012]. Although the adoption of AR technology seems to be synthetic in view of enhancing the user interface, it is a radical change that an organization should undergo in terms of the volume of effort and expenditure considered.

As new technology such as AR continues to radically disrupt industries, it can sometimes be overwhelming if the firm is not technologically competent to handle the new technologies [Wright 2017]. Moreover, it is extremely critical for the firms to understand the competitive advantage that the new technology offers in relation to the existing technologies, as companies are hesitant to explore new technologies [Wright 2017]. Hence, the two factors we study under the broad dimension of technological context are *technological competence* and *relative advantage*.

3.1.1. Technological competence

Technological competence refers to the firm's technical competencies, including IT infrastructure and IT human resource capabilities [Zhu & Kraemer 2005]. Technological competence can be acquired by comparing the IT proficiency of the firm to that of competitors or industry standards. The availability of systems in the market, considered as the technological maturity that is prevalent in the industry, attributes to the competency of the firm [Oh et al. 2009]. Firms inclined towards innovation have a tendency to support new technology adoption [Anandarajan et al. 2002]. In addition, the technology competence of a firm also comprises the technical competency of its employees and their training and development to adopt new technologies [Curran 2017]. The higher the technological competence of a firm, the more likely it is to accept new technologies [Zhu et al. 2002].

In the context of AR technology in e-commerce firms, if the e-commerce firms wish to integrate AR into their e-commerce mobile app, they need to enhance their technological competency by developing 3D product models using 3D modeling software and have a strong research and development team [Lindsay 2017]. If the e-commerce firm is technologically competent, it will be confident enough to adopt new technologies such as AR. For example, large

technologically competent firms such as Apple and Snap Inc. (Snapchat) have been in the news lately for acquiring AR start-ups [Loizos 2016; Wolde 2015]. Hence, we hypothesize:

H1: The level of technological competence is positively associated with the adoption intention of AR by e-commerce firms.

3.1.2. Relative advantage

Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes [Rogers 2003]. Information technology is a powerful instrument to gain a sustainable competitive advantage [Colgate 1998]. Past research shows an affirmative relationship between the perceived gain of using the technology over the competition (relative advantage) and adoption of information system innovations [Oh et al. 2009]. Thus, innovative practices and technology implementations give a firm a sustainable advantage over its competitors [Greathouse 2016].

In the context of AR in e-commerce, it is critical for e-commerce firms to understand the competitive advantage offered by AR to differentiate themselves amongst their competitors and to adopt creative methods to cater to their consumers. In fact, some retailers are adding novelty to their retail by incorporating AR to handle the intense competition between physical and online marketplaces. For example, Eyewear retailer Warby Parker differentiates itself from competitors by using AR technology to allow shoppers to try items on before a purchase, while retailers such as Nordstrom use AR technology to distinguish themselves from competitors by offering a fully personalized shopping experience based on the individual shopper's style, sizes, and preferences [Chen 2016]. As the firms begin to realize the benefits of AR by gaining a competitive advantage over their competitors, they will be willing to invest in AR technology early and would willingly adopt the technology. Hence, we hypothesize:

H2: The relative advantage of AR is positively associated with the adoption intention of AR by e-commerce firms.

3.2. Organizational Context

Organizational context refers to the descriptive measures about the organization, such as its scope, size, managerial structure, and organizational resources [Oliveira & Martins 2011]. Past research has established the key role of organizational structure in the innovation adoption process [Burns & Stalker 1962; Daft & Becker 1978]. Although a decentralized organizational structure with a degree of fluidity in responsibilities for employees and lateral communication amongst them is critical for effective adoption of new technologies [Baker 2012], past research also emphasizes formal reporting relationships and centralized decision-making for implementing new technologies [Baker 2012; Zaltman et al. 1973]. Decision-makers should have enough cognitive skills and knowledge to understand their own organization, their customers' needs, and new technologies [Brynjolfsson & Hitt 1996]. Their role is critical in fostering innovation within organizations [Bartel & Lichtenberg 1987; Bartel et al. 2007].

Additionally, although organizational resources in terms of people, equipment, technology, and information are important for fostering innovation within an organization, financial resources are probably the key element in fostering innovation and implementing new processes, products, or services. This is because implementing new technologies requires investments that go beyond those needed to address immediate operational needs, and because financial resources are essential for acquiring and supporting the people, equipment, technology, and infrastructure involved in innovation [Griliches 1990; Herold et al. 2006].

Lastly, regarding the role of top management support, even though new technologies in organizations may be critical to enhance productivity, research has indicated that employees are often resistant to use new technologies largely because of poor communication about the strategic benefits of new tools by the top management and decision-makers [Knight 2015]. Top management can revamp the communication process to promote new technologies by being supportive of innovations that add up to the firm's core mission and vision and by introducing such technologies within the organization's overall strategy [Baker 2012; Tushman & Nadler 1986]. Hence, the factors we study under the broad dimension of organization are *decision-makers' knowledge* and *financial strength* and *top management support* of the firm.

3.2.1. Decision-makers' knowledge

The adopter must have the knowledge and expertise to start any innovation adoption, followed by implementation and confirmation of the decision [Hameed et al. 2012]. Individuals' knowledge and experience are considered a fundamental determinant of channel choice [Kim et al. 2011]. The decision-makers' knowledge and innovativeness play a key role in the adoption of technology; the bigger these qualities are, the more probable it is that a firm will adopt the new technology [Lin & Lee 2005; Thong 1999; Wüstenhagen et al. 2007]. In the survey EY conducted across different geographies, 81% of senior business leaders endorsed knowledge as the key success factor of a firm's innovation and growth [Green 2016].

In the context of AR technology in e-commerce, although AR has limitless potential in the e-commerce space and several top brands are leveraging this technology within their retail journey to accelerate their sales, AR comes with its unique set of challenges, which the decision-makers must be aware of to create an immersive and personalized shopping experience for their customers and keep them satisfied. For example, without high-quality 3D product

models, the consumer experience might be inferior [Williams 2016]. Moreover, because AR technology is evolving and requires constant innovation in software and hardware to keep up with the developing industry, e-commerce firms have to ensure that their decision-makers are knowledgeable and updated to adapt to this evolving technology [Williams 2016]. As e-commerce firms are able to create the best shopper experience by constantly innovating and competing with the current mobile AR experiences through the knowledge of their decision-makers, they would willingly adopt the technology. Hence, we hypothesize:

H3: The decision-makers' knowledge of AR is positively associated with the adoption intention of AR by e-commerce firms.

3.2.2. Financial strength

New technology acceptance is positively influenced by the organizational size and budget [Kim et al. 2011]. The capacity of the organization to pay for installation and any enhancement costs is a significant decision influencer [Kuan & Chau 2001]. Limited financial resources can force firms to be overcautious in their investment and capital expenditure. A vague technology investment choice can inflict severe financial consequences on the firm, which may even lead to economic failure [Ghobakhloo et al. 2011b]. Since the implementation of new technology needs long-term investment and high cost of IT setup, firms with sufficient financial resources will favor the adoption of new technologies [Pan & Jang 2008; Thong & Yap 1995]. Hence, only those firms that have access to sufficient finance are truly capable of adopting their desired technology [Ghobakhloo et al. 2011b]. For example, Amazon as an online retail megastore has a comparatively low net income; however, its stupendously high cash flow has helped it throughout its new technology initiatives and offerings [Fox 2014].

In the context of AR technology in e-commerce firms, such firms need to invest heavily in web servers for hosting the data, databases, and AR tags for points of interest (POI) in the case of tag recognition including a gyroscope and a GPS system for location-based mobile AR applications [Kounavis et al. 2012]. Thus, small businesses are evaluating the costs versus benefits of the investment [Gavurin 2016]. However, large retail firms are investing heavily in AR technology for e-commerce. For example, large technology firms like Apple and Snap Inc.; Uniqlo, a Japanese-based retail store; China's largest online grocery store Yihaodian; and Ikea have been investing heavily in AR [Augment 2017; Harborth 2017]. Consequently, financial strength is extremely important for adoption of AR by e-commerce firms. Hence, we hypothesize:

H4: The financial strength of a firm is positively associated with the adoption intention of AR by e-commerce firms.

3.2.3. Top management support

Management support has been perceived as an important facilitator of technology adoption [Kim et al. 2011]. Top management could influence new technology adoption positively by enunciating a vision and fortifying value through the firm [Ramdani et al. 2009]. The innovative nature of a firm is measured as the degree of support extended to new technology in the company. Organizational support is a significant variable for a company to introduce any new technology into the business and run it successfully [Oh et al. 2009]. In general, in a firm where the top management is greatly passionate and innovative, the management welcomes new technologies and is often prepared to take the risk. Top managers play a vital role in obtaining resources and planning for implementation [Grover 1999]. For example, a lack of top management commitment toward employee resistance to new technology adoption led to the failure of FoxMeyer, a billion-dollar US pharma entity. On the other hand, TISCO, an Indian company, through continuous management support, was successful in rolling out new technology adoption [Bano 2014; Scott 1999]. A positive attitude on the part of senior managers toward change is important to create an organizational environment that is receptive to innovation. Top management commitment and support for innovation are particularly important during the implementation phase, when coordination across organizational divisions and conflict resolution are critical [Sila 2013].

In the context of AR technology in e-commerce, these new technologies are very different from other technologies in terms of the complexity and innovation involved in using them effectively and integrating with e-commerce. E-commerce firms need to move beyond the IT efforts and make huge efforts in terms of marketing and sales to ensure the technologies resonate with the needs of the online shoppers [Chen 2016]. All this requires tremendous support from the top management of the organization. This will lead to effective adoption of AR technologies by e-commerce companies. For example, as Apple is acquiring AR startups, it also brought the AR kit to market for the developers to build AR applications for iPhones and iPads and has also put AR software in as many as a billion mobile devices through the download of the new iOS 11 operating system. Thus, by providing the right management support, Apple has created an almost-instant market for AR developers to target, resulting in enhanced AR adoption by the organization [Webb 2017]. Hence, we hypothesize:

H5: Top management support is positively associated with the adoption intention of AR by e-commerce firms.

3.3. Environmental Context

Environmental context encapsulates the environment in which a firm conducts its business, which includes its industry, competitors, and dealings with the government [Oliveira & Martins 2011; Tornatzky & Fleischer 1990]. For effective adoption of new technology from the environmental point of view, the firm has to consider the holistic view of the industry, which includes consumers, competitors, the regulatory environment, and technology vendors. In the context of AR technology in e-commerce, the two factors we study under the broad dimension of environment are *consumer readiness* and *competitive pressure*. Although other environmental factors such as government regulation and support from technology vendors can be either constructive or detrimental in nature and are vital for new technology adoption, they are not considered for this study, as they are significant for *e-commerce adoption by a firm* in general rather than *adoption of a specific technology such as AR* in conducting e-commerce operations innovatively. As these factors are significant for e-commerce adoption by a firm in general, they have already been studied for e-commerce adoption by firms [Ghobakhloo et al. 2011a; Xu et al. 2004]. However, this study moves beyond e-commerce adoption by a firm to study adoption of a new specific technology such as AR for operationalizing their e-commerce business innovatively. Consequently, the focus of the study is to understand the influence of the environmental factors *consumer readiness* and *competitive pressure* for the adoption of AR by e-commerce firms.

3.3.1. Consumer readiness

Consumer readiness is a mixture of consumers' inclination to engage with new technologies and the readiness of support technology for the customer [Zhu et al. 2003]. Researchers have explored the ability and preparedness of customers as predictors of adoption, and others have investigated customers' attitudes toward the technology as a means of predicting behavioral intentions [Lin & Hsieh 2007; Venkatesh et al. 2003; Walker et al. 2002]. This encompasses role clarity, motivation (intrinsic and extrinsic), and ability. Also, the customers' use of a new technology contributes to co-production of an innovative service, which requires customers to engage continuously in the new patterns—for example, scanning to check out the items in a grocery store has revolutionized the behavioral pattern of how a customer buys a product [Meuter et al. 2005].

In the context of AR in e-commerce, keeping online shoppers engaged as they visit online stores is of high priority for all retailers and is extremely difficult. Engaging users through AR leads to longer times spent browsing an online store, interacting with products, and testing additional functionality through AR [Williams 2016]. However, one of the most difficult challenges of AR is educating the broader market [Lindsay 2017]. Consumers are not exposed to AR regularly and do not see its wide-reaching applications in their daily lives. As the consumers get ready to use AR effectively, the e-commerce firms will be motivated to adopt it to give consumers a better shopping experience. Hence, we hypothesize:

H6: Consumer readiness is positively associated with the adoption intention of AR by e-commerce firms.

3.3.2. Competitive pressure

The industry structure and the number of companies currently using the technology will influence adoption of new technology, as firms will act fast to make sure that they stay ahead in the race. Competition intensifies the need and opportunity to adopt innovative technologies in businesses. Firms that compete aggressively with their rivals embrace technology innovations to be able to shrink their costs [Oh et al. 2009]. Competitive pressure has been recognized as one of the constraints that a firm considers when determining the adoption of new technologies [Zhu et al. 2003]. According to Oh et al. [2009], successful implementation of technology innovations in an organization also depends on the mutual relationship of innovative characteristics prevalent in the industry and those of the adopters. For example, Canon faces stiff competition from its rival Nikon, which has driven the firm to differentiate itself from a highly standardized and commoditized product of digital cameras. It has encouraged the company to come up with launches of printers, copiers, etc. as a diversification [Martin 2014].

In the context of AR technology in e-commerce, retailers such as Nordstrom have distinguished themselves from competitors by offering a fully personalized shopping experience, guided by a knowledgeable curator who knows an individual shopper's style, sizes, and preferences. AR has the potential to deliver these personalized services to the masses, which may influence the adoption intention of AR by e-commerce firms [Chen 2016]. Hence, we hypothesize:

H7: Competitive pressure is positively associated with the adoption intention of AR by e-commerce firms.

4. Research Method, Data, and Analyses

To test the research model in Figure 1, we first developed a survey instrument with items on a five-point Likert scale, ranging from strongly disagree to strongly agree. The survey instrument was constructed by identifying relevant measurements from a comprehensive literature review. To ensure the content validity, the scales for different measures were adopted from prior research in the context of the adoption of technology innovation, as seen in Appendix D. The questionnaire so framed was then pilot tested for readability and ability to express the research intention.

The sampling frame comprised of high-ranking managers involved in decision-making (such as CEO, director, founder, or senior managers) in firms with e-commerce operations in their business and who are familiar with AR technology but have yet to adopt this technology for their firms. This was indicated as the qualifying criterion for the respondents, enforced via a question in the survey. We first contacted 300 managers from firms employing e-commerce operations through an initial mailing list of companies prepared mostly from India and Singapore, requesting them to participate in the online survey. Prior to sending them our request to participate in the survey, we reviewed their profile and the company details through the Internet. The firms included in our mailing list spanned different industries such as retail, finance, and technology; however, all the selected firms had e-commerce operations. This was the selection criterion for the firms when the initial mailing list was prepared. Upon confirming the firm having e-commerce operations and the respondents being top managers from these firms, we requested their participation in the survey through an online survey link. We also conducted a paper-based survey with a few respondents in Singapore who agreed to participate but were too busy to complete the online survey. In addition to the mailing list from India and Singapore, we also got a few respondents from companies with e-commerce operations in the USA through personal connections. All the respondents were top managers from firms running e-commerce operations. We asked the respondents if they were willing to adopt AR technology for their e-commerce business. In the instructions given to the respondents, we asked them to respond to the questions by keeping their firm in mind. Of the 300 managers contacted from India, Singapore, and the USA, we received responses from 242 participants, of which 107 were usable, with a response rate of 44.2%; we excluded incomplete questionnaires and/or respondents who did not meet the qualifying criterion from our analyses.

In addition to the focal research variables, we incorporated suitable control variables in the research model (Figure 1). The control variables are the features of the potential adopters that might influence their adoption of AR technology. Controls used in this study were the size of the firm, location, and age of the firm [Barbera 2013; Ilaboya & Ohiokha 2016; Trencansky & Tsaparlidis 2014]. Firm size has been shown to be an important organizational attribute for innovation diffusion, with larger firms making more investments in technology innovations [Rogers 1995; Zhu et al. 2003, 2006]. Also, as the responses were gathered from managers of firms located in three different countries and the firms had varying numbers of years since they were established, it was important to control these variables to avoid any potential misinterpretation or deviations in the results.

For our data analysis, we used partial least squares (PLS), a latent structural equation modeling (SEM) technique, as implemented in SmartPLS 2.0, which utilizes a component-based path modeling application [Ringle et al. 2005]. PLS makes minimal demands in terms of sample size, measurement scales, and residual distributions compared to other SEM techniques (e.g. LISREL, EQS, or AMOS) [Chandra et al. 2010, 2012; Teo et al. 2009b]. Various IS studies have employed PLS and have found it to be an effective method of analysis [Chandra et al. 2012; Hsieh & Tseng 2018; Liang et al. 2007; Srivastava & Chandra 2018]. The present study achieved a 95% confidence interval across 500 bootstrap resamples.

5. Results

5.1. Demographics

Table 1 provides the demographics of the survey respondents. The sample was comprised of 76% large organizations and 24% small organizations, with an adequate representation from "well-established firms," being 10 or more years old (80%), and "stably established firms," being 5 to 10 years old (11% of the population). Further, the firms participating in the survey were mostly in Asia, with 51.4% running their operations in Singapore and 43% in India. In addition, 5.6% of firms participating in our survey were from the USA.

Table 1: Demographic Profile of Survey Respondents

Demographic Variable	Category	Frequency [N=107]	Percentage (%)
Size of firm	More than 200 employees	81	76
	Less than 200 employees	26	24
Years since establishment	1–5 years	9	8
	5–10 years	12	11
	10 years	86	80
Location of firm	Singapore	55	51.4
	India	46	43
	USA	6	5.6

5.2. Measurement Model

In line with recommendations [Anderson & Gerbing 1988; Hair et al. 1998], we followed a two-stage analytical procedure, in which the first stage included confirmatory factor analysis to study the measurement model and its robustness, followed by structural relationship analysis to establish the relationship between the dependent and independent variables.

To assess the robustness of the measurement model used in the study, three types of validity examination—content validity, convergent validity, and discriminant validity—were conducted. Content validity was examined to establish the consistency of the measurement items with the existing research literature, followed by pilot testing of the instruments [Bock et al. 2005; Chandra et al. 2010]. To examine the extent to which different items used to measure the hypothesized constructs are measuring the same concept, a convergent validity test was conducted [Chandra et al. 2010; Srivastava & Teo 2007]. To carry out convergent validity, composite reliability (CR) and the average variance extracted (AVE) were examined for the measures, AVE being the ratio of construct variance to the total variance among indicators [Hair et al. 1998]. Previous studies that have used PLS for the analysis have considered 0.5 as the measure for the threshold for CR. However, the suggested threshold for reliable measurement is 0.7 or above, as per Chin [1998]. The CR values ranged from 0.86 to 0.95 for the measures, as seen in Table 2. Similarly, the recommended threshold value for AVE is 0.5 [Fornell & Larcker 1981]. As shown in Table 2, the AVE measures ranged from 0.68 to 0.89, which is well above the acceptable values.

Finally, as recommended by Fornell and Larcker [1981], the discriminant validity of the independent variables was examined by finding the square root of the AVE. The results mentioned in Table 2 confirm discriminant validity. The measures of the square root of the AVE seen on the diagonal of Table 2 are all greater than the inter-construct correlations (the measures in the off-diagonal cell entries in the table). This demonstrates satisfactory convergent and discriminant validity. Further, the cross-loadings of items on other constructs (Appendix E) are quite low, which indicates appropriate discriminant validity. The other factors that were identified—financial strength and competitive pressure—did not satisfy the validity test; hence, those constructs were removed from further analysis.

Finally, as shown in Table 2, we observe that none of the correlations among the independent and control variables are above 0.80. Therefore, we conclude that there are no serious problems of multicollinearity confounding the results (Chandra et al. 2012; Gujarati 2003). Furthermore, we also tested for multi-collinearity among the independent variables by examining the variance inflation factor (VIF). The resultant VIF values for all of the constructs were between 1.64 and 2.70, which are all below the conservative acceptable value of 5 [Allison 1999; Belsley et al. 1980; Chandra et al. 2010].

Table 2: Descriptives and Correlations

	CR	AVE	CA	Mean	SD	AI	CR	DMK	RA	TC	TMS
AI	0.95	0.87	0.92	3.40	1.14	**0.93**	0.62**	0.60**	0.67**	0.60**	0.77**
CRE	0.88	0.71	0.79	3.36	1.06	0.62**	**0.84**	0.53**	0.54**	0.51**	0.51**
DMK	0.93	0.87	0.85	3.14	1.12	0.60**	0.53**	**0.93**	0.62**	0.51**	0.74**
RA	0.93	0.86	0.84	3.36	1.10	0.67**	0.54**	0.62**	**0.93**	0.55**	0.68**
TC	0.86	0.68	0.77	3.49	1.18	0.60**	0.51**	0.51**	0.55**	**0.82**	0.50**
TMS	0.94	0.89	0.88	3.16	1.08	0.77**	0.51**	0.74**	0.68**	0.50**	**0.94**

Key: AI: adoption intention; CRE: consumer readiness; DMK: decision-makers' knowledge; RA: relative advantage; TC: technology competence; TMS: top management support
CR: composite reliability; AVE: average variance extracted; CA: Cronbach's Alpha; SD: standard deviation
Note: The numbers highlighted in bold on the diagonal represent the square roots of the average variance
**p<0.05; **p<0.01*

5.3. Common Method Bias

Because the data on all the variables for this research were self-reported and collected through the same questionnaire during the same period of time with a cross-sectional research design, it is important to test for any possibility of common method bias. Variance occurring due to the measurement method may cause systematic measurement error and further bias the true relationship among the theoretical constructs [Chandra et al. 2012]. We performed statistical analysis to assess the severity of common method bias in the data. First, we performed Harman's one factor test [Podsakoff & Organ 1986]. We loaded all the variables in the study into exploratory factor analysis and examined the factor solution to determine the number of factors essential to account for the variance in the variables [Podsakoff et al. 2003]. The test indicated the presence of four factors accounting for a total of nearly 70% of the variance. Because a single factor did not emerge and one general factor did not account for most of the variance, we conclude that common method bias is not a significant problem with the data [Podsakoff et al. 2003]. Second, we

adopted the technique recommended by Liang et al. [2007] using PLS to assess the magnitude of common method bias in the data. We did this by introducing a common method factor whose indicators included all the principal constructs' indicators and calculated each indicator's variances substantively explained by the corresponding principal construct and also the common method factor. As Appendix F shows, the average substantively explained variance of the indicators is 0.895, whereas the average method-based variance is only 0.011. The ratio of substantive construct variance to common method variance is about 81:1. Further, most method factor loadings are not significant, which indicates that common method is not a serious concern for this research [Liang et al. 2007]. These tests helped us preclude the possibility of common method bias contaminating the results from this research.

5.4. Structural Model

After establishing the validity of the measurement model, the proposed hypotheses were examined using PLS. The analysis results are shown in Figure 2. The high variance of 74% explained by the model shows the robustness of the proposed AR adoption model. Upon assessing the antecedents, which were framed under the TOE framework, the first antecedent, technology competence, framed under the technology context has a significant relationship with the adoption intention of AR ($\beta = 0.21$, $t = 2.64$, $p < 0.01$), thus establishing the strong positive association hypothesized in H1. Similarly, the relationship between the relative advantage that would be gained by implementing AR technology, which was constructed under the technology context, and the adoption intention of AR was again proved to have a significant relationship ($\beta = 0.19$, $t = 2.05$, $p < 0.05$), thereby establishing the positive association hypothesized in H2.

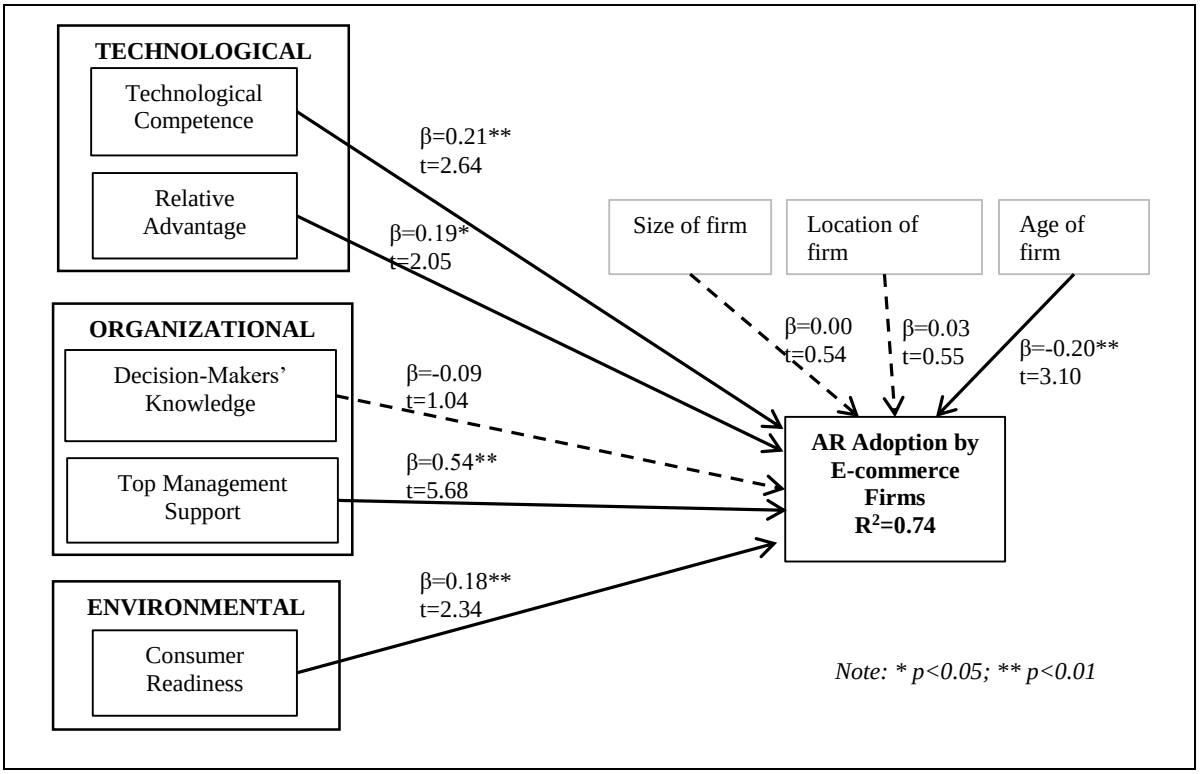

Figure 2: Research Model—Results

Next, we examined the outcomes for the organizational context variables. Decision-makers' knowledge was one of the three antecedents that we considered under the organizational context, and its relationship with the adoption intention of AR proved not to be significant ($\beta = -0.09$, $t = 1.04$, $p > 0.05$), thereby refuting hypothesis H3. This is a surprising non-significant relationship, and the reasons, we think, might be because we have considered larger firms and the firms are customer-centric, making value addition for the customers the priority. This will be discussed further in the following sections. Another antecedent we considered under the organizational context is top management support; the relationship it has with the dependent variable adoption intention of AR is significant, as expected ($\beta = 0.54$, $t = 5.68$, $p < 0.01$), strongly establishing hypothesis H5. The final antecedent that passed the validity test was consumer readiness; its relationship with the adoption intention of AR shows a significant relationship ($\beta = 0.18$, $t = 2.34$, $p < 0.01$), thereby establishing the relationship hypothesized in H6. The control variable age of the firm is

negatively associated with the adoption intention of AR (β = -0.20, t = 3.10, $p < 0.01$), while the size and location of the firm do not show a significant relationship with adoption intention. As financial strength and competitive pressure did not fulfill the validity requirements, they were dropped from the final model testing, and hence H4 and H7 were not tested.

6. Discussion

Results of the analysis indicate that the technological variables of technological competence and relative advantage, organizational variable of top management support, and environmental variable of consumer readiness are important variables influencing the adoption intention of AR technology by e-commerce firms, thereby supporting hypotheses H1, H2, H5, and H6. The two *technological variables* identified for the study were technological competence and relative advantage. *Firstly*, findings of the study showed technological competence has a strong impact on AR of e-commerce firms. Thus, our study confirms that technological competence of e-commerce firms is cruicial for the adoption intention of new technologies such as AR. The results are consistent with previous studies in the context of other technologies, such as e-commerce [Trainor et al. 2011] and mobile marketing [San-Martín et al. 2016]. Since AR is a growing technology facing frequent changes in terms of the development environment, use cases, etc., having technologically competent IT professionals who can continuously keep track of changes and upgrade to develop a solution to implement the technology is inevitable. *Secondly*, relative advantage was found to have a strong impact on the AR adoption intention. The purpose of any firm that makes an investment in technology implementation is to differentiate its position in the market and to create a sustainable competitive advantage. The technology implementation can be justified if the invested company is able to save its costs or reduce its risk, or if it creates a new stream of revenue generation by attracting customers and retaining them. Some of the benefits of the AR technology include providing AR consumers with a unique and fun-filled experience and the ease to envision the item they are considering buying, thus attracting more customers [Kang 2014; Retail Perceptions 2016].

The *organizational variables* identified for the study were decision-makers' knowledge, financial strength, and top management support. *Firstly*, regarding decision-makers' knowledge, although past studies have shown employees' knowledge as a significant factor for the adoption of technologies such as e-commerce [Mirchandani & Motwani 2001; Scupola 2009], surprisingly, this factor showed a non-significant relationship with the adoption intention of AR technology. One possible explanation for the insignificance of decision-makers' knowledge for the adoption of AR technology for e-commerce firms is that most firms are influenced by factors relevant to the external business environment, such as the relative advantage of the AR technology in attracting consumers or the need for the consumers to visualize the product before buying, rather than by the internal decision-makers' perspectives [Bhattacharya & Wamba 2015]. Another possible explanation could be the relative newness of the AR technology, which might contribute to the lesser degree of knowledge of decision-makers who prefer to take fewer risks in implementing AR technology in their business [Bhattacharya & Wamba 2015]. The *second* organizational factor is financial strength. The financial strength is extremely critical for any technological innovation in a firm; it determines the financial, technical, and managerial resources of the firm, which would facilitate the innovation initiation of a firm [Rogers 1995; Zhu et al. 2006]. However, the measurements of this construct did not fulfill the validity criteria in our study, and the factor had to be dropped from further analysis. The *third* organizational variable identified for the AR adoption intention by e-commerce firms, top management support, was consistent with the previous studies that established the key role of top managers in developing positive perceptions towards technological innovation, such as cloud computing [Borgman et al. 2013; Oliveira et al. 2014], e-procurement [Teo et al. 2009a], enterprise system [Ramdani et al. 2009], and e-commerce [Stockdale and Standing 2006]. In fact, the top management in a firm is significant for adoption of any technological innovation by supporting money and resources [Oliveira et al. 2014]. Since the top management decides the overall company strategy, its vision and attitude toward the technology are decisive for AR's existence in the company's value chain.

Lastly, regarding the *environmental factors* of consumer readiness and competitive pressure, consumer readiness exhibited a significant relationship with the dependent variable adoption intention of AR. For any technology to be successful, it is important that the end user perceives it to be beneficial and receives it well. This illustrates the customer's willingness to adopt a new technology. This result can be viewed as in concurrence with earlier studies carried out in the customer context establishing the perceived ease of use and perceived usefulness [Huang & Tseng 2015]. However, although competitive pressure is suggested to be a predictor of adoption of new technologies such as radio frequency identification (RFID) [Brown & Russell 2007; Sharma et al. 2008; Wang et al. 2010] and e-procurement [Teo et al. 2009a], it could not meet the validity criteria in our study and hence had to be dropped from the final analysis on AR adoption.

Holistically, the results highlight the importance of the factors considered and validate the implications for the adoption of AR technology. Therefore, these factors must be taken into consideration by both e-commerce firms and

AR vendors when building an AR-based solution and implementing it. However, future research incorporating additional factors can be conducted to improve the accuracy and dynamism of the proposed model.

7. Implications

Despite the much-hyped expectation in terms of value delivery by AR technology and increasing use cases, there is still slack in the mainstream adoption of AR technology in retail space [Xiao-Jun et al. 2013]. Literature in the past, written from the customer perspective, suggests that the perceived usefulness and perceived ease of use of any new technology are important factors for its adoption. However, in an organizational context, technology itself, along with environmental and inter-organizational traits, plays a significant role in the adoption of AR technology by an e-commerce firm. It is not only important to understand the factors that influence the adoption intentions of AR, but it is imperative to understand the ways in which a firm can address and handle such factors to build a business model to increase its overall value delivery efficiency and gain competitive advantage. This research is predicated on these significant theoretical and practical problems related to AR adoption. Our current study examines the factors that influence adoption of AR in e-commerce firms by analyzing the scenario in three dimensions of the TOE framework: the technological, organizational, and environmental contexts. In addition to being one of the first studies to investigate this dynamic and contemporary research problem, the paper outlines some important implications for both research and practice.

7.1. Implications for Research

First, the current state of AR research in the IS field is sparse. Also, the research so far is mostly from the technological understanding and advancement of AR [Harborth 2017]. Technological aspects are important for future developments of AR, but acceptance and adoption of AR technology are also critical, falling in the natural domain of IS research [Harborth 2017]. This research augments insights from IS by understanding the organizational acceptance and adoption of this innovative technology. As AR research in the domain of IS is sparse, this study contributes theoretically by setting the foundation for future research in this area. *Second*, prior research on AR has studied its adoption from the *consumer's perspective* using well-established adoption theories such as DOI [Rogers 1995] and the TAM [Davis et al. 1989]. This is one of the first studies to present an AR adoption model grounded on the TOE framework. The validated model shown in Figure 2 can be used as a direction for future research to study the technology adoption intention of e-commerce firms. The research suggests the key role of *technological*, *organizational*, and *environmental* contexts for the adoption of AR by e-commerce firms. The study extends the literature on AR technologies. It will be instrumental in increasing the interest of future researchers in implementation and management of AR technologies. *Third*, the study highlights the factors that can influence the adoption intentions of technologies like AR. We extend the literature on different factors along with literature on AR itself by presenting a framework that provides a theoretical basis for understanding the antecedents of adoption intentions in the context of AR. Future research can examine these characteristics in depth to expand the list. *Fourth*, the study highlights the significance of studying the adoption of technologies from an organizational perspective. Future research can study the organizational perspective of acceptance and adoption of new technologies. *Fifth*, the research presents a validated research model for the adoption intention of AR by e-commerce firms. The framework can be used to study the adoption of other technologies such as virtual reality and virtual worlds for e-commerce in organizations.

7.2. Implications for Practice

In addition to having implications for research, the study has various important implications for e-commerce firms, AR vendors, and IS technologists. *First*, although the 21st century is a technology-driven era and online companies are trying to innovate to survive in the cut-throat competition, the e-commerce technology arena still lacks new developments. Several companies are moving toward launching apps for wearables; however, one area that holds plenty of potential and is still not tapped to the fullest is AR technologies. The current study is predicated on this gap. For example, at present, if someone has to buy a pair of sunglasses online, the most sophisticated e-commerce sector technologies will provide an ability to upload his/her picture and use basic tools to give the consumer a feel for how he/she looks in them. AR technology can take the consumer's online experience to the next level by accessing the user's webcam/front camera in real time and automatically positioning the pair of glasses on his/her face to give a natural buying experience. Similarly, retailers can provide interactive advertisements with AR technologies using smartphone interfaces such that consumers can experience the product in real time and even make purchases there and then. This paper emphasizes the significance of AR technologies and what factors companies should consider to facilitate easy adoption of this interactive technology in their business model.

Second, the study unambiguously highlights factors that are key drivers for the adoption of AR systems and urges practitioners, AR vendors, and technologists to seriously consider these factors for successful adoption of AR for better value delivery. AR technologies differ from other technologies in terms of complexity, level of innovation, and effort required to integrate with e-commerce. Past studies have highlighted the role of ease of use and perceived

usefulness for the consumer adoption of new technologies. However, this study emphasizes that for AR—in which the technology expertise, environmental support, and organizational qualities of the firm are crucial and exhibit diverse characteristics—the acceptance must be thoroughly studied in the provided context to understand the applicability and value creation.

Third, the study emphasizes not only the potential of AR but also the role of an organization's top management in implementing such a technology. If the organization's top management is determined and focused on the technology implementation and has clarity on value creation and capturing methods of the new implementation, it will be more conducive for the adoption to take place and to achieve results. For example, beauty retail such as FaceCake uses AR technology to allow users to visually search any beauty look, and adoption of such technologies is possible only because of the top management support. FaceCake's CEO Linda Smith and top management strongly support the use of AR technology in their business model [Weinswig 2016].

Fourth, the research suggests that technology competence is one of the key factors for successful adoption of AR by organizations. A firm must concentrate on its internal capacity building and should continuously seek to monitor the industry landscape for new technology and keep upgrading.

Fifth, the study highlights that AR vendors must understand their clients, their customer base, and their readiness to accept such technologies. Vendors, upon studying the market landscape, can create demand for their products. Also, the vendors must propose the competitive advantage that a firm can gain over other players upon implementing AR technology. For example, as mobile sales are expected to reach $626 billion by 2018 and consumers are moving towards m-commerce, e-commerce organizations are proposing AR apps that connect digital content with the real world [Singh 2015]. This trend was adopted by the Times Group in India, which realized that India has 54% of smartphone users who engage in m-commerce and so developed the AR "Alive app," which recognizes images, QR codes, logos, locations, etc. and makes them live on the smartphone [Singh 2015].

The results in general highlight that technology and inter-organizational traits play a significant role in influencing new technology adoption intentions. In summary, it is vital for e-commerce firms, AR vendors, and industry experts to proactively consider the technological, organizational, and environmental contexts, as well as to have a clear business vision to differentiate themselves in the market to create and sustain competitive advantage. The stakeholders must devise an inclusive business strategy to create value upon the adoption of AR technology in their existing business model.

8. Limitations of the Study and Future Scope

Although this study makes substantial contributions in terms of better understanding the landscape from an organizational standpoint, there are a few limitations. Firstly, exploring factors affecting AR adoption from an organizational viewpoint is a fairly new area in IS research. The observations and their inferences were derived from a targeted survey of potential adopters. Therefore, generalizing the results can be viewed as an issue. The research highlights the significant factors affecting the adoption intention of AR, but more research is required on this subject to uncover further dimensions. Secondly, even though we have found a few variables that influence the adoption of AR technology, upcoming revisions may discover additional factors to improve the capability of the model. It might be rational to add maturity of technology, pricing standardization, and the product or service function that is to be transformed into the existing business model as additional decision variables. For example, technology adoption can fail if the perceived technology lacks direction [Lawrence 1997]. Future research can be done on this subject for different geographies, which have different regulatory and infrastructural developments. Thirdly, the research model framed is cross-sectional in nature; that is to say, with this research model, we have measured the perceptions and intentions at a single point in time. However, there is a high likelihood of changes in perception as time progresses and users get acquainted with the technology [Davis & Venkatesh 2004]. A dynamic model that is capable of predicting behavioral intentions over time would be more fitting to study AR technology, which can be one of the focuses for future research. Lastly, two of our factors—financial strength and competitive pressure—though hypothesized, had to be dropped from the final analysis, as they did not meet the specific validity criteria. Since both factors are critical for technology adoption by firms [Ghobakhloo et al. 2011b; Oh et al. 2009], future research should consider including the two proposed factors in the firm-level adoption studies of AR.

9. Conclusion

The research proposes and tests the technology adoption model of AR, which can serve as an initial step in the direction of efficacious embracing of AR by e-commerce firms. In contrast to earlier research on technology adoption conducted from the customer perspective establishing the usefulness and ease of use of the new technological system, this article highlights the key factors influencing the adoption intention of AR. The measurement model validation established the robustness of the proposed model. The conceptualization of factors influencing the adoption intention

provides direction to e-commerce firms, AR vendors, technology practitioners, and researchers to focus not only on the customer perspective but also on the organizational factors, as adoption decisions are dependent on the traits of the organization. Furthermore, the structural model examination validated the relationship between various proposed factors and the adoption intention of AR, thereby highlighting the serious need to devise appropriate strategies for successful adoption and value creation through the technology. The results of the structural relationship can serve as a starting point for e-commerce firms to formulate their strategies around the prominent factors, including technology competence, top management support, customer readiness, and relative advantage. In addition to providing an empirical validation of the proposed model grounded on the TOE framework, the paper provides several directions for researchers for further studies in this focus area of the adoption, implementation, and impact of a potentially beneficial AR technology.

Acknowledgment

The authors would like to thank B. Pushpa Rani, Shivaram Anantha Subramanian, Supreeth Bharati, and Sushma Manava for their help and support during the various stages of this study.

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APPENDIX A: Key Studies on Behavioral Research on Augmented Reality			
Author(s)	**Context of the Paper**	**Methodology**	**Key Findings**
Alpert et al. 2003	The paper studies the consumer perception of adaptive e-commerce websites.	Qualitative	Adapting the content based on the consumer preference plays a vital role in persuading consumers. The interactive data provide a wealth of information for an organization to customize the interface based on behavioral patterns. The ownership and the controlling attitude are embedded in the consumer, showing positive growth in sales, according to the study.
Huang & Liu 2014	To examine the extent to which presence, media richness, and narrative experiences yield the highest experiential value in AR interactive technology	Quantitative	Results indicate that narrative experience induces a higher experiential value than other simulative experiences, including presence and media richness.
Huang & Tseng 2015	To study the relationship of vivid memories and exploratory consumption behavior with AR technology based on script and referencing theories	Quantitative	Vivid memories created in consumers by the AR interface substantially influence consumption behavior, thereby proving the positive inclination of consumers toward AR technology.
Kallweit et al. 2014	AR as a marketing tool in the retail industry	Quantitative	This study states that AR has a positive influence on improving the perceived utility of the product. In the retail industry, AR gives an opportunity to fill the information gap and positively impact consumer satisfaction.
Kang 2014	Usage intention of AR in e-commerce and its relativity to monetary, emotional, convenience, and social values in terms of utilitarian and hedonic expectancies	Quantitative	Only utilitarian expectancies are positively related to the user's motivation to use AR technology. Efficient e-strategies must be developed by the management in order to provide customers with a better shopping experience.
Martínez et al. 2014	AR adoption and bottlenecks	Qualitative	Although AR has the potential to solve business problems in various industries, reduction of cost, relative advantage, compatibility, and trialability are some bottlenecks that could influence the adoption.
Olsson et al. 2013	To study the acceptance and success of future mobile AR by understanding the potential end users' expectations	Qualitative	User experience and central user requirements related to mobile AR were identified.
Ross & Harrison 2016	To study consumers' perceptions of AR's usefulness and ease of use, as well as their attitudes and behavioral intentions towards AR-enabled apparel	Qualitative	The results demonstrated a lack of knowledge of AR and its applications in the apparel sector. Initial reactions to the 3D graphics and text were positive, but users were concerned about privacy and security.
Tabusca 2015	To study the realities of AR in terms of technological, economical, and environmental views	Qualitative	AR technology is emerging as one of the hottest technology developments. It is not merely a marketing vehicle but offers scope to increase an organization's revenue. However, there are technical and social problems that need to be addressed.

Tutunea 2013	This paper studies the level of knowledge and socio-economic development with AR.	Qualitative	The paper states that there is a knowledge gap on AR even in developed nations. It also suggests promoting the technology to increase its market share.
Van Krevelen & Poelman 2010	This paper studies the applications and uses of AR technology in various industries.	Qualitative	AR is perceived to provide ubiquitous computing that is tactile. However, adoption of AR in daily life is subject to the elimination of limitations, such as availability, cost ergonomics, etc.
Wang et al. 2013	Business information modeling with AR	Qualitative	AR tracking, coupled with sensors, will help the BIM visualization process, eliminating the risk by prototyping the models. AR will allow the organization to make an informed decision.

APPENDIX B: Literature on TOE Framework with Examples of Similar Researches Grounded in TOE

Author(s)	IT Adoption	Analyzed TOE Factors	Methodology	Key Findings
Baker 2012	Technological innovation	Technological context → availability; characteristics Organizational context → formal and informal linking structures; communication process, size; slack Environmental context → industry characteristics and market structure; technology support infrastructure; governmental regulation	Qualitative	The intrinsic value of the firm, its characteristics, and demographical attributes of the firm constitute the organizational view of the framework. The organizational structures as centralized or decentralized affect the adoption and implementation processes. Governmental regulations can be either constructive or detrimental in nature, which is vital in new technology adoption.
Bhattacharya et al. 2018	RFID	Technological context →relative advantage; cost; complexity; compatibility Organizational context →top management support; size; IT expertise Environmental context → competitive pressure; external support; catalyst agent	Quantitative	Results of the analysis indicate that relative advantage and competitive pressure are the significant variables for RFID adoption in retail.
Chiu et al. 2017	Broadband mobile applications	Technological context →relative advantage; compatibility; complexity; trialability; observability Organizational context → top management support;	Quantitative	Top management support, competitive pressure, and relative advantage are identified as critical factors for the adoption of broadband mobile applications by enterprises.

		employees' knowledge; absorptive capability; information intensity Environmental context → competitive pressure business partner; external supports; government support		
Gangwar et al. 2015	Cloud computing	Technological context →relative advantage; compatibility; complexity Organizational context → top management support; organizational competency; training and education Environmental context → competitive pressure; trading partner support	Quantitative	Findings show that relative advantage, top management commitment, and competitive pressure are important determinants for cloud computing adoption in organizations.
Hameed et al. 2012	IT innovation	Technological context → relative advantage; cost Organizational context → top management support; organization size; IT expertise; organization readiness Environmental context → competitive pressure; partners' readiness	Qualitative	Innovation adoption includes factors from different dimensions. The organizational analysis is significant only if the environment and technological factors are considered as other factors of influence. Organizations seeking knowledge of the innovation to be adopted will be the first step toward adoption. The adopter must have the knowledge and expertise to begin any innovation adoption, followed by implementation and confirmation of the decision. TOE frameworks give insights into the organizational perspective and have become a useful method to identify the factors.
Kuan & Chau 2001	EDI	Technological context →perceived direct benefits; perceived indirect benefits Organizational context → perceived financial cost; perceived technical competence Environmental context → perceived industry pressure; perceived government pressure	Quantitative	Perceived benefits, organizational readiness, and external pressure are the major factors for technology adoption. Organizational readiness includes financial resources and the capacity of the organization to pay for installation and any enhancement costs. External pressure includes competitive pressure imposed by a firm's trading partner. The TOE model is proven for studying the adoption of technology innovation in any firm.

Oliveira & Martins 2010	E-business adoption across industries	Technological context →technology readiness; technology integration Organizational context → firm size Environmental context → competitive pressure; trading partner collaboration	Quantitative	Technological readiness, competitive pressure, and trading partner collaboration are important drivers for both the telecommunications and tourism industries. However, there are differences in the significance of the various factors between them, except for competitive pressure.
Pan & Jang 2008	ERP	Technological context → IT infrastructure; technology readiness Organizational context → size; perceived barriers Environmental context → production and operations improvement; enhancement of products and services; competitive pressure; regulatory policy	Quantitative	IT infrastructure is found to be insignificant when it comes to affecting ERP adoption. The factors in the organizational context are found to be significant. Production and operations improvement is the only significant factor that discriminates between adopters and non-adopters in the environmental context. Enhancement of products and services, competitive pressure, and regulatory policy factors are generally perceived to be of importance to ERP practice.
Ramdani et al. 2009	ERP	Technological context → relative advantage; compatibility; complexity; trialability; observability Organizational context → top management support; organizational readiness; IS experience; size Environmental context → industry; market scope; competitive pressure; external IS support	Quantitative	Firms with a greater perceived relative advantage, greater ability to experiment with these systems before adoption, greater top management support, greater organizational readiness, and a larger size are predicted to become adopters of enterprise systems.
San-Martín et al. 2016	Mobile CRM adoption	Technological context →technology competence Organizational context → innovativeness; employee support Environmental context →customer information management	Quantitative	The study confirms that the technological competence of the company (infrastructure and available technological knowledge) is key for benefits derived from the implementation of mobile CRM.

Teo et al. 2006	Deployment of B2B e-commerce: B2B firms versus non-B2B firms	Technological context → unresolved technical issues; lack of IT expertise and infrastructure; lack of interoperability Organizational context → difficulties in organizational change; problems in project management; lack of top management support; lack of e-commerce strategy; difficulties in cost–benefit assessment Environmental context → unresolved legal issues; fear and uncertainty	Quantitative	Organizational and technological inhibitors are more severe than environmental inhibitors in inhibiting the deployment of B2B e-commerce. The reasons why non-B2B firms do not deploy web-based B2B e-commerce applications are the lack of top management support and their lack of understanding of potential benefits and drawbacks relating to B2B e-commerce.
Zhu & Kraemer 2005	E-business	Technological context → technology competence Organizational context → size; international scope; financial commitment Environmental context → competitive pressure; regulatory support	Quantitative	Technology competence, financial commitment, competitive pressure, and regulatory support are found to have significant influence on the extent of e-business use. Among these, technology competence appears to be the strongest factor. Competitive pressure and regulatory support differ across developed versus developing countries. This finding confirms that economic environments shape e-business use.

APPENDIX C: TOE Framework Definitions		
Context	**Factor**	**Definition**
Technological	Technological competence	Technological competence refers to the firm's technical competencies, including IT infrastructure and IT human resource capabilities [Zhu & Kraemer 2005].
	Relative advantage	The degree to which an innovation is perceived as being better than the idea it supersedes [Rogers 2003, p. 229]
Organizational	Decision-maker's knowledge	The knowledge and expertise to start any innovation adoption, followed by implementation and confirmation of the decision [Hameed et al. 2012]
	Financial strength	Access to sufficient finance is truly capable of adopting their desired technology [Ghobakhloo et al. 2011b]
	Top management support	Devoting time to the IT program in proportion to its cost and potential, reviewing plans, following up on results, and facilitating the management problems involved with integrating IT with the management process of the business [Young & Jordan 2008]
Environmental	Consumer readiness	Consumer readiness is a mixture of consumers' inclination to engage with new technologies and the readiness of support technology for the customer [Zhu et al. 2003].
	Competitive pressure	The level of pressure from competitors within the same industry [Alshamaila et al. 2013]
Control variables	Size of the firm	Total number of employees [Zhu et al. 2006]
	Location of the firm	Country of operation of the firm [Barbera 2013; Ilaboya & Ohiokha 2016; Trencansky & Tsaparlidis 2014]
	Age of the firm	Years since establishment of the firm [Barbera 2013; Ilaboya & Ohiokha 2016; Trencansky & Tsaparlidis 2014]

APPENDIX D: Measures and Scales
Technology competence *Adapted from Alshamaila et al. [2013], Oh et al. [2009], and Zhu et al. [2002]*
1. In my organization, IT professionals as a percentage of total employees are high compared to other organizations [Oh et al. 2009]. 2. I believe that my organization has IT resources on par with e-commerce firms [Zhu et al. 2002]. 3. I believe that my organization effectively explores new IS innovations available on the market [Alshamaila et al. 2013].
Relative advantage *Adapted from Jeon et al. [2006], Shiau et al. [2009], and Thong [1999]*
1. Technology innovations like AR technology will provide better profitability [Thong 1999]. 2. I believe that AR will help in the betterment of my organization's processes [Shiau et al. 2009]. 3. I believe that the adoption of AR technology will provide better payoffs [Jeon et al. 2006].
Decision-makers' AR knowledge *Adapted from Jeon et al. [2006] and Thong [1999]*
1. I believe that my organization's senior management has expertise in innovative technology practices [Jeon et al. 2006; Thong 1999]. 2. I believe that my organization's senior management has adequate knowledge in new technologies like AR [Jeon et al. 2006; Thong 1999].
Financial strength *Adapted from Jeon et al. [2006], Shiau et al. [2009], and Zhu et al. [2006]*
1. I believe that my organization has the capacity to absorb the cost of implementing technology like AR [Jeon et al. 2006; Zhu et al. 2006]. 2. The high cost of implementing and maintaining AR technology may deter my organization's adoption of AR [Jeon et al. 2006; Shiau et al. 2009; Zhu et al. 2006].
Top management support *Adapted from Ghobakhloo et al. [2011a], Grandon and Pearson [2004], Grover [1999], and Oh et al. [2009]*
1. I believe that my organization's top management provides adequate resources for new technology (AR) adoption [Grandon & Pearson 2004; Oh et al. 2009]. 2. I believe that my organization's top management is enthusiastic about the adoption of AR technology [Ghobakhloo et al. 2011a; Grandon & Pearson 2004; Grover 1999; Oh et al. 2009]. 3. I believe that my organization's top management involves decision-making on new technology adoption [Ghobakhloo et al. 2011a; Grandon & Pearson 2004].
Consumer readiness *Adapted from Meuter et al. [2005] and Zhu et al. [2003]*
1. I believe that my organization's customers have knowledge on how to use AR technology [Meuter et al. 2005; Zhu et al. 2003]. 2. I believe that my organization's customers are technology savvy [Meuter et al. 2005; Zhu et al. 2003]. 3. I believe that my organization's customers think AR technology is the best in terms of convenience and ease of use [Meuter et al. 2005].
Competitive pressure *Adapted from Ghobakhloo et al. [2011a], Shiau et al. [2009], and Zhu et al. [2003]*
1. I believe that competitors who have adopted technological innovation such as AR will have a strong positively related influence on AR adoption in my organization [Ghobakhloo et al. 2011a; Shiau et al. 2009; Zhu et al. 2003]. 2. I believe that my organization's products and services are easily replaceable on the market [Ghobakhloo et al. 2011a].
Adoption intention *Adapted from Davis et al. [1989] and Venkatesh and Davis [2000]*
1. I believe that my organization intends to adopt AR technology in the future [Davis et al. 1989; Venkatesh & Davis 2000]. 2. I would strongly recommend my organization use AR technology [Davis et al. 1989; Venkatesh & Davis 2000]. 3. I believe that the adoption of AR will largely benefit the organization [Davis et al. 1989; Venkatesh & Davis 2000].

APPENDIX E: Indicator Variables: Cross Loadings						
	AI	CR	DMK	RA	TC	TMS
"AI1"	0.928	0.639	0.633	0.590	0.593	0.734
"AI2"	0.941	0.553	0.533	0.651	0.560	0.707
"AI3"	0.927	0.543	0.511	0.636	0.603	0.717
"CR1"	0.562	0.860	0.496	0.395	0.428	0.459
"CR2"	0.436	0.806	0.380	0.372	0.471	0.310
"CR3"	0.553	0.854	0.445	0.593	0.464	0.508
"DMK1"	0.520	0.502	0.922	0.562	0.466	0.686
"DMK2"	0.593	0.484	0.941	0.600	0.495	0.691
"RA1"	0.609	0.446	0.599	0.925	0.522	0.668
"RA2"	0.637	0.562	0.561	0.932	0.524	0.598
"TC1"	0.402	0.319	0.383	0.401	0.800	0.338
"TC2"	0.619	0.534	0.407	0.497	0.865	0.514
"TC3"	0.491	0.436	0.490	0.482	0.804	0.413
"TMS1"	0.740	0.434	0.673	0.654	0.496	0.947
"TMS2"	0.718	0.542	0.723	0.633	0.495	0.943

Key: AI: adoption intention; CR: consumer readiness; DMK: decision-makers' knowledge; RA: relative advantage; TC: technology competence; TMS: top management support

APPENDIX F: Indicator Variables: Cross Loadings					
Construct	**Indicator**	**Substantive Factor Loading (R1)**	**$R1^2$**	**Method Factor Loading (R2)**	**$R2^2$**
Adoption intention	AI1	0.789**	0.623	0.159*	0.025
	AI2	0.993**	0.986	-0.059	0.003
	AI3	1.013**	1.026	-0.099	0.010
Consumer readiness	CR1	0.834**	0.696	0.020	0.000
	CR2	0.943**	0.889	-0.148	0.022
	CR3	0.751**	0.564	0.122	0.015
Decision-makers' knowledge	DMK1	0.959**	0.920	-0.036	0.001
	DMK2	0.905**	0.819	0.035	0.001
Relative advantage	RA1	0.938**	0.880	-0.012	0.000
	RA2	0.919**	0.845	0.012	0.000
Technology competence	TC1	0.999**	0.998	-0.216*	0.047
	TC2	0.711**	0.506	0.160*	0.026
	TC3	0.774**	0.599	0.047	0.002
Top management support	TMS1	0.992**	0.984	-0.054	0.003
	TMS2	0.898**	0.806	0.055	0.003
Average		0.895	0.809	-0.001	0.011

Key: AI: adoption intention; CR: consumer readiness; DMK: decision-makers' knowledge; RA: relative advantage; TC: technology competence; TMS: top management support
*Note: *p < .05; **p < .01*