

# Consumer-based m-commerce: exploring consumer perception of mobile applications

Pruthikrai Mahatanankoon<sup>b</sup>, H. Joseph Wen<sup>a,\*</sup>, Billy Lim<sup>b</sup>

<sup>a</sup>*Department of Accounting and MIS, Harrison College of Business, Southeast Missouri State University, Cape Girardeau, MO 63701, USA*

<sup>b</sup>*School of Information Technology, College of Applied Science and Technology, Illinois State University, Normal, IL 61790-5150, USA*

Available online 4 November 2004

## Abstract

With m-commerce still in its infancy, there have been relatively few attempts to systematically explore the opportunities and challenges posed by m-commerce. This study is an early attempt aims to provide empirical data on consumer perception of mobile applications. This paper first examines the value proposition of mobility. It then investigates m-commerce operation modes and potential consumer-based applications. A consumer perception survey was conducted to reveal the attributes that are perceived as important by consumers for making m-commerce choices. Results provide company executives with useful insights into m-commerce applications and their commercial potentials.

© 2004 Elsevier B.V. All rights reserved.

**Keywords:** Mobile commerce; Value proposition; Operation modes; M-commerce applications

## 1. Introduction

To give a broad categorization of the advances in computing, many experts classify the 1980s as the decade of the PCs, the 1990s as the decade of the Internet, and propose to label the first decade of the 21st century as the decade of mobile computing and mobile commerce (m-commerce). While m-commerce is not delivering the promises that many pundits had proclaimed just a few years ago in terms of providing unprecedented commercial functionality to the masses

[1–3], it is still projected to be one of the main driving forces for next generation computing and a major revenue generating platform for many corporations. Research firm IDC confirmed US\$500 million in m-commerce revenues for 2002 and projects the amount to be US\$27 billion by 2005. Forrester Research also predicts that by 2007, up to 2.3 million wired phone subscribers in the US would make the switch to wireless access, making an average of 2.2 wireless phones per household.

Research efforts in m-commerce also continue to gain great strides over the last few years. For example, the recognition and ramification that ‘E’≠‘M’ (E as in ‘electronic’ commerce and M as in ‘mobile’ commerce) in wireless/mobile application design allow for

\* Corresponding author. Tel.: +1 573 651 2908.

E-mail address: [hjwen@semo.edu](mailto:hjwen@semo.edu) (H.J. Wen).

a more usable and user-friendly environment for conducting m-commerce [4,5]. Also, the advent of location-based services enables m-commerce to be further leveraged so that the mobility aspect is taken advantage of rather than just repackaging old applications in a new format [6].

With the NASDAQ market plunge in 2000 and its recent recovery in 2003, it is safe to assume that many of the excess capacities built by the mobile carriers in the early dotcom boom days have been ironed out and the over expectations and promises grounded. Now, in the post dotcom bust era, it is expected that more careful analysis, thorough empirical studies, and rigorous development projects be conducted to identify market trends, products design, interoperable standards, and other critical success factors so that costly mishaps can be limited.

It is with the above observation that this research is to set out to conduct a study that investigates the various aspects of mobility *and how consumers perceived different mobile applications*. This permits the mobile developers/practitioners to better design and target the appropriate user groups so that the goal of making m-commerce a reality instead of another technology fad that goes by the wayside can be achieved.

In Section 2, we briefly summarize the value proposition of mobility and discuss the various aspects of mobility. Then, the two modes of operation for mobile computing are described in Section 3. The research method is then presented in Section 4. They are followed by the discussion of the results and the implementation of the study in Section 5. Finally, the paper concludes with the limitations and future research.

## 2. Value proposition of mobility

Mobile devices have been the fastest adopted consumer products of all time with more mobile phones shipped annually than automobiles and PCs combined [7]. However, just as is the case for e-commerce in the early years when its unique characteristics were not well understood, m-commerce is in very early stages of development now and little is known about factors that influence consumers' attitudes and value perceptions about them [8–13].

While a growing body of literature has pointed out the main value-added elements of m-commerce, the primary drivers for adopting and intending to adopt mobile services remain unclear [14,15].

E-commerce creates value for customers in a manner that is different from that achieved in conventional business [16]. Correspondingly, m-commerce extends not only the benefits of the web, but also allows for unique services and additional benefits when compared to traditional e-commerce applications [17,18]. As noted by Keen and Mackintosh [19], the demand side of m-commerce is a search for value and hence there is a need to build an understanding of the elements and special features of wireless electronic channels that are value-adding from the consumer's point of view. Every company entering the mobile space has the same goal—leveraging this channel to create customer value [20]. Customers are thus asking for proofs that the adoption of mobile services will add value to their businesses [21], and respectively, to their consumers.

Keen and Mackintosh also note that the key value proposition of mobility is the creation of choice, or new freedoms, for customers. In a similar way, words commonly used to describe the main value-added feature of m-commerce include flexibility, convenience, and ubiquity. While being pertinent and illuminating, such terms nevertheless appear to be too general to grasp the essence of the consumer value creation process in m-commerce, as they fail to address the relevance of contextuality [22]. The distinctive feature of mobile commerce is the significance of the user's location, his situation, and his mission [9]. To gain an understanding of the drivers for consumer adoption and usage of m-commerce services, there is, thus, a need to look into why and when flexibility is valuable to customers. It is, after all, obvious that the freedom benefits created by mobility are not equally valid for different mobile services and for different settings.

Current e-commerce providers, engaged through mobile devices, will find advantage in developing unique m-commerce value propositions founded upon the specific dimensions of “always on,” location-centric, convenience, customization, and identifiability [23]. These features, which are not

available to traditional e-commerce, are discussed below.

1. “Always on”: Because of its inherent design, a mobile phone can be “always on” and is always portable. This permits its users to engage in activities such as meeting with people or traveling while conducting transactions through their Internet-enabled mobile devices.
2. Location-centric: Not only does a mobile phone go everywhere, GPS may also be constructed to recognize where the phone is and to personalize the available services accordingly. Knowing the location of the Internet user creates a significant advantage for m-commerce over wired e-commerce. Utilizing this technology, m-commerce providers will be able to better receive and send information relative to a specific location.
3. Convenience: People will no longer be constrained by time or place in accessing e-commerce activities. Rather, m-commerce could be accessed in a manner that may eliminate some of the labor of life’s activities. For example, consumers waiting in line or stuck in traffic will be able to pursue favorite Internet based activities or handle daily transactions through m-commerce applications. Consumers may recognize a special comfort that could translate into an improved quality of life. By making services more convenient the customer may actually become more loyal. Consequently, communication facilities within m-commerce are key applications for the delivery of convenience.
4. Customization: Mobile phones have a much higher penetration than PCs, so m-commerce producers can be more creative and customizable in designing segmented, lifestyle tools. For instance, using demographic information collected by wireless service providers and information on the current location of mobile users, more targeted advertising can be done. The advertising messages can be customized based on information provided by consulting the user at an earlier stage or by the history of users’ purchasing habits.
5. Identifiability: A mobile phone has a built-in ID to support secure transactions whereas a PC is virtually anonymous. Mobile devices are typically used by a sole individual, making them

ideal for individual-based target marketing. Through GPS technology, service providers can accurately identify a user. Mobile offers the opportunity to personalize messages to various segments, based upon time and location, by altering both sight and sound.

Despite tremendous interest in the melioration of m-commerce, there is little, if any, research that examines how to develop value-added consumer-based mobile applications. Therefore, the primary purpose of this paper is to explore the factors that allow for the composition of an effective m-commerce application. Managers can then incorporate these critical m-commerce factors into their overall m-commerce strategies when creating new m-commerce applications. Given the potential assemblage of wireless Internet devices, an enhanced understanding of m-commerce could acutely improve a company’s overall ability in e-business strategy formulation.

### 3. M-commerce operation modes

M-commerce operation modes can be generalized in two categories: (1) content delivery (notification and reporting) mode and (2) transaction (purchasing and data entry) mode [23]. They are about having access to information and being able to carry out a particular transaction unconstrained by time and location.

In the *content delivery mode*, as shown in Table 1, the mobile web is used to notify and report important content messages such as sports news, personalized financial news, premium games, and mobile greeting cards. All content providers must ensure that their services are optimized for the mobile channel and live up to the highest levels of quality and usability. The centerpieces of the content delivery are personalized information. The personalization involves presenting choices relevant to the time and place of interaction and is based on the user’s previous transactions or preferences. For example, a customer who makes a restaurant reservation online could be prompted for a mobile direction map and a choice of post-dinner events, all based on previous behavior. The personalization, however, will mean open access to customer preference and behavior. Customers will be

Table 1  
M-commerce Operation Modes

	Content delivery mode	Transaction mode
Definition/ characteristics	This operation notifies and reports important content messages to consumers such as sports news and personalized financial news.	This operation runs business transaction over the wireless Internet. Consumers can browse through the catalog and order products on mobile devices.
Promotion measures/ ways	<ul style="list-style-type: none"> <li>• Sending instant coupon to near-by customers;</li> <li>• Notifying customers when they have been outbid in an auction that is about to close;</li> <li>• Delivering sports news, financial news, and personalized information;</li> <li>• Offering ring-tones and other downloads to m-phone customers; and</li> <li>• Using the Web as a cost-effective way to augment its core products with related information and service functions.</li> </ul>	<ul style="list-style-type: none"> <li>• Using micro-payment technology in transactions involving vending machines, tickets, trains, or taxi fares;</li> <li>• Automating ubiquitous customer billing transaction services;</li> <li>• Running real-time ubiquitous online auction transactions;</li> <li>• Charging a fee for mobile games, entertainment, and fun; and</li> <li>• Providing convenience to implement a transaction at any time or place.</li> </ul>

willing to provide personal information to companies only if it clearly benefits them. Determining the line between intrusiveness and helpfulness will be a challenge for companies that operate the content delivery mode.

In the *transaction mode*, companies use the wireless Internet to run business transactions. M-commerce consumers can browse through the catalog and order products online. Although there are still some hidden obstacles (e.g., transaction security, speed, and ease of use), it seems that most companies are likely to benefit directly from transactions on the wireless Internet, especially for small and medium-sized enterprises. In fact, there have been many successful cases, including the On-Pay m-commerce system, which is capable of executing transactions from external online merchants including vending machines, tickets, trains, gasoline, and taxi fares. Time sensitive and simple (yes-or-no) transactions are the key success factors to this operation mode.

M-commerce adds mobility and convenience to the Internet and creates a whole new set of opportunities. The portability of mobile devices offers new business applications outside the scope of fixed, desktop-based Internet offerings. Nevertheless, as m-commerce is still in its infancy, mobile applications are still not widely implemented or adopted by mobile users. This study is set out to investigate and explore consumers' perception of

various mobile applications. Our goals are to understand how to better design and target appropriate applications for mobile users.

#### 4. Methods

To better understand the interrelationship of the aforementioned aspects of mobility and a set of identified mobile applications, an exploratory study was conducted at the end of 2003 to early 2004. The study was conducted in a large state university in the Midwest region of the USA using undergraduate and graduate students who used mobile phone with Internet capability. These students had technical backgrounds with majors either in computer science, information systems, or telecommunications management.

To examine what activities are most valuable to the mobile users, three data analysis stages were carried out. In the first stage, based on our initial pilot study, we generated a pool of 44 consumer-based mobile applications (see Appendix A for the list). In the second stage, we further refined these applications by examining the histogram of each application, and ranked them according to what seemed to be the most preferred by the consumers. In the last stage, we used exploratory factor analysis to classify different types of mobile applications. The following sections describe the methods in detail.

#### 4.1. Stage 1: item generation

Due to the exploratory nature of this study, two pilot studies were conducted to brainstorm a list of possible mobile usage applications and to verify the underlying factors related to these usages. The first pilot study was to generate a list of mobile applications through brainstorming sessions using 60 undergraduate and 15 graduate students from a large state university in the Midwest region of the USA. These students were consumers of mobile devices who had backgrounds in information technology.

In generating the list, they were given the concept of mobile commerce and were asked to creatively describe several mobile applications that would be appealing to them. The exhaustive list contained broad spectrum of creative and innovative mobile applications, such as “buying soda from a vending machine,” “paying a parking ticket on the spot,” “receiving personalized shopping offers,” etc. We compiled these narratives and rephrased the descriptions the respondents provided to simplify them and to ensure that these mobile applications were relatively generic and consistent with previous empirical observations from both academic and trade articles. Redundant or similar mobile applications were eliminated. At this stage, we generated list of forty-four potential mobile commerce applications (items).

To ensure a certain degree of validity of the construct, a pilot study was performed to verify and to examine the readability and correctness of the questionnaire. A sample of 28 graduate students majoring in information systems was given the initial list of mobile applications. Normality test was used to examine these responses and to ensure a certain degree of validity of the construct for the final survey. Several corrections were made to these items as a result; however, we did not eliminate any of them from our study.

#### 4.2. Stage 2: ranking of mobile applications

A web-based survey was conducted using undergraduate and graduate students who have mobile phone with Internet access. The respondents were guaranteed anonymity and confidentiality of their responses, and were also given extra credits for their willingness to participate in the study. There were 272

students who responded to our questionnaire. We had to eliminate 12 respondents who did not own a mobile device and dropped another 10 redundant responses. Therefore, there were 251 respondents used in this study. The sample consisted of 77% male and 23% female. Nearly two-third of the respondents were undergraduate students. Their ages ranged from 18 to 54 years of age (avg.=25, S.D.=6.1). These students were asked to respond to the 44 randomly listed mobile applications on how important the activities are to users when using mobile commerce services (1=not important to 5=very important).

Responses to the questionnaire were analyzed through the use of the SPSS v11.0 statistical package. The analysis focused upon the calculation of descriptive statistic by examining the histogram of each application and ranked them according to what seemed most preferred by the consumers. The goal of descriptive statistics was to generate a list of top essential mobile applications that were perceived most important to consumers.

#### 4.3. Stage 3: construct validation

Exploratory factor analysis was used to provide an initial classification of each m-commerce operation modes and to eliminate items with low factor loadings. This allowed us to explore new relationships among top ranked mobile applications, therefore eliminating the ones that were not important as perceived by the consumers. We later performed first-order and second-order confirmatory factor analysis (CFA) to validate the construct. The goal of this stage was to classify different types of mobile applications for content delivery and transaction modes. The study used CFA only for classification purposes only, not to extensively validate the scales for the construct or to develop a survey instrument.

### 5. Results and discussion

To determine what applications should be ranked as perceived by the respondents, we compared the mean of each mobile application (1=not important to 5=very important). Table 2 shows descriptive statistics and ranking of mobile applications. We anticipated that the usage of mobile commerce applications may

Table 2  
Descriptive statistics and rankings of mobile applications

M-commerce applications	Mean	S.D.	Ranking
Sending or receiving e-mails	3.92	1.14	1
Reporting (transmitting information) emergencies based on location (e.g., roadside assistance, accidents, etc.)	3.76	1.26	2
Searching for specific information on the Internet	3.76	1.15	2
Using directory services (e.g., Google search, yellow pages, etc.),	3.76	1.20	2
Transmitting (automatically) emergencies information (e.g., personal assistance, roadside assistance, etc.),	3.71	1.27	3
Using Internet search engines (e.g., yahoo, lycos, hotbot, etc.)	3.68	1.25	4
Working with the mobile device in traffic jam, airport, or conferences	3.44	1.24	5
Receiving time-sensitive information regarding weather reports, financial information, traffic information, etc.	3.37	1.28	6
Sharing digital files or personal information online with friends, family, or strangers	3.37	1.23	6
Reading and receiving news (through subscription service or browsing)	3.36	1.14	7
Surfing the Internet casually	3.35	1.19	8
Managing personal appointments and meetings through Intranet/Internet	3.21	1.29	9
Chatting with others on the Internet	3.19	1.23	10
Viewing or sending pictures via the Internet	3.12	1.19	11
Calendaring and alerting Internet services (not using internal mobile functions)	3.08	1.29	12
Listening to music from the Internet, including downloaded MP3 songs	3.02	1.32	13
Tracking the location of product and services that are needed, including finding goods, boxes, people, etc.	3.02	1.21	13
Transferring money from a preconfigured bank account	2.93	1.32	14
Performing routine banking services (pay bills, check account, etc.)	2.90	1.37	15
Shopping for goods on the Internet (books, flowers, groceries, etc.)	2.90	1.24	15
Formatting website for display on mobile device	2.89	1.35	16
Playing interactive games on the Internet	2.84	1.30	17
Checking in airport without physical documents (e.g., mobile passport)	2.80	1.40	18
Booking travel tickets through the Internet	2.75	1.23	19
Issuing electronic payment in physical shops	2.75	1.29	19
Reading or sending messages from/to a specific newsgroup	2.67	1.18	20
Reading downloaded e-books	2.56	1.23	21
Paying a parking ticket on the spot	2.56	1.28	21
Posting or viewing on-line classify ads	2.53	1.19	22
Reserving a restaurant table	2.53	1.22	22
Receiving time sensitive discount tickets from physical store (e.g., e-coupon based on upcoming sales)	2.46	1.16	23
Watching video clip from the Internet	2.45	1.22	24
Buying a drink from a vending machine and billing it to the mobile device	2.44	1.30	25
Filling out and sending damage reports (notifications of claim) to insurance companies	2.43	1.20	26
Taking part in Internet auctions	2.41	1.20	27
Receiving location sensitive discount tickets from physical store (e.g., e-coupon from a nearby store)	2.40	1.17	28
Finding the location of a new/used car of certain model, color and features	2.38	1.15	29
Receiving an alert notification from an online travel company about a new lower fare	2.36	1.19	30
Managing in-house and inventory-on-move	2.35	1.11	31
Trading stocks and initiating a request to have the money transferred	2.35	1.24	31
Controlling home appliances (heating system, car, etc.) through remote activation	2.31	1.23	32
Conducting advanced banking services (e.g., loan negotiations, ordering credit cards)	2.30	1.18	33
Receiving personalized shopping offers	2.03	1.10	34
Receiving personal advertisements	1.85	1.03	35

evolve around buying products, locating friends and family, or receiving instant coupons, but our results suggest that consumers prefer using mobile phones for emergencies situations and information searching. Moreover, among the top 10 mobile applications, the majority of the applications deal with *content*

*delivery mode*, such as sending or receiving e-mails, searching for specific information, or receiving time-sensitive news and weather report.

These top-ranked applications were generally accompanied by consumers' sense of "always-on" and convenience. This finding supports our idea that



being constantly connected to the Internet provides consumers with the most preferable value-added benefits. By servicing and enhancing voice communications, the convenience of having a mobile device with Internet capability during critical situations was most appealing to consumers. This commonsense notion motivates practitioners and researchers to look back at the basic understanding of consumer's behaviors and tries to understand the psychological motivation of mobile usage itself.

However, the actual transactional m-commerce applications (*transaction mode*), such as issuing electronic payment, buying products from physical shops, or transferring money from a preconfigured bank account, did not rank as high as we had predicted they would. There are several explanations and they are given below.

First of all, consumers' concerns over the security and privacy of their mobile transactions remain high. Many location-based services, such as the ability to pinpoint the location of mobile users, lessen consumers' sense of security and privacy. By being able to verify specific transactions, the need for authentication between trading partners must be coupled by the ability for mobile providers to track the location of products and services, and transferring money wirelessly. To increase consumers' confident, some additional security services should be provided when accessing e-mails or searching for specific information on the Internet. Even among the simplest applications, mobile developers need to acknowledge the concerns consumers have regarding their mobile surfing. Some mobile usage patterns may contain confidential information as well as clues to individual emotional psyche that can be devastating if the information gets in the wrong hand.

Customization strategy may be used to ease the fear of mobile transaction with respect to security and privacy. This is an area that can be one of the hidden value-added benefits and potential that mobile application developers and m-commerce businesses need to educate their mobile consumers with. For example, consumers have the ability to change the security and privacy settings to match their individual taste and concerns. This function is analogous to the setting of "cookies" in various e-commerce websites. However, concerns for privacy could deter consumers from fully utilizing their mobile functionalities and thus, the knowledge and respon-

sibility to protect their identity and screening out harmful marketers rests partly on the hands of the service providers.

Second, many mobile applications that were ranked in the lower tier (11–35) include activities relate to entertainment and social activities. Even though some of these applications were technological feasible of being implemented, consumers did not value them highly. One explanation could be that most consumers were not familiar with the application, or it was not yet a part of a usage norm. For example, conducting loan negotiations or ordering credit cards seems less attractive to many users as these are non-mainstream mobile applications yet. Another explanation could be related to the user interface of a mobile phone. Using a mobile phone to view video clip is totally limited by the screen size, resolution, and transmission speed. In fact, many mobile applications are obviously restricted by ergonomics factors as well as the comfort level of consumers using them.

Another interesting finding was that among the top 10 applications, two applications were related to using mobile phones as personal organizers. However, they were not related to either content delivery or transaction mode. One possible explanation could be that these applications were incorporated onto many mobile devices, which consumers did not view as part of the value-added applications. It is evidently true that many consumers use mobile phones because part of the PDA functionalities generally comes with the devices.

### 5.1. Exploratory and confirmatory factor analysis

In our initial exploratory factor analysis, we eliminated 26 mobile applications with low factor loadings ( $<0.60$ ) or cross factor loadings. The initial principle components (varimax rotation) suggest a five-factor solution based on the final 18 mobile applications. The five factors accounted for 72.4% of the total variation among items. Table 3 shows the factor loadings using a varimax rotation of the 18 mobile applications. Our findings suggest that we can group m-commerce applications into five categories.

The first factor deals with using mobile device to find and search for information on the Internet. This

Table 3  
Factor loadings of mobile applications

Mobile applications	F1	F2	F3	F4	F5
M1: Searching for specific information on the Internet	0.796				
M2: Sending or receiving e-mails	0.754				
M3: Reading and receiving news (subscription service or browsing)	0.683				
M4: Using directory services (e.g., google search, yellow pages, etc.)	0.823				
M5: Using Internet search engines (e.g., yahoo, lycos, hotbot, etc.)	0.830				
M6: Performing routine banking services (pay bills, check account, etc.)		0.784			
M7: Transferring money from a preconfigured bank account		0.780			
M8: Issuing electronic payment in physical shops		0.796			
M9: Conducting advanced banking services (e.g., loan negotiations, etc.)		0.682			
M10: Receiving personalized shopping offers			0.792		
M11: Receiving time sensitive discount tickets from physical store			0.672		
M12: Receiving location sensitive discount tickets from physical store			0.716		
M13: Receiving personal advertisements			0.814		
M14: Receiving an alert notification from an online travel company			0.674		
M15: Transmitting emergencies information (e.g., roadside assistance)				0.877	
M16: Reporting emergencies based on location				0.883	
M17: Playing interactive games on the Internet					0.838
M18: Listening to music from the Internet					0.800

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Rotation converged in six iterations.

factor is consistent with our proposed “content delivery” mode. The second factor deals with using mobile device to support transferring of money between consumers and businesses (B2C). We find that this factor is consistent with our proposed “transaction” mode. We also discover three new factors related to the usefulness of mobile devices. The third factor reveals different location-based services, such as receiving time sensitive discount tickets and receiving personal advertisement, while the fourth and fifth factors involve using mobile devices for emergency and entertainment purposes, respectively.

We used confirmatory factor analysis (CFA) to validate the five classifications of mobile applications. The results in Fig. 1 show the first-order and second-order factor models of mobile applications. Standardized regression weight and correlations among different mobile operation modes are shown. The results show that these fit measures support the measurement model overall. The first-order CFA produced a  $\chi^2/df$  of 2.104, with a GFI of 0.901, an AGFI of 0.859, a CFI of 0.944, an RMR of 0.086, and an NFI of 0.900. The second-order CFA also produced a moderate fit. The fit measures from the second-order CFA were:  $\chi^2/df=2.092$ , GFI=0.897,

AGFI=0.859, CFI=0.943, RMR=0.088 and NFI=0.897. Although we do not attempt to develop a construct for mobile applications, the result is an indication that the data supports the measurement construct well.

The challenge now lies in the hands of the practitioners to persuade potential adopters of m-commerce with arrays of applications that can improve the quality of their lives. The results of our study provide two interesting insights to help address this challenge. First, our proposed mobile operation modes were not the major factors that entice consumers to use mobile applications. Location-based, emergency-assistant, and entertainment applications are also the major concerns for most mobile users. However, in some cases, developers can determine the success of their mobile applications through social and behavioral factors.

Second, one size does not fit all. Consumers have different usage objectives that focus on a single or a combination of the aspects of mobility. Designing a mobile application that falls within the same aspect may increase the likelihood to promote unfamiliar applications to consumers. For example, consumers who choose to receive up-to-date news through their mobile phone are more likely to perform routing



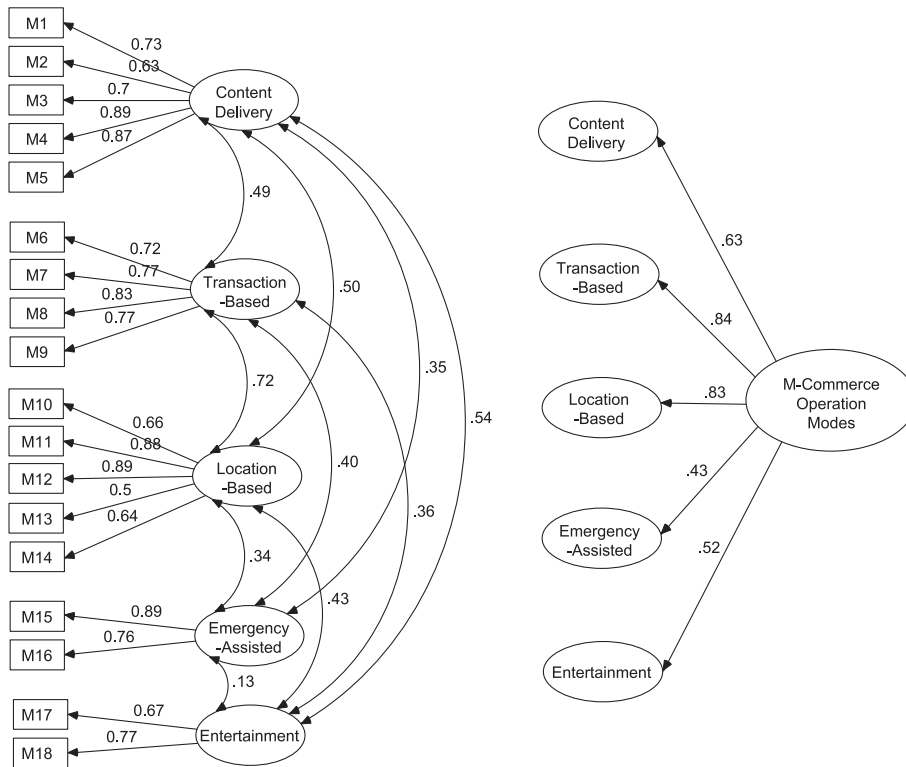


Fig. 1. First-order and second-order CFA of mobile operation modes.

banking services for the sake of convenience. In sum, mobile application developers can better target a specific user group by incorporating the applications within the same aspects together in forms of various package offerings.

## 6. Limitations and future research

There were several limitations regarding our findings. First of all, we used convenience sample which came from undergraduate and graduate students who are more familiar with information technology than the general consumer population. Their suggestions during the pilot study carried over many mobile applications that do not exist today. However, we felt that these applications were potentially feasible in the near future. Secondly, multi-item measures along with convergent and discriminant validity testing should give us better results. Future research could explore new ways to conceptualize and

operationalize various aspects of mobility and mobile operation modes.

Lastly, our knowledge of a successful mobile application is still limited. Researchers, as well as practitioner, should view this issue as a new opportunity, which can only be tackled through underlying interrelated facets of behavioral and social theories, using technology only as a binding factor. Although there are differences between early vs. late adaptors of mobile devices, practitioners cannot always assume that these applications will allure consumers when the issues of behavioral factors such as the sense of security and consumers' privacy have not been fully examined.

## 7. Conclusions

Business success in the 21st century will depend on what one knows about one's customers. M-commerce presents many new opportunities and

challenges to carry out one-on-one customer relationship in the world of e-business. For m-commerce to reach its full potential, operation modes and strategies must offer the customers maximum effectiveness through value-added, location-centric, and customized mobile applications. It is expected that new and even more innovative applications will arise as more people are connected to the Web through mobile devices.

## Appendix A

---

### List of 44 consumers' mobile applications

---

Booking travel tickets through the Internet  
 Buying a drink from a vending machine and billing it to the mobile device  
 Calendaring and alerting Internet services (not using internal mobile functions)  
 Conducting advanced banking services (e.g., loan negotiations, ordering credit cards)  
 Controlling home appliances (heating system, car, etc.) through remote activation  
 Chatting with others on the Internet  
 Checking in airport without physical documents (e.g., mobile passport)  
 Filling out and sending damage reports (notifications of claim) to insurance companies  
 Finding the location of a new/used car of certain model, color and features  
 Formatting website for display on mobile device  
 Issuing electronic payment in physical shops  
 Listening to music from the Internet, including downloaded MP3 songs  
 Managing in-house and inventory-on-move  
 Managing personal appointments and meetings through Intranet/Internet  
 Performing routine banking services (pay bills, check account, etc.)  
 Paying a parking ticket on the spot  
 Playing interactive games on the Internet  
 Posting or viewing on-line classify ads  
 Reading and receiving news (through subscription service or browsing)  
 Reading downloaded e-books  
 Reading or sending messages from/to a specific newsgroup  
 Receiving an alert notification from an online travel company about a new lower fare  
 Receiving personal advertisements  
 Receiving personalized shopping offers  
 Receiving time sensitive discount tickets from physical store (e.g., e-coupon based on upcoming sales)

---

## Appendix A (continued)

---

### List of 44 consumers' mobile applications

---

Receiving location sensitive discount tickets from physical store (e.g., e-coupon from a nearby store)  
 Receiving time-sensitive information regarding weather reports, financial information, traffic information, etc.  
 Reporting (transmitting information) emergencies based on location (e.g., roadside assistance, accidents, etc.)  
 Reserving a restaurant table  
 Searching for specific information on the Internet  
 Sending or receiving e-mails  
 Sharing digital files or personal information online with friends, family, or strangers  
 Shopping for goods on the Internet (books, flowers, groceries, etc.)  
 Surfing the Internet casually  
 Taking part in Internet auctions  
 Tracking the location of product and services that are needed, including finding goods, boxes, people, etc.  
 Trading stocks and initiating a request to have the money transferred  
 Transferring money from a preconfigured bank account  
 Transmitting (automatically) emergencies information (e.g., personal assistance, roadside assistance, etc.)  
 Using directory services (e.g., google search, yellow pages, etc.)  
 Using Internet search engines (e.g., yahoo, lycos, hotbot, etc.)  
 Viewing or sending pictures via the Internet  
 Watching video clip from the Internet  
 Working with the mobile device in traffic jam, airport, or conferences

---

## References

- [1] S. Feldman, Mobile commerce for the masses, *IEEE Internet Computing* 4 (6) (2000 (June)) 74–75.
- [2] J.A. Senn, The emergence of m-commerce, *Computer* 33 (12) (2000 (December)) 148–151.
- [3] R. Malladi, D.P. Agrawal, Current and future applications of mobile and wireless networks, *CACM* 45 (10) (2002 (October)) 144–146.
- [4] V. Venkatesh, Understanding usability in mobile commerce, *CACM* 46 (12) (2003 (December)) 53–56.
- [5] Y. Lee, I. Benbasat, User interface design for mobile commerce, *CACM* 46 (12) (2003 (December)) 49–52.
- [6] B. Rao, L. Minakakis, Evolution of mobile location-based services, *CACM* 46 (12) (2003 (December)) 61–65.
- [7] I. Clarke III, Emerging value propositions for M-commerce, *Journal of Business Strategies* 18 (2) (2001 (Fall)) 133–149.
- [8] W. Guerley, Making Sense of the Wireless Web, *Fortune* August 15, 2000. Available at: <http://www.fortune.com>.
- [9] P. May, *Mobile Commerce: Opportunities, Applications, and Technologies of Wireless Business*, Cambridge University Press, 2001.
- [10] M.A. Eastlick, S. Lotz, Profiling potential adopters and non-adopters of an interactive electronic shopping medium, *International Journal of Retail & Distribution Management* 27 (6) (1999) 209–223.

- [11] J. Rowley, Product Search in E-shopping: a review and research propositions, *Journal of Consumer Marketing* 17 (1) (2000) 20–35.
- [12] R. Amit, C. Zott, Value creation in E-business, *Strategic Management Journal* 22 (2001) 493–520.
- [13] V. Venkatesh, S.A. Brown, A longitudinal investigation of personal computers in homes: adoption determinants and emerging challenges, *MIS Quarterly* 25 (1) (2001) 71–102.
- [14] A. Urbaczewski, J. Wells, S. Suprateek, M. Koivisto, Exploring cultural differences as a means for understanding the global mobile internet: a theoretical basis and program of research, *Proceedings of the 35th Hawaii International Conference on System Sciences (HICSS-35)*, Big Island, Hawaii, January 7–10, IEEE Computer Society Press, Los Alamitos, 2002.
- [15] P.E. Pedersen, L.B. Methlie, H. Thorbjørnsen, Understanding mobile commerce end-user adoption: a triangulation perspective and suggestions for an exploratory service evaluation framework, *Proceedings of the 35th Annual Hawaii International Conference on System Sciences (HICSS-35)*, Big Island, Hawaii, January 7–10, IEEE Computer Society Press, Los Alamitos, 2002.
- [16] J. Han, D. Han, A framework for analyzing customer value of internet business, *Journal of Information Technology Theory & Application* 3 (5) (2001) 25–38.
- [17] Mobilocity, Mobile Travel Services—Strategies for Moving Forward, Mobilocity white paper, December (2000) Available at: <http://www.eyefortravel.com/papers/mobilocity.pdf>.
- [18] A. Tsalgatidou, E. Pitoura, Business models and transactions in mobile electronic commerce: requirements and properties, *Journal of Computer Networks* 37 (2) (2001) 221–236.
- [19] P. Keen, R. Mackintosh, *The Freedom Economy: Gaining the M-commerce Edge in the Era of the Wireless Internet*, Osborne/McGraw-Hill, Berkeley, CA, 2001.
- [20] R. Kalakota, M. Robinson, *M-Business: The Race to Mobility*, McGraw-Hill, New York, 2001.
- [21] Mobilocity, Fundamentals of M-Business: White Paper,” May (2001) Available at: [http://www.mobilocity.com/mi/Mobilocity\\_Fundamentals2001.pdf](http://www.mobilocity.com/mi/Mobilocity_Fundamentals2001.pdf).
- [22] M. Kakiyama, C. Sørensen, Mobility: an extended perspective, *Proceedings of the 35th Hawaii International Conference on System Sciences (HICSS-35)*, Big Island, Hawaii, January 7–10, IEEE Computer Society Press, Los Alamitos, 2002.

- [23] J. Wen, P. Mahatanankoon, M-commerce operation modes and applications, *International Journal of Electronic Business* 2 (3) (2004 (May–June)) (Accepted and forthcoming).



**Dr. Pruthikrai Mahatanankoon** is an Assistant Professor of Information Systems in the School of Information Technology at Illinois State University. He holds a PhD from Claremont Graduate University. Dr. Mahatanankoon's areas of expertise are Internet usage in the workplace, virtual organizations, and m-commerce.



**Dr. H. Joseph Wen** is an Associate Professor of MIS and chairperson of the Department of Accounting and Management Information Systems at Donald L. Harrison College of Business at Southeast Missouri State University. He holds a PhD from Virginia Commonwealth University. He has published over 100 papers in academic refereed journals, book chapters, encyclopedias and national conference proceedings. Dr. Wen has received over six million dollars research grants from various State and Federal funding sources. His areas of expertise are Internet research, electronic commerce (EC), transportation information systems, and software development.



**Dr. Billy Lim** is a Professor of Computer Science in the School of Information Technology at Illinois State University. He holds a PhD from University of Louisiana at Lafayette. Dr. Lim's areas of research include Web services, Web development technologies, and modern database management systems.