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Understanding Information Systems Continuance for Information-Oriented Mobile Applications

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Abstract:

Consumers' use of mobile data applications is expected to rise significantly in the next few years. While user acceptance and adoption of mobile applications have received growing interest from IS researchers, only a paucity of studies have focused on user continuance behaviors in the mobile commerce context. Studying the IS continuance behavior of 147 registered users of an information-oriented mobile application, this research extends the general model of IS continuance to include a number of explanatory antecedents: information quality, system quality, process quality, and hedonic value. The enhanced framework makes a significant contribution to the theory of IS continuance intention, and at the same time, it offers implications to mobile service providers for creating high quality mobile applications for consumers.

Keywords: information systems continuance, mobile commerce, structural equation modeling

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I. INTRODUCTION

Beginning with the introduction of the Wireless Application Protocol (WAP) in Europe and iMode in Japan at the turn of the century and subsequently the BlackBerry "smartphone" release in the U.S. in 2002, mobile devices have proliferated. Once just for voice and e-mail communications, these ingenious devices have become true mobile information systems with an ever increasing array of applications. As long as you are within range of a cell phone tower, you can get news, weather, flight information, and driving directions. Recent "mobile apps" permit you to trade stocks, get paperless store coupons, get reminders for "to do" lists, find your friends' current locations, and (with GPS) get the arrival time of the next bus you're waiting for in Chicago. This research addresses the motivation of users to continue to use information-oriented mobile applications once they have tried and adopted them.

Based on a body of theory-based research on information system (IS) use developed in the last decade, this research project aims to understand the antecedents of consumers' continuance behaviors in the context of information-oriented mobile applications. While a large body of research on IS acceptance exists [Davis, 1989; Davis et al., 1989; Venkatesh and Davis, 2000; Venkatesh et al., 2003], few prior studies focused on understanding the psychological motivations after users' initial acceptance of systems [Bhattacherjee, 2001]. Therefore, current IS acceptance models provide limited explanation of users' continuance behaviors. IS continuance at the consumer level is crucial to the survival of many business-to-consumer e-commerce and m-commerce firms, as previous studies have shown that customer retention could translate to significant savings in operating costs and improved profitability for companies [Khalifa and Liu, 2007]. Therefore, research is needed to better understand the antecedents of IS continuance in the mobile context.

User acceptance and adoption of mobile applications have received some interest from academic researchers. Researchers have found that, just like many other types of IS, technological factors such as technology advancement and availability do not automatically lead to actual use [Bruner and Kumar, 2005]. Rather, cognitive constructs related to technology acceptance and adoption have been found to be better predictors of mobile technology and application use [Constantiou et al., 2007]. Therefore, relatively few studies have extended the Technology Acceptance Model (TAM) to study the mobile environment [Fang et al., 2006]. Further, there are a relatively limited number of studies that focus on user continuance behaviors in the mobile context [Hong et al., 2006; Hung et al., 2007; Kim and Steinfield, 2004; Kim et al., 2008; Lin and Shih, 2008; Thong et al., 2006]. Research on IS continuance of mobile applications is important from both practical and academic perspectives.

Information-oriented mobile applications (IOMA) are defined as software programs that offer users timely, personalized, and/or localized information anytime, anywhere on mobile devices. Today, especially in the U.S., consumers' adoption and use of these mobile applications is still limited, but it is forecasted to grow significantly in the next few years as mobile data services become pervasive and mobile providers open up their platforms to third-party developed applications [Malhotra and Segars, 2005]. Hence it is both timely and important to study IS continuance in this age of emergence of B2C m-commerce applications. Further, factors such as system quality, information quality and process quality are different for mobile applications due to context awareness, personalization and ubiquity characteristics. Understanding the role of system quality, information quality, and process quality in relation to continuance behavior in the mobile context lays the groundwork for systems designers and operators to create a better user experience and prolonged use of applications and services.

This study expands the Expectation–Confirmation Model of IS Continuance developed by Bhattacherjee [2001] to focus on identifying the antecedents of IS continuance in the information-oriented mobile application context. The expanded model examines the impact of system quality, information quality, process quality, and hedonic value on users' continuance behaviors. These antecedents were selected for the particular context of information-oriented mobile applications. While other antecedents, such as individual differences in skills, motivation, task complexities, incentives, and the like would also enhance knowledge about IS continuance, we assert that the selected antecedents are particularly interesting to the context of IOMA and make a significant contribution and extension to prior theory.

II. THEORETICAL BACKGROUND AND RESEARCH MODEL

Information-Oriented Mobile Applications

The seductive lure of ubiquitous access to information anytime, anywhere has yet to be universally realized [Islam and Fayad, 2003], although significant progress has been made in recent years. Niche markets for mobile applications emerged in certain industries early on, such as transportation and logistics, where there was a clear return on investment. Additionally, particular geographical regions of the world have had more acceptance and use of mobile applications than others [Islam and Fayad, 2003]. For example, Japan sends more e-mail through the phone than through the PC. While the adoption and use of mobile applications is still relatively limited, the last several years has seen a tremendous growth as mobile data services have continued to expand and as mobile providers have opened up their platforms to applications created by third-party developers. Perhaps the most salient, successful example of a platform to develop, deploy, and promote third-party applications is Apple's App Store that had approximately 1.5 billion mobile application downloads over a period of a year[1] and 10 billion downloads after just over two and a half years.[2] The multibillion dollar mobile commerce market is anticipated to continue its growth over the next several years.

Researchers have investigated how, when, and why consumers adopt mobile commerce applications and have detailed some of the challenges that mobile commerce providers and consumers face [Fang et al., 2006; Karaiskos et al., 2008; Malhotra and Segars, 2005; Yoo et al., 2005]. Individual attitudes and behaviors toward mobile applications have also been studied under the lens of the technology acceptance model [Lu et al., 2007, 2005; Wu and Wang, 2005]. Other researchers have studied acceptance under similar, but different lenses. Karaiskos et al. [2008] conducted a study on the drivers and inhibitors of mobile data services uptake using Triandis's theoretical model, rather than Davis's technology acceptance model, which argues for the inclusion of affect as a separate determinant of intention. Maholtra and Segars [2005] categorize mobile application adopters using Rogers' framework that groups adopters into five clusters: innovators, early adopters, early majority, later adopters, and laggards. They found that innovators and early adopters (those who utilize a technology during its early stages) perceived the mobile Web as highly compatible with the consumer's needs, but also perceived that the change in behavior required and the trialability of the innovation to be an obstacle. Overall these early adopters, who are representative of many of the current mobile commerce users, found a relative advantage of information acquisition, transactions, and entertainment tasks. Maholtra and Segars stratify the service needs of potential adopters that providers should offer into multiple layers:

> *Clearly, services such as messaging (SMS and email), along with banking and financial information, form the foundation of needs compatability in the mobile commerce arena. The next layer of services that appear important to adopters are entertainment and information-based (involving news, music, and games, for example). For later adopters, maps and context based services become an important aspect of service.*

Numerous different types of mobile applications/services have been researched, including location-based services [Pura, 2005], mobile advertising [Tsang et al., 2004], mobile banking [Lee et al., 2003; Luarn and Lin, 2005], mobile commerce [Massoud and Gupta, 2003; Pedersen, 2005] and payments [Dahlberg et al., 2008; Nysveen et al., 2005b], mobile chat services [Nysveen et al., 2005a], mobile gaming [Kleijnen et al., 2004; Nysveen et al., 2005b], mobile multimedia services [Pagani, 2004], and mobile parking services [Pedersen, 2005]. The wide array of studies of mobile applications/services suggest the application-specific nature of mobile applications/services; therefore, a prerequisite of valid and generalizable findings in this area is to carefully define the scope of the research. In this article we focus on a general category of information-oriented mobile applications (IOMA) which we define as mobile applications that offer users timely, personalized, and/or localized information anytime, anywhere on mobile devices. IOMA are different from mobile transactional systems where mobile-commerce transactions such as online purchase, payment processing, or stock trading take place. IOMA require the use of a smartphone that is connected to the mobile Internet or wireless local area network such as WiFi. In most cases, a client-side application is downloaded and installed on the smartphone, providing the user with the user interface and icon access to the application content. Requested information is delivered to the user's device via the mobile Internet or wireless local area network. IOMA possess the dual attributes of both an information systems application and an information service.

Researchers have identified some of the ideal attributes of mobile applications for innovators and early adopters: immediacy, personalization, timeliness, context, ubiquity, and constancy [Malhotra and Segars, 2005]. However, there are other factors related to the device (e.g., availability, price, quality of service/user experience) that also influence consumers' adoption behavior [Islam and Fayad, 2003]. Other researchers have investigated the

[1] http://www.informationweek.com/news/internet/ebusiness/showArticle.jhtml?articleID=218500402
[2] http://technolog.msnbc.msn.com/_news/2011/01/22/5899527-apple-exceeds-10-billion-apps-downloaded

moderating effect of task type on mobile technology acceptance [Fang et al., 2006]. They found that the effect or impact of the antecedents of adoption (i.e., perceived usefulness, perceived ease of use, perceived playfulness, and perceived security) vary depending on the task type being performed (e.g., general tasks, gaming tasks, and transactional tasks). Researchers have also provided targeted advice to mobile commerce providers to promote adoption of mobile applications such as the recommendation that they should "create or co-source value-driven content and avenues for transaction(s) that are geared for easy experimentation and early success among potential adopters" [Malhotra and Segars, 2005].

Even though the adoption of mobile applications has received some attention, research into the continued use of those applications has received relatively little focus. Most of the identified prior IS continuance studies in the mobile context applied either the Technology Acceptance Model (TAM) or Expectation-Confirmation Theory (ECT) of IS continuance (see Table 1 for a list of prior IS continuance studies in the mobile context and their constructs and findings). Early work by Kim and Steinfeld [2004] surveyed mobile Internet subscribers in Korea and found that information quality, connection quality, ease of use, and service charges significantly impact the level of overall user's satisfaction of mobile Internet services which affects a consumer's continuance intention. Thong et al. [2006] extended Bhattacherjee's IS Continuance model [2001] by adding two post-adoption beliefs (i.e., perceived ease of use and perceived enjoyment). Their study found that users will form intentions to continue mobile Internet service usage if they find it to be useful, easy to use, and enjoyable. Another study by the same researchers [Hong et al., 2006] investigated three different models related to adoption and continued use (i.e., expectation confirmation, technology adoption model, and a hybrid) and found that the hybrid model was the best at explaining intention to continue to use the mobile Internet. Another study investigated the factors for consumers' continued usage behavior of mobile commerce services using the lens of the Expectancy Disconfirmation Theory (EDT) [Lin and Shih, 2008] in understanding satisfaction. Lin and Shih found that post-adoption construct, satisfaction, and pre-adoption constructs, mobile vendor trust, and personal values, impact the continued usage of mobile applications. However, satisfaction had overwhelmingly greater influence on continuance intention than the pre-adoption constructs had. Kim et al. [2008] investigated factors that are most important to maintain continuers and reconvert discontinuers of mobile data services. Results suggest that perceived usefulness and social influence were most important for discontinuers and ubiquitous connectivity was most important for continuers. The predictive power of satisfaction and perceived usefulness was further confirmed by the study of Ng and Kwahk [2010] in their study of the continuance behaviors of mobile Internet users. This study examined the impact of users' familiarity with their existing mobile Internet services and switching costs on continuance intention, and it found that familiarity had significant and positive influence on continuance intention, while switching costs had no impact. Finally, the study of Kim et al. [2010] focused on identifying the antecedents of the satisfaction and continuance intention constructs in the IS Continuance model. The study found that extrinsic motivation factors—post-usefulness and post-monetary value, and intrinsic motivation factors, post-ease of use, and post-enjoyment—influenced both satisfaction and continuance intention significantly. In addition, the study also found that these factors were moderated by users' uncertainty avoidance. Although there has been an initial investigation into user continuance behaviors in the mobile context, there is still much to learn of continuance behavior related to information-oriented mobile applications.

The review of existing IS continuance research in the mobile context revealed a number of research gaps. First, most of the existing studies merely confirmed the validity of TAM and ECT for studying user continuance behaviors in the mobile context and did not make any theoretical breakthrough beyond the existing models. Second, those studies that attempted to extend existing models made limited theoretical contributions. The extended models showed no significant improvement in terms of predictive or explanatory power over ECT and offered very little practical insights to practitioners who wanted to improve customer retention of mobile products or services. Third, some of the existing studies attempted to improve our understanding of continuance intention in the mobile context by incorporating user factors such as personal values, trust in mobile technologies, uncertainty avoidance, and personal innovativeness, suggesting the multifaceted and individualized nature of IS continuance research. While these findings are valuable, little research attention was focused on system- or service-oriented constructs such as system quality and information quality, which were more within the control of mobile system or service providers and could lead to practical recommendations to them. Finally, the existing studies largely focused on understanding the antecedents of the satisfaction and continuance intention constructs and completely ignored the perceived usefulness and confirmation constructs. The authors of this study feel that understanding the antecedents of perceived usefulness and confirmation is more valuable as ECT suggests that the satisfaction and continuance intention constructs were largely explained by the perceived usefulness and confirmation constructs [Bhattacherjee, 2001]. Understanding the antecedents of perceived usefulness and confirmation will help us better address customer retention and continued usage of mobile products and services.

Table 1 captures constructs and major findings of prior studies related to IS continuance research in the mobile context.

Table 1: Prior Studies		
	Constructs Studied	Major Findings
Kim and Steinfield, 2004	Information quality, connection quality, ease of use, satisfaction, and service charges	Information quality, connection quality, ease of use, and service charges significantly influence satisfaction and user continuance intention for mobile Internet services.
Hong et al., 2006	Perceived usefulness, perceived ease of use, confirmation, satisfaction, and continued IT usage intention	The hybrid model integrating the Expectation–Confirmation Model, and Technology Acceptance Model has the highest explanatory power of user continuance intention for mobile Internet services.
Thong et al., 2006	Perceived ease of use, perceived usefulness, perceived enjoyment, confirmation, satisfaction, and continued IT usage intention	The findings support the expanded Expectation–Confirmation Model, which includes perceived ease of use and perceived enjoyment, in predicting user continuance intention for mobile Internet services.
Kim et al., 2008	Usefulness, usability, system quality, social influence, compatibility, ubiquitous connectivity, perceived cost, perceived value, behavioral intention, and user type	Usefulness and social influence affect perceived value of mobile data services more strongly for discontinuers than for continuers.
Lin and Shih, 2008	Mobile technology trusting expectation, mobile vendor trusting expectation, personal values, disconfirmation, performance, satisfaction and continuance intention	Personal values and trust influence satisfaction, which influences continuance intention of m-commerce service.
Kim et al., 2010	Post-usefulness, post-monetary value, post-ease of use, post-enjoyment, uncertainty avoidance, satisfaction, and continuance intention	Intrinsic motivations (post-ease of use and post-enjoyment) and extrinsic motivations (post-usefulness and post-monetary value) influence both satisfaction and continuance intention significantly. Uncertainty avoidance moderates the effect of these motivations.
Ng and Kwahk, 2010	Service user satisfaction, perceived value, familiarity, switching costs, and continuance intention	Service user satisfaction, perceived value, and familiarity influence continuance intention significantly.

IS Continuance Model

This project draws on the theoretical work of Bhattacherjee [2001], which was the most widely cited study that conceptualized and tested a model of IS continuance that took into account the distinctions between acceptance and continuance behaviors (see Figure 1). Based on the Expectation–Confirmation Theory, the model suggests that rational users of IS undergo a nontrivial decision process prior to making an informed IS continuance decision choice. Bhattacherjee posits that IS continuance intention is primarily determined by users' satisfaction with their prior IS use. User satisfaction is determined by users' expectation of the IS, which is represented as ex post perceived usefulness, and confirmation of expectation following actual use. Consistent with TAM, perceived usefulness is also a direct predictor of IS continuance. Finally, users' confirmation of expectation tends to affect usefulness perception in order to keep user expectation consistent with reality.

The Model of IS Continuance has been repeatedly confirmed and widely adopted by studies in various IS contexts [Hong et al., 2008; Limayem et al., 2007; Vatanasombut et al., 2008]. The model was also modified for studying IS continuance when usage was mandatory [Sorebo and Eikebrokk, 2008]. It was found that ease of use perception played a critical role in IS continuance when usage was mandatory. Information-oriented mobile applications are one form of information system and share attributes common to systems studied in previous continuance research that adopted Bhattacheriee's model—the software applications studied were all interactive end-user systems, and the usage was voluntary Furthermore, prior studies have repeatedly confirmed the appropriateness of ECT for studying IS continuance in the mobile context (e.g., Hong et al., 2006; Thong et al., 2006; Ng and Kwahk, 2010; and Kim et al., 2010). Therefore, we expect that the IS continuance model developed by Bhattacheriee [2001] will hold true in this context and provide a solid theoretical foundation for the proposed model.

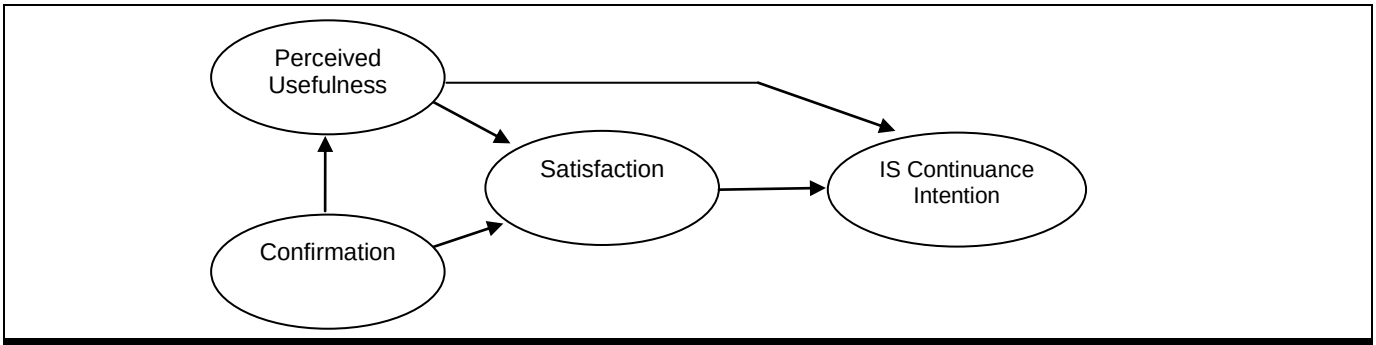


Figure 1. Post-acceptance Model of IS Continuance [Bhattacherjee, 2001]

Proposed Model

The conceptual model underlying the current research is depicted in Figure 2, the Expanded Model of IS Continuance for Information-oriented Mobile Applications. The proposed model expands the Post-acceptance Model of IS Continuance by including four new constructs: Information Quality (IQ), System Quality (SQ), Process Quality (PQ), and Hedonic Value (HV). In the conceptual model, Outcome-related construct, Information Quality, is hypothesized to affect Perceived Usefulness. System-related constructs, System Quality, and Process Quality, are hypothesized to affect Confirmation. The conceptual model also depicts the proposition that Hedonic Value directly influences IS Continuance Intention.

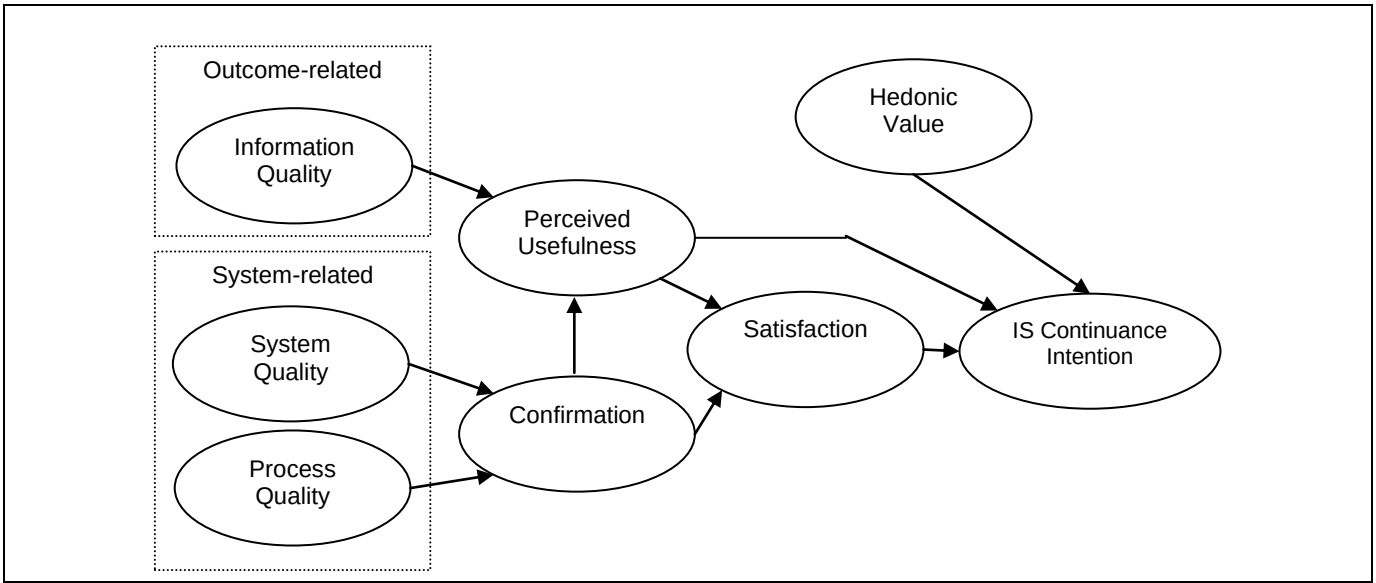


Figure 2. Expanded Model of IS Continuance for Information-Oriented Mobile Applications

A relevant stream of research focused on subscriber churn and customer loyalty in the context of mobile telephony (e.g., Seo, et al., 2008; Kim and Yoon, 2004; Ahn et al., 2006; Eshghi et al., 2007). These studies offered another perspective for examining IS continuance. When mobile telephony services were viewed as an information technology, low subscriber churn rate, strong customer loyalty, and a high level of customer retention suggested high user IS continuance. A common theme identified from these studies was the quality-satisfaction-loyalty chain, which suggested that quality variables, such as connectivity and call quality, influenced customer satisfaction with the service provider, which ultimately determined customer loyalty to the service provider. This proposition deviated from the traditional IS continuance research, which disproportionally focused on individual user (e.g., personal innovativeness, trust, and demographics) and social variables (e.g., social influences) and offered more direct and operative recommendations on areas for quality improvements to service providers. Following this logic, this study posits that the user's perceived usefulness, confirmation, satisfaction, and continuance intention were influenced by the quality constructs of IOMA; therefore, the research model extends ECT to incorporate constructs that assess the various aspects of quality of IOMA.

Information quality and system quality have long been proposed as measures of IS success [DeLone and McLean, 1992]. Nevertheless, these two constructs are fundamentally different. Information quality is concerned with the output of IS, whereas system quality focuses on the information processing system itself [DeLone and McLean,

1992]. Therefore, in this study, we label information quality as an outcome-related construct and system quality as a system-related construct.

Information-oriented mobile applications are examples of customer-centric IS, where the user is the kernel and driving force behind the system [Liang, 2006]. Liang et al. [2006] suggested that three components—product/service, technology, and process—of a customer-centric IS serve the user to make the system successful. The conceptualization can be extended to the IOMA context. From the user's perspective, the product/service of IOMA is information that can be accessed anytime, anywhere. *Information quality* (IQ) refers to the quality, timeliness, and relevance of the information that is output by the system. The technology of IOMA is represented by systems features that support mobility, availability, and ubiquity. Thus, *system quality* (SQ) measures the quality of features of the system, including items such as availability, responsiveness, flexibility, and overall quality of the service. Localization and personalization are unique system processes supported by IOMA. *Process quality* (PQ) refers to the ability of the system to localize and personalize information that is received and configure how the content is displayed to each user. Therefore, information quality, system quality, and process quality are deemed to be important factors affecting user perception in the context of IOMA.

While both antecedents of *Satisfaction* (S)—confirmation and perceived usefulness—represent different cognitive levels. *Confirmation* (C) refers to the user's realization of the expected benefits of IS use. In other words, this construct captures pre-consumption expectations and confirmation of those expectations after system use. The benefits of information-oriented mobile applications include mobility, availability, localized and personalized information [Arbanowski et al., 2004; Islam and Fayad, 2003]. The benefits are realized through a number of system quality variables such as availability and system features such as personalization features. Therefore, we propose that confirmation is derived from IS features and quality measures directly related to the IS itself.

Perceived usefulness (PU) is a cognitive belief that has been consistently found to influence initial and continued IS use [Bhattacherjee, 2001; Davis et al., 1989; Karahanna and Straub, 1999]. It represents the user's post-consumption (ex post) expectation of the IS following actual use. In other words, this construct captures the user's expectation of future usefulness after having used the system. Compared to confirmation, perceived usefulness represents a more holistic perception about IS that embodies both the confirmation of system features and the expectation of desired system outcomes [Bhattacherjee, 2001]. Therefore, we propose that perceived usefulness is influenced by outcome-related construct (i.e., information quality) and confirmation.

Hedonic value (H) refers to users' feeling of joy, elation, fun, or pleasure, or depression associated with IS use [Karaiskos et al., 2008]. While the PU construct explores the utilitarian aspects of IOMAs, the hedonic value is also potentially instrumental in determining users' continuance intention in this context. Entertainment value and perceived enjoyment of mobile IOMAs has been recognized by prior studies [Anckar and D'Incau, 2002]. In addition to the hedonic value that may be derived from the mobile content itself, instant gratification for users as the result of IOMAs' mobility and ubiquity offers more hedonic value than traditional media [Green, 2003; Rae, 2005]. Additionally, IOMAs have also been found to help users "kill time"; hence they are expected to provide users with hedonic value in this regard [Perry et al., 2001]. Therefore, many IOMA on the market today can be classified as hedonic information systems, which "aim to provide self-fulfilling rather than instrumental value to the user and are strongly connected to home and leisure activities" [Heijden, 2004]. A concept closely related to hedonic value, perceived playfulness, has appeared in numerous IS studies and been found to play an important role in enhancing users' motivation to learn and use information systems [Moon and Kim, 2001; Webster and Martocchio, 1992]. When treated as a situational characteristic of the interaction between the individual and IS, perceived playfulness is defined as the degree to which a person believes that using a particular system would make him or her joyful [Fang et al., 2006]. In technology acceptance literature, perceived playfulness has been consistently found to influence behavioral intention directly [Fang et al., 2006; Moon and Kim, 2001]. Both Davis et al. [1992] and Heijden [2004] found that enjoyment perceived by users had a direct influence on user intention. Heijden's [2004] research even challenged the traditional TAM model by suggesting that perceived enjoyment be a stronger determinant of intention to use than PU in hedonic information systems. Nevertheless, the influence of hedonic value on IS continuance has not been sufficiently studied and understood by prior research. Hedonic values of information systems are important to understand when studying IS continuance because prior studies have found that various consumer groups demonstrated different dispositions toward utilitarian and hedonic behaviors. For example, socio-economically disadvantaged individuals were found to continue information technology use more for entertainment purposes, while more educated and affluent users tended to continue using information technologies for utilitarian purposes [Hsieh et al., 2008]. Hedonic value was also found in IS continuance literature in the mobile context to be a determinant of continuance intention in the form of perceived enjoyment [Thong et al., 2006; Kim et al., 2010]. Given the consumer-oriented nature of IOMA, hedonic value will likely turn out to be an important consideration in the continuance decision process. Therefore, our research model proposes that hedonic value will affect users' continuance intention in the IOMA context. By including hedonic value as a determining construct, the research

model allows us not only to evaluate the predictive power of hedonic value but also to reexamine Heijden's [2004] claim of the superior predictive power of hedonic value over PU in the context of IS continuance.

Based on the conceptual model, this study will test the following hypotheses:

Table 2: Model Hypotheses	
H1	Users' perceived information quality is positively associated with their perceived usefulness of IS use (IQ → PU).
H2	Users' perceived system quality is positively associated with their extent of confirmation (SQ → C).
H3	Users' perceived process quality is positively associated with their extent of confirmation (PQ → C).
H4	Users' extent of confirmation is positively associated with their perceived usefulness of IS use (C → PU).
H5	Users' perceived usefulness of IS use is positively associated with their satisfaction with IS use (PU → S).
H6	Users' extent of confirmation is positively associated with their satisfaction with IS use (C → S).
H7	Users' perceived usefulness of IS use is positively associated with their IS continuance intention (PU → CI).
H8	Users' satisfaction with IS use is positively associated with their IS continuance intention (S → CI).
H9	Users' perceived hedonic value is positively associated with their IS continuance intention (HV → CI).

III. METHOD

Measures (Instrument Development)

The primary research methodology for the study is survey. The research model constructs are measured using multi-item scales. The items were developed using a multi-stage approach. In the first stage, thirty-six initial questionnaire items were generated based on an extensive literature review of how previous researchers had measured the same concepts. The items were modified to fit the context of information-oriented mobile applications where necessary. Table 3 summarizes the sources for the items for each of the model constructs.

Table 3: Model Constructs		
Construct	Definition	Measurement
IS Continuance Intention (CI)	Users' intention to continue using the IOMA	Adapted from Bhattacherjee [2001]
Satisfaction (S)	Users' satisfaction with prior IOMA use	Adapted from Bhattacherjee [2001]
Perceived Usefulness (PU)	Users' perception of the expected benefits of the IOMA use	Adapted from Bhattacherjee [2001]
Confirmation (CO)	Users' perception of the congruence between expectation of the IOMA use and its actual performance	Adapted from Bhattacherjee [2001]
Hedonic Value (HV)	Users' feeling of joy, elation, fun, or pleasure, or depression associated with the IOMA use	Adapted from Karaiskos, Bina, and Giaglis [2008]
Information Quality (IQ)	Users' perception of the quality of the information obtained with the IOMA use	Adapted from Shchiglik and Barnes [2004]
System Quality (SQ)	Users' perception of the quality of the IOMA as a software application	Adapted from Kim, Lee, and Kim [2008]
Process Quality (PQ)	Users' perception of the extent to which customization, personalization, or localization is allowed in the IOMA	Adapted from Chakraborty, Lala, and Warren [2003]

In the second stage, content validity of the items was established by three IS researchers and three practitioners who developed mobile applications. They were asked to comment on the validity of the items and suggest additions, deletions and/or modifications. Feedback from these experts resulted in some revisions to the initial items. Finally, two IS researchers reviewed the items independently to further refine the questionnaire. As the result of this

process, thirty items were retained for the final questionnaire. The items were written in the form of statements and survey participants were asked to indicate to what extent they agreed or disagreed with the statement (5-point Likert scale). Appendix 1 displays the items included in the final questionnaire.

Data Collection Procedure

Data for this study was collected via a survey of the users of a mobile application. Survey participants were registered users of an information-oriented mobile service, InstaFind. InstaFind is a free mobile application that provides Blackberry users with access to information such as local businesses, driving directions, weather, flight information, movie listings, local gas prices, and top international, national, and local news. Information is filtered using the user's preselected location or location detected by the mobile device's GPS capability. Users are given some freedom to customize what information they would like to receive and how the information is displayed on their mobile devices. InstaFind was developed with the J2ME technology. The application requires the use of a Blackberry smartphone that has access to either mobile Internet or a wireless local area network. To use the application, a user downloads client software and installs it on a Blackberry smartphone. The client-side software allows the user to access InstaFind by selecting the program icon on the device. Since the launch of InstaFind, over 12,000 users have registered to use the application. The application and relevant services were available only to registered users.

For the purpose of this study, in December 2008, an e-mail containing a link to the online questionnaire was distributed to 1,000 randomly selected registered users of InstaFind who had used the service at least once in the previous month. The e-mail message included verbiage about the general goals and procedures of the study along with a link that took respondents to the study's Web-based questionnaire. The e-mail also provided instructions about how to access and complete the questionnaire. As an incentive, respondents were registered in a drawing for small cash prizes. The online survey was designed so that multiple entries from the same respondent were prohibited. The online survey was pretested to ensure that it functioned correctly. Among the 166 responses received, 147 were found to be complete and usable, resulting in an effective response rate of 14.7 percent.

Early respondents and late respondents were compared to ensure that the study did not suffer from non-response bias. Early respondents were those whose surveys were received in the first 25 percent of responses, and late respondents were those whose surveys were received in the last 25 percent of respondents. The characteristics of the respondents and their organizations for the two groups were compared using one-way ANOVA. The variables used in the analysis included gender, age, income, primary purpose of the user's mobile device, mobile information needs, and innovation adopter category. All the comparisons between the early respondent and late respondent groups rendered insignificant results. The insignificant results suggest that the study did not suffer from non-response bias.

IV. STATISTICAL ANALYSIS AND RESULTS

Sample Characteristics

The characteristics of the respondents are summarized in Table 4—Table 9. In general, the data suggest that our sample is diverse and normally distributed across age, income, and primary purpose of the user's mobile device. However, the majority of respondents are male, tend to need information on the go, are relatively wealthy, and tend to be earlier adopters of innovations. These characteristics are consistent with the profile of mobile data users at the time the research was conducted. To determine the innovation adopter category of survey participants, respondents were asked to specify the extent of agreement with the following two statements using a 5-point Likert scale:

- Among my peers, I am usually the first to try out new information technologies and services.
- I like to experiment with new technologies.

The mean of the respondent's ratings of these two items was used to assign the respondents to one of the five innovation adopter categories: Laggards, Late Majority, Early Majority, Early Adopters, and Innovators [Rogers, 1995].This user characteristic is important to our study because prior research has demonstrated a connection between the user as a technology adopter and as a user of mobile services [Constantiou et al., 2007].

Table 4: Gender

Gender	Frequency	Percent (%)
Male	103	70.1%
Female	44	29.9%

Table 5: Age		
Age	Frequency	Percent (%)
Under 20	2	1.4%
20–29	28	19.0%
30–39	45	30.6%
40–49	44	29.9%
50–59	23	15.6%
60 and over	5	3.4%

Table 6: Income		
Income	Frequency	Percent (%)
Under $25,000	7	4.8%
$25,000–$49,000	31	21.1%
$50,000–$74,999	40	27.2%
$75,000–$99, 999	32	21.8%
Over $100,000	37	25.2%

Table 7: Primary Purpose of the User's Mobile Device		
Purpose	Frequency	Percent (%)
Personal	80	54.4%
Business	67	45.6%

Table 8: Mobile Information Needs		
Mobile Information Needs	Frequency	Percent (%)
Very Infrequently	1	0.7%
Infrequently	4	2.7%
Sometimes	44	29.9%
Frequently	48	32.7%
Very Frequently	50	34.0%

Table 9: Innovation Adopter Category		
Innovation Adopter Category	Frequency	Percent (%)
Laggards	1	0.7%
Late Majority	5	3.4%
Early Majority	19	12.9%
Early Adopters	49	33.3%
Innovators	73	49.7%

Table 10 displays the descriptive statistics of the variables regarding continuance intention. The sample demonstrated above average intention to continue using the mobile application in the future.

Table 10: Continuance Variables				
Continuance Variables	Minimum	Maximum	Average	Std. Deviation
I intend to continue using the application.	1	5	3.810	1.036
I intend to continue using the application than using any alternative services.	1	5	3.408	1.058

Data Analysis

This study employed the two-step approach suggested by Anderson and Gerbing [1988] to analyze the model data. In the first step, the validity of the measurement model was assessed using Confirmatory Factor Analysis (CFA). CFA allows researchers to test the validity of the factorial structure for a measurement model. In other words, CFA allows researchers to determine the extent to which questionnaire items postulated to measure latent factors or constructs actually do so. The second step involved testing the causal structure of the proposed research model using the Structure Equation Modeling (SEM) technique. SEM is a statistical technique that allows simultaneous analysis of variables of a hypothesized model to determine the model's consistency with the data. The methodology focuses on examining the strength of the causal relations between the constructs [Bentler, 1988]. The statistical tool used in data analysis was AMOS version 5.0.

The overall fit of the hypothesized model was assessed using six fit indices: Chi-square, Chi-square/df, Normed Fit Index (NFI), Comparative Fit Index (CFI), Root Mean Square Residual (RMR), and Root Mean Square Error of Approximation (RMSEA). According to Marsh and Hocevar [1985], Chi-square/df ratios of up to 3 are indicative of acceptable fit models. While the Chi-square statistic is a global test of a model's ability to reproduce the sample variance/covariance matrix, it is highly sensitive to sample size and model complexity. Therefore, other model-fit indices such as CFI that are independent of sample size should be evaluated along with the Chi-square statistic. CFI was the primary fit-statistic of the six for the purposes of this study, as recommended by Bentler [1992]. A CFI above 0.90 is indicative of a well-fitting model [Bentler and Bonett, 1980]. As Browne and Cudeck [1993] suggested, a RMSEA that is less than 0.08 indicates good fit and reasonable errors of approximation in the population. Byrne [1998] suggested that a standardized RMR value of 0.05 or less indicates a well-fitting model.

Measurement Model

CFA was performed on all the items simultaneously to evaluate the validity of the items and nine underlying constructs in the measurement model. The initial results suggested that some construct revisions were needed to improve the model fit. Items recommended for deletion were evaluated from both a statistical and a substantive point of view before deletion. The following criteria were used to determine if an item should be deleted:

1. If the item had a low and statistically insignificant (at 0.01 level) factor loading (regression weight) on its corresponding construct.
2. If deletion of the item would not jeopardize the theoretical integrity of the construct.

Six items were ultimately deleted. The final measurement model was re-specified to include twenty-four items to measure the eight constructs of the research model (see Appendix 1). The factor loadings of the items are shown in Table 11. All items have high factor loadings on the constructs they are measuring. The resulting measurement model had a good model-to-data fit (see Table 12).

Table 11: Factor Loading

Item	IQ	SQ	PQ	PU	C	S	HV	CI
I1	.89							
I3	.92							
I4	.85							
I5	.90							
I6	.88							
I7		.92						
I8		.95						
I11		.73						
I12			.83					
I13			.78					
I15			.85					
I16				.93				
I17				.91				
I18				.92				
I19				.96				
I20				.90				
I21					.95			
I23					.96			
I24						.97		
I25						.98		
I26							.88	
I27							.73	
I29								.87
I30								.90

Keys:

IQ—Information Quality	C—Confirmation
SQ—System Quality	S—Satisfaction
PQ—Process Quality	HV—Hedonic Value
PU—Perceived Usefulness	CI—Continued Intention to Use

Table 12: Fit Indices for the Re-specified Measurement Model					
Chi-square	Chi-square/df	NFI	CFI	RMSEA	RMR
436.86	1.98	0.91	0.95	0.08	0.03

The internal consistency of the measurement model was assessed by computing the composite reliability. These reliability coefficients are displayed for all the latent variables in Table 13. All variables have higher composite reliability coefficients than the benchmark of 0.60 recommended by Bagozzi and Yi [1988]. This suggests a high internal reliability of the data exists. Convergent validity is often assessed by evaluating the Average Variance Extracted (AVE) with the expectation that for each construct this measure exceeds 0.50 [Hair et al., 1998]. The AVEs for all the latent variables, as displayed in Table 13, exceed this recommendation.

Table 13: Reliability and Validity		
Latent Variables	Composite Reliability	Average Variance Extracted (AVE)
Information Quality (IQ)	0.949	0.789
System Quality (SQ)	0.904	0.761
Process Quality (PQ)	0.861	0.673
Perceived Usefulness (PU)	0.967	0.854
Confirmation (C)	0.954	0.912
Satisfaction (S)	0.975	0.951
Hedonic Value (HV)	0.789	0.654
Continuance Intention (CI)	0.879	0.783

Discriminant validity analysis examines whether two constructs are statistically distinct from each other. Discriminant validity requires that the Average Variance Extracted (AVE) be greater than .50 [Fornell and Larcker, 1981], but it also requires a comparison between AVEs with shared variances (inter-construct squared correlation) between constructs as suggested by [Hair et al., 2006] and [Fornell and Larcker, 1981].

Shared variance between constructs represents "the amount of variance in observed variables relating to another construct that a latent construct is able to explain," and it is estimated using the square of the correlation between two constructs [Fornell and Larcker, 1981]. The numbers in bold in Table 14 are the AVEs, and the rest of the numbers in the table represent the shared variances between the constructs in the research model. The AVEs were found to be greater than the shared variance estimates in all cases except one indicating that discriminant validity is supported.

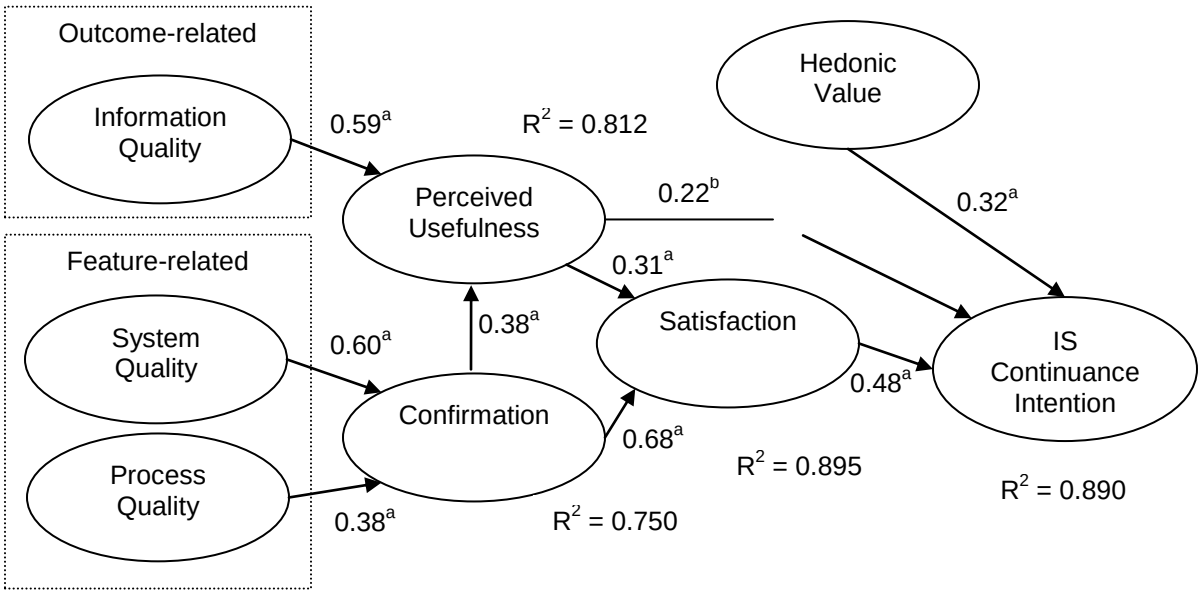
Table 14: AVEs and Shared Variances Between Constructs								
	IQ	SQ	PQ	PU	C	S	HV	CI
IQ	**0.789**							
SQ	0.500	**0.761**						
PQ	0.578	0.295	**0.673**					
PU	0.743	0.523	0.514	**0.854**				
C	0.507	0.648	0.497	0.638	**0.912**			
S	0.570	0.596	0.496	0.736	0.861	**0.951**		
HV	0.644	0.534	0.618	0.579	0.542	0.546	**0.654**	
CI	0.615	0.581	0.549	0.682	0.738	0.817*	0.717	**0.783**

Structural Model

Using the SEM technique, the structural model demonstrated good model fit (see Table 15). Figure 3 displays a schematic representation of the resulting model. The estimation of the revised model yielded a Chi-square of 471.64 with 234 degrees of freedom. The Chi-square/df ratio was 2.02, with a CFI of 0.95 and NFI of 0.90. Both RMSEA (0.08) and RMR (0.03) are well within the range of acceptability. Table 16 displays the structural coefficients and standard errors of the structural paths. All of the structure paths were statistically significant at the 0.01 level (two-tailed). The 9 hypotheses about the relationships between the constructs in the model were tested through the significance of the structural coefficients; therefore, all hypotheses were supported.

Table 15: Fit Indices for the Revised Structural Model					
Chi-square	Chi-square/df	NFI	CFI	RMSEA	RMR
471.64	2.02	0.90	0.95	0.08	0.03

Table 16: Model Hypothesis-Testing Results				
Hypothesis	Structural Path	Structural Coefficient	Standard Error	Significance
H1	IQ → PU	0.59	0.09	p < .001 Supported
H2	SQ → C	0.60	0.08	p < .001 Supported
H3	PQ → C	0.38	0.09	p < .001 Supported
H4	C → PU	0.38	0.05	p < .001 Supported
H5	PU → S	0.31	0.07	p < .001 Supported
H6	C → S	0.68	0.06	p < .001 Supported
H7	PU → CI	0.22	0.10	p < .01 Supported
H8	S → CI	0.48	0.08	p < .001 Supported
H9	HV → CI	0.32	0.09	p < .001 Supported



Model fit: Chi-square = 471.64 (df=234, p<.001), NFI=0.90, CFI=0.95
Path significance: [a]p < .001, [b] P < .01

Figure 3. SEM Analysis of Research Model

Alternative Models

While the proposed model demonstrated a very good fit with the data, efforts were made to evaluate whether alternative models could be suggested. First, the modification indices were examined to see whether additional linkages between constructs were suggested by the data. The modification indices suggested no additional path was warranted. Second, two alternative models were tested. In the first alternative model, a path was created between IQ and C suggesting that the outcome-related factor, Information Quality, might influence Confirmation. The AMOS results showed that the overall fit of the model deteriorated after the path between IQ and C was added. IQ was not found to influence C significantly (structural coefficient = 0.078; p = 0.409). This finding confirmed our understanding of the different cognitive levels that C and PU represented. In the second alternative model, a path was created between HV and PU, suggesting that the hedonic value perceived by the user might influence the perceived usefulness of the IOMA. The AMOS results again showed that the overall fit of the model deteriorated after the path between HV and PU was added, suggesting that HV did not influence PU significantly (structural coefficient = 0.070; p = 0.479). This supported the findings from prior studies, which suggested that hedonic value of the system influences the user's intention to use the system directly rather than through perceived usefulness [Fang et al., 2006; Moon and Kim, 2001]. The examination of the alternative models suggested that the current research model offers the best overall model fit and explanatory power.

V. DISCUSSION AND CONCLUSION

The enhanced model of IS continuance intention builds on theoretical work of Bhattacherjee, but includes additional antecedents based on the context of information-oriented mobile applications. It was anticipated that hypotheses four through eight (i.e., confirmation → perceived usefulness, confirmation → satisfaction, perceived usefulness → satisfaction, perceived usefulness → continuance intention, and satisfaction → continuance intention) would be supported as multiple studies had previously tested and validated the relationships between those constructs in other contexts. In addition to the basic IS continuance model, this study included antecedents of perceived usefulness and confirmation—information quality, system quality, and process quality—as well as the impact of hedonic value on IS continuance intention. Interestingly, all of the hypotheses in the study were empirically supported, further enhancing understanding of IS continuance in the IOMA context. As these constructs have also been found to influence user initial acceptance and adoption of technology in prior studies, the findings of this study confirmed their dual importance in understanding both initial and continued technology adoption. This research on IS continuance of mobile applications has implications for both theory and practice.

Implication for Theory and Research

This study makes a contribution to the understanding of IS continuance intention, especially in the IOMA context. While there has been some published research addressing the acceptance and adoption of mobile applications, few published studies have even investigated continuance behaviors in the mobile applications context. This research extends our understanding of the general model of IS continuance intentions, but further enhances our understanding by adding meaningful, explanatory antecedents that help provide explanation about the antecedents of continuance. Factors such as system quality, information quality, and process quality help to capture important characteristics of information-oriented mobile applications that may be context aware, personalized, and accessible anytime and at any place.

The study found that the quality of information output by an IOMA positively impacts the perceived usefulness. Information quality includes items such as the timeliness and the relevance of the information, as well as the overall quality of the information. Additionally, system quality and process quality, which describe the quality of the overall system rather than the information produced by the system, were found to positively impact the confirmation construct. In other words, the quality of the system (e.g., availability, responsiveness, flexibility) and quality of the process (e.g., ability to localize and personalize the information) lead to greater realization of the expected benefits of the IOMA.

Additionally, the data supports the assertion that hedonic value (e.g., users' feeling of joy, elation, fun, or pleasure, or depression associated with IS use) impacts the intention to continue to use IOMAs. The portability of IOMAs and ubiquitous access to information anytime, anywhere makes this antecedent especially relevant in this context where users may fill previously unused small blocks of time with mobile applications.

This study has made a number of theoretical contributions to the field. It provides validation of the general IS continuance model in yet another context. However, unlike prior studies of IS continuance in the mobile context, this study has significantly expanded the IS continuance model by introducing new antecedents that capture a more accurate model of IS continuance for the context of IOMA. These antecedents are likely relevant to other contexts that share similar attributes to IOMA such as context-awareness, personalization, and ubiquity. The expanded model offers a different perspective from prior studies by incorporating the quality-satisfaction-loyalty linkage. Instead of focusing disproportionately on individual user factors as prior studies have done, this study chose to focus on the impact of quality and hedonic assessments of IOMA on continued use. By dissecting quality issues relevant to IOMAs, this study identified how different aspects of IOMA quality influenced various attitudinal constructs (i.e., perceived usefulness and confirmation) in the model of IS continuance. In prior studies, the antecedents of the perceived usefulness and confirmation constructs were not sufficiently studied leaving practitioners with little recommendations for improving IS continuance.

Implications for Practice

IS continuance at the consumer level is crucial to the survival of many business-to-consumer e-commerce and m-commerce firms. Customer retention could translate to significant savings in operating costs and improved profitability for companies [Khalifa and Liu, 2007]. It is critical that service providers understand the impact that information quality and system quality have on perceived usefulness and user confirmation and ultimately the impact that these constructs have on the intention to continue to use IOMAs. While consumer adoption of devices is expected to grow significantly in the next few years, providers must find ways to provide responsive, flexible, high quality IOMAs that recognize who is using the system, where they are in order for the system to provide accurate, timely, and relevant information. We re-assert that practice should further incorporate ambient/context awareness

[Arbanowski et al., 2004; de Reuver and Haaker, 2009], personalization [Arbanowski et al., 2004; Ho and Kwok, 2002] and adaptation [Arbanowski et al., 2004] into information-oriented mobile applications.

Limitations

As with any study, there are limitations to this study. Although our research instrument built on previously validated instruments and reasonable precautions were taken to minimize bias, we recognize that the conclusions of this research, like many using the survey method, may be threatened by common method variance [Podsakoff et al., 2003; Sharma, n.d.]. While we assert that the theoretical relationships of the continuance model have held across numerous studies, we do recognize that high factor loadings and very high explained variance may be indicative of user responses that are biased by the method. While we don't provide a specific estimate of the percentage of the observed correlation that is spurious correlation due to CMV [Podsakoff et al., 2003], we do acknowledge that possibility.

The constructs of the model, in particular the antecedents to the general IS continuance model, were created for the specific context of information-oriented mobile applications. Thus these constructs may not generalize to other types of information systems. We recognize, as have other researchers [Nysveen et al., 2005b], that different contexts may impact the influence of specific antecedents of continuance and potentially the relative influence between other constructs. More research is needed to identify context-dependent antecedents and specific constructs' impact across contexts. This aim is beyond the scope of this article. However, Nysveen et al. use types of interactivity (i.e., person-interactive, machine-interactive) and process characteristics (i.e., goal-directed, experiential) to classify different mobile services and investigate the moderating influence of these characteristics on the relationship of motivational influences, attitudinal influences, normative pressure, and perceived control on consumers intention to use mobile services [Nysveen et al., 2005b]. Characterizing continuance intentions in such a manner may prove to be more generalizable across contexts.

The sample for the study was drawn from users of a particular information-oriented mobile application (InstaFind). While we believe that this application is an exemplar of information-oriented mobile applications, the sample may not generalize to other contexts, including across other types of mobile applications and devices. Other devices and other mobile applications may embody varying levels of information and system quality. Additionally, it is important to note that research participants were early adopters and were selected to participate in the research because they had recently used the InstaFind information service. Further, even though the fit of the model is good, there may be additional antecedents that further explain continued information systems use.

Finally, there have been great changes in the mobile arena in the last decade and particularly in recent years. Obviously data analyzed in this study was collected at a specific point in time. Characteristics of the mobile data users may shift in response to numerous characteristics including the prevalence of mobile data devices, the decreasing cost of use, and increased competition among vendors of devices and services.

Conclusion

This research enhances our understanding of the antecedents of consumers' continuance behaviors in the context of information-oriented mobile applications. While there has been some research of mobile application acceptance, this is one of the first studies that focuses on user continuance behaviors in the mobile commerce context. The findings show that information quality, system quality, process quality, and hedonic value directly or indirectly impact the intention to continue to use the IOMA. Empirical evidence suggests that the positive benefits and outcomes of systems use, plus the satisfaction with the system and the feeling of joy or fun associated with using the system, all lead to continued use of information-oriented mobile applications.

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APPENDIX A: MEASUREMENT ITEMS

Table A-1: Measurement Items

Constructs		Measurement Items
Information Quality (IQ)	I1*	The information provided by the application is accurate.
	I2	The information provided by the application is timely.
	I3*	The information provided by the application is relevant to me.
	I4*	The information provided by the application is easy to understand.
	I5*	The application provides the information at the right level of detail.
	I6*	The application provides the information in an appropriate format.
System Quality (SQ)	I7*	The application responds to my search with high speed.
	I8*	The application is available whenever I need to use it.
	I9	The application allows flexibility in search keywords.
	I10	The application is well-designed.
	I11*	Overall, the application is a service with high quality.
Process Quality (PQ)	I12*	The application recognizes who I am when I use it.
	I13*	The application allows me to customize the information I receive.
	I14	The application allows me to configure how the content is displayed.
	I15*	The application provides information that is relevant to where I am.
Perceived Usefulness (PU)	I16*	Using the application improves my performance in getting the information that I am looking for.
	I17*	Using the application allows me to get information anytime anywhere.
	I18*	Using the application increases my productivity in getting information.
	I19*	Using the application enhances my effectiveness in getting information.
	I20*	Overall, I find the application useful in getting the information that I am looking for.
Confirmation (C)	I21*	My experience with using the application was better than what I expected.
	I22	The customer service provided by the application was better than what I expected.
	I23*	Overall, my experience with using the application met my expectation.
Satisfaction (S)	I24*	I am pleased with my overall experience of using the application.
	I25*	Overall, I am satisfied with the application.
Hedonic Value (HV)	I26*	Using the application is fun.
	I27*	The application gives me an additional channel for information when other channels are not available.
	I28	The application allows me to kill time when I am not doing anything else.
Continued Use (CU)	I29*	I intend to continue using the application.
	I30*	I intend to continue using the application rather than using any alternative services.
* The item was retained for data analysis.		

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