

# Are Mobile Payment and Banking the Killer Apps for Mobile Commerce?

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## Abstract

*Mobile commerce had been expected to become a major force of e-commerce in the 21<sup>st</sup> century. However, the rhetoric has far exceeded the reality so far. While academics and practitioners have presented many views about the lack of rapid growth of mobile commerce, we submit that the anticipated mobile commerce take-off hinges on the emergence of a few killer apps. After reviewing the recent history of technologies that have dramatically changed our way of life and work, we propose a set of criteria for identifying and evaluating killer apps. From this vantage point, we argue that mobile payment and banking are the most likely candidates for the killer apps that could bring the expectation of a world of ubiquitous mobile commerce to fruition. Challenges and opportunities associated with this argument are discussed.*

## 1. Introduction

The idea of ubiquitous mobile commerce has been around for at least a decade ever since mobile phones were rapidly adopted by users all over the world, especially in the developing countries where landline-based phone services were almost non-existent. By 2002, the number of world wide mobile phone connections reached 1 billion and exceeded that of the regular phone connections, and by 2005, this number had already doubled [11]. Mobile phone users in China alone reached 416 million in the mid-2006, exceeding the entire population of the United States, and the number has been increasing by about 3-4 million each month [5]. On the other hand, the growth of mobile commerce, defined as conducting commercial transactions via wireless network and devices, seems to have largely stagnated. The total value of transactions using mobile phone is trivial compare to that of B2C e-commerce: \$155 million worldwide in mobile phone payment in 2006 [10] vs. \$71 billion in B2C in the US alone in 2004 [8].

“Many experts would propose that the first decade of the 21<sup>st</sup> century will be the decade of mobile

computing and m-commerce. So far the promise and hype have surpassed the substance.” [27, p. 31]. Why is there this great disparity between the phenomenal growth in the number of mobile phone users and the value of mobile commerce? Are mobile phones just for convenience and freedom, not for real commerce? Scholars and practitioners have come up with a number of theories based on direct observations or scientific research. Many of such research focus on the factors influencing consumer adoption of mobile commerce services from the perspectives of consumer psychology and behavior (e.g., [3, 4, 12, 14, 15, 18, 19, 20, 22]). This focus toward consumer behavior is typified in the statement that “the success of m-commerce services is likely to depend on how flexible and malleable the technology is to all users to shape it to their individual and group needs in various social and business contexts. It will be the innovativeness of users and uses, not the innovativeness of the technology, that will drive m-commerce growth to a new level” [14, p. 44].

However, looking at the recent history of great information technology innovations that have significantly changed the way we live and do business, we rarely see the cases where it is the innovativeness of users and uses of a technology that made the difference. On the contrary, we see that it is often the innovativeness of a technology that changed the course of human history in the digital age, such as VisiCalc, Windows, Office, E-mail, Web Browser, Online Transactions, Search Engines, and etc. Few of these allow much flexibility for users in terms of how it could be used, yet they have helped spawn completely new markets and industries and destroyed many old and seemingly unrelated ones. And in the meantime, these killer apps have altered the lives of billions around the world. Thus, we argue that the anticipated take-off of mobile commerce depends on the introduction and adoption of killer apps – technologies or applications that significantly alter the way we live and do business. In this article, we examine the characteristics of such killer apps and screen the emerging mobile commerce applications via the lens of killer apps. In the end, we present the argument that mobile payment and banking services

could well be the killer apps that would move mobile commerce into a new era when the current rules of games for business and society are significantly altered again.

## 2. Research on Mobile Commerce

As mobile services and applications have become a significant part of individual and organizational life in the last two decades, research on mobile commerce has also flourished. However, a survey of the literature seems to suggest that the real world of mobile commerce has moved far ahead of the academic research on mobile commerce in both the diversity of innovations and the sophistication of the applications. Mobile commerce has become a significant, in some cases indispensable, part of the everyday life for hundreds of millions of people around the world, especially in Asia and Europe. For example, in China alone there are over 400 million mobile phone users as of 2006 and SMS (short message service) has been extremely popular among mobile phone users [12, 28]. Similar situation is also reported in Finland where its mobile phone penetration rate has reached 100% [3].

On the other hand, academic research on mobile commerce has largely clustered around the issue of user adoption (e.g. [3, 4, 12, 14, 15, 18, 19, 20, 24]). The innovation diffusion theory [23], theory of planned behavior [2], and technology acceptance model [6] are often used as the theoretical foundations for user adoption or acceptance models used in these studies. Empirical findings are generally consistent with the predictions of the theoretical models, with various content specific antecedents being added to the base models, such as barriers and perceived entertainment value [3], perceived expressiveness and perceived enjoyment [18], and perceived user friendliness [20].

While it is important to understand the factors that influences user adoption or acceptance of mobile services and applications, we submit that a significant issue in mobile commerce has not received adequate attention from scholars, that is, what type of mobile services or applications have the potential to significantly alter the rule of the game not only for mobile commerce but also for the digital economy in general? In another words, what are the killer apps for mobile commerce? With the rapid penetration of mobile services in the general population around the world and proliferation of mobile applications available to mobile users, recognizing and fostering killer apps in the early stages of the mobile commerce

and ubiquitous computing era could have significant technological, economic, and social consequences. Thus, in the rest of the paper, we focus on the issue of killer apps for mobile commerce.

## 3. In Search of Killer Apps

A glimpse of the short history of information technology suggests that the digital revolution during the last five decades were marked by extraordinary innovations or applications that significantly accelerated or altered the course of anticipated progress. Mainframe computers would have not had much impact on the world of business had it remained in the academic and military institutions where they were developed. It was not until the financial reporting applications became available for businesses when computers became indispensable for large businesses and organizations in the 1970s. When IBM introduced its first Personal Computer in the early 1980s, it was suggested that only a few hundred of these computing machines would be needed for the whole world. However, thanks to the office automation software (word processing, spreadsheet, email, and presentation), PCs have transformed billions of office labors into knowledge works and millions of homes into offices and entertainment centers. While the Internet technology was already developed and in use in the 1960s, it would have remained in universities and research institutions had the Web and Web Browser were not invented.

However, what took us into the era of Internet was yet another set of applications built on the infrastructure of the Internet: the online transaction technologies that enabled purchasing of products or services offered anywhere in the world from a home or office computer that is connected to the Internet. Now we are experiencing another wave of life altering technological innovations, the so-called Web 2.0 – Internet-enabled social networking, collaboration, sharing, and entertainment – that could take the World-Wide-Web as we know it to another new level with significant consequences to business and society few can predict.

Collectively, these history altering innovations are called “killer applications,” or “killer apps” for short. Killer apps seem to be easily identifiable after the fact and extremely difficult to recognize when they are emerging. Yet it is the latter that has tremendous social and economic values [7]. To help recognize potential killer apps in the early stages of their life cycle, we must first define what a killer app is and what

characteristics are unique to the killer apps. While there are quite a few definitions and descriptions for killer apps in the literature, scholars and practitioners seem to diverge on the precise set of characteristics killer apps commonly possess, if such common characteristics can be identified at all. Alani and his colleagues [1] define killer apps as “applications in which (a) the technology is essential, and (b) many users can find profit or utility.” However, this definition seems too broad to be useful for identifying the killer apps that truly changed the way we live and do business in the last few decades. On the other hand, Downes and Mui [7] define killer apps as “new information technology goods and services that change the rules of the game for people who aren’t even remotely connected to the killer apps’ intended markets.” They emphasize the disruptive and transformative power of killer apps and argue that killer apps invariably wind up displacing unrelated

older offerings, destroying and re-creating industries far from their immediate use, and creating chaos in the complex relationships among business partners, competitors, customers, and regulators of markets.

Drawing on the ideas of these scholars, we define killer apps as “information technologies and applications with their intended and unintended consequences that significantly changes the way we live and do business.” With this definition, we look back at the history of digital technology and attempt to identify the killer apps that occurred over the last five decades of the digital revolution. We submit that it is beyond the purpose of this study to identify each and every innovation and application that may qualify for the definition of killer apps. Table 1 only summarizes some of the widely acknowledged killer apps in the digital age.

Table 1: Example of Killer Apps based on Information Technology

<b>Application</b>	<b>Key Characteristics</b>	<b>Industries Significantly Affected</b>
Spreadsheet	<ul style="list-style-type: none"> <li>• Demonstrated how PCs can be used for improving work productivity.</li> <li>• Showed why PCs might be useful to a large number of people.</li> </ul>	<ul style="list-style-type: none"> <li>• PC manufacturers</li> <li>• Software</li> <li>• Electronics</li> </ul>
E-Mail	<ul style="list-style-type: none"> <li>• Significantly shortened the delivery time of mail messages.</li> <li>• Virtually eliminated the cost of sending mail.</li> <li>• Significantly reduced the need for telephone calls</li> </ul>	<ul style="list-style-type: none"> <li>• PC manufacturers</li> <li>• Software</li> <li>• Networking equipment</li> <li>• Postal services</li> <li>• Telecommunications</li> </ul>
Microsoft Office	<ul style="list-style-type: none"> <li>• Transformed millions workers into knowledge workers</li> <li>• Drastically improved office worker productivity.</li> </ul>	<ul style="list-style-type: none"> <li>• PC manufacturers</li> <li>• Software</li> <li>• Office equipment industry</li> <li>• Education</li> </ul>
Web Browser	<ul style="list-style-type: none"> <li>• Enabled ordinary people to access the vast amount of information stored in computer systems around the world.</li> <li>• Spawn new industries such web search engines, online advertising, and e-commerce.</li> </ul>	<ul style="list-style-type: none"> <li>• PC manufacturers</li> <li>• Software</li> <li>• Telecommunications</li> <li>• Entertainment</li> <li>• Publishing and Advertising</li> <li>• Mass Media</li> </ul>
Online Transaction Processing	<ul style="list-style-type: none"> <li>• Transformed the Internet from a reservoir of information to a global platform for commerce.</li> <li>• Spawn new business models such B2C, B2B, C2C, and P2C.</li> <li>• Spawn new industries such as online auction and online advertising.</li> </ul>	<ul style="list-style-type: none"> <li>• Financial Services</li> <li>• Retail and Wholesale,</li> <li>• Publishing and Advertising</li> <li>• Entertainment</li> <li>• Telecommunications</li> </ul>

<p>Search Engines</p>	<ul style="list-style-type: none"> <li>• Drastically reduce the amount of time for finding relevant information on the Internet.</li> <li>• Dramatically leveled the playing field for people all over the world by delivering valuable information equally and timely to anyone, anywhere, and at anytime.</li> </ul>	<ul style="list-style-type: none"> <li>• Software</li> <li>• Publishing and Advertising</li> <li>• Mass Media</li> <li>• Education</li> </ul>
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From these killer apps and drawing on the published literature, we can describe killer apps as those technologies and applications that usually exhibit the following characteristics:

**They are disruptive.** Killer apps are usually disruptive to the establish structure of industries and the orders of society. The emergence of a killer app often destroys extant industries and creates completely new ones. “In business, killer apps undermine customer relationships, distribution networks, competitor behavior, and economies of size and scale. Killer apps create global competitors where only local players previously mattered. They given customers, suppliers, and new entrant power, upsetting the careful cultivation of competitive advantages that were themselves based on technology, technology that is now suddenly obsolete” [7, p. 8]. VisiCalc kicked off the office automation software industry and solidified personal computer technology and personal computer manufacturing industry, which in turn decimated the typewriter manufacturers and marginalize personal calculator manufacturers. The communications protocols developed for the Internet, the famed TCP/IP suite, virtually wiped out the telecommunication carriers and equipment manufacturers who used proprietary communication protocols, such as electronic data interchange (EDI) networks used by many large organizations and the local area networks (LAN) based on Novel and Microsoft technologies.

**They are transformational.** Killer apps often bring new ways of doing business, conducting personal affairs, and interacting with society. The advert of a graphical web browser, Mosaic, and later NetScape and Internet Explorer, brought the Internet out of research institutions and into homes and offices of billions of ordinary people, thus ushered in the World-Wide-Web era. The Web has since dramatically changed the ways of how we do business, how we interact with others, and how we live. E-commerce technology has become a cornerstone of competitive strategies in almost all businesses large and small; E-government initiatives have made government agencies at all levels much more accessible and transparent to citizens; and the consumer surplus created by online shopping of goods and services such

as air tickets, travel packages, books, music, and consumer electronics are in the billions of dollars each year [21]. It is hard to imagine the global economy we see today without the killer apps such as Web browser and online transaction processing, and of course, the underlying Internet. We submit that very few innovations and inventions in the human history, perhaps with the exception of electricity, can match the degree and scope of transformations in industries and society brought by the Web during the last decade.

**They are indispensable.** A killer app must demonstrate that it is indispensable to a large percentage of the potential users by either growing into existing markets or creating new markets of its own [1]. Once again, web browsers provide an excellent example. Few other computer applications or devices, other than the computer itself, have had such profound role in everyday life of individuals, businesses, and organizations. From the ways of how international and governmental organizations and agencies provide services to their constituents, to the ways of how an elementary school child does her homework, web browsers are indispensable to a significant portion of the population today. Same is true for most of the other killer apps, such as office automation software, email, and search engine. On the other hand, web blogs and variations, regardless their extreme popularity, can hardly be recognized as a killer app because only a small percentage of the population might find them indispensable in their lives, while the majority of the population could certainly live without them.

**They create significant economic value.** The economic value of killer apps must be significant to their users. There must be a clear cost/benefit advantage for using the killer apps [1]. Social and entertainment values alone are not enough to make killer apps. Web browsers are recognized as a killer app not because they enable people to browse the Internet for information or to post blogs on social networking websites, but because they facilitate individuals and businesses to conduct commercial transactions that create billions of dollars of sales and savings to the users. Online shopping is not just convenience for consumers but has real economic

value. It was estimated that Amazon saved consumers \$100 million in 2000 alone [21]. Social networking and information websites survive not because they have millions of users but because advertisers generate real revenues for their clients from these millions of users. Another case in point is online gaming. As popular as it is among young and mostly male population, the economic value of participating in online gaming is concentrated to the content providers and network operators, leaving the most significant part of the ecosystem, the players, with zero or negative economic returns for their investment (time and money). Such application will not become killer apps no matter how popular they are.

**They have mass appeals.** To be qualified as a killer app, a new innovation and application must have strong appeals to a significant portion of the population. Although online gaming is very popular among some segments of Internet users, it will not become a killer app because of the limited appeal to the majority of the population, in addition to the negative economic benefits to its users. On the other hand, almost all office workers in the world use some sort of office automation software for their daily work, creating enormous economic values to their employers and themselves. Mastering of office software has become as essential as being able to read and write to knowledge workers and professionals who, in the information age, make up the most significant block of the workforce. Other killer apps, such as web browser, online transactions, and search engines, all have similar appeal to the majority, if not all, of the population in the world.

**They create significant unintended consequences.** One of the hallmarks of killer apps is their significant

unintended impact on users, industries, and society that might not even be remotely connected to their intended purposes. For example, VisiCalc spreadsheet was created to help accountant to perform complex data analysis faster, yet it showed why personal computers could be used by a large number of people. The consequence was the phenomenal growth of the PC and software industries in the next three decades. Similarly, when the web browser was created by a group of computer science graduate students at UIUC, it was meant to make navigating the nascent World-Wide-Web of information easier for researchers. What happened next was perhaps beyond even the wildest imagination of those students. Even the Internet itself, though not really a killer app by definition but a platform many of the killer apps are based on, was created for an entirely different purpose: a communication network that could withstand a nuclear attack. The effect of unintended consequences is perhaps the greatest quality of a killer app that differentiates it most from the rest of the innovations and applications.

#### 4. Killer Apps for Mobile Commerce

After having identified the most common characteristics of killer apps in the information technology domain, we now examine the emerging mobile commerce applications and innovations from the lens of killer apps in an attempt to identify one or more, if any, candidate killer apps for mobile commerce. For that purpose, we compare these applications using the killer app characteristics identified in the previous section. An overview of this comparison is presented in Table 2.

Table 2: Comparing Emerging Mobile Commerce Services

Characteristics of Killer Apps	Emerging Mobile Commerce			
	SMS	Mobile Email and Web Browsing	Mobile TV, Gaming and Entertainment	Mobile Payment and Banking
<i>Disruptive</i>	Low	Low	Medium	<i>High</i>
<i>Trans-formational</i>	Low	Low	Low	<i>High</i>
<i>Indispensable</i>	Medium	Low	Low	<i>High</i>
<i>Economic Value</i>	Medium	Low	Low	<i>Medium</i>
<i>Mass Appeal</i>	Medium	Low	Medium	<i>High</i>
<i>Unintended Consequences</i>	Low	Low	Medium	<i>High</i>

#### 4.1 Short Message Service (SMS)

SMS is by far the most widely adopted and most frequently used mobile commerce services by mobile phone users. SMS services combine the accuracy and conciseness of email and the convenience and instantaneous of mobile phones. SMS also combines the best qualities of asynchronous emails with synchronous phone calls: instant yet non-intrusive.

However, the adoption of SMS is uneven across countries and demographic groups. It is more popular in countries where mobile phone service charges are based on each call, such as Asian and European countries, than in countries where services are charged based on a fixed monthly fee and mobile to mobile calls are free within the same network. It is also more popular among younger users than the rest of the demographic groups. While the popularity of SMS is still growing at extraordinary rate, and in some countries, such as China, Japan, and Finland, SMS has generated significant economic impact to both mobile service providers and content providers [3, 30], we posit that it is unlikely to emerge as a killer app for mobile commerce because it is low to medium on all six identified killer app qualities, as shown in Table 2.

SMS has been in service since the later 1990s in many countries including the US. So far its impact on business and society has been very limited even in countries where the usage is high such as those in Asia and Europe. Alternative technologies such as BlackBerry in US and I-Mode in Japan also lowered its indispensability and limited the extent of its adoption across the world. Its economic impact to individuals and businesses are also limited since it is used primarily as a social networking tool rather than a means for commercial transactions. The economic benefits are most appropriated by the network carriers and little is spilled over to its users and the rest of the society. However, SMS could play significant roles in the future mobile killer apps either as an integrated service or as an auxiliary service. For example, SMS could be used to initiate, verify, or confirm mobile banking and payment services, as many mobile commerce patents imply.

#### 4.2 Mobile Email and Web Browser

Many mobile phones today have the capability of browsing the Web and some can even sending and receiving emails. The advent of technologies such as personal digital assistant (PDA), BlackBerry, and iPhone, has transformed mobile phones from pure

communication devices into multifunctional mobile computing terminals. While such services have proved to be indispensable to many high end users, such as executives in business and government organizations and professionals in finance, legal, and sales, their impact on the rest of the population has been limited largely due to the high cost and narrow utility to users. Given the confined screen space and limited bandwidth, browsing the Web on or sending/receiving email via a mobile phone will always be considered as a supplement to rather than a substitute for the fixed browser on home or office PCs. The potential economic and structural impact to individuals, businesses, and the society is most likely incremental and evolutionary, not revolutionary or disruptive. Thus, we argue that mobile email and web browsing services are unlikely to emerge as killer apps for mobile commerce.

#### 4.3 Mobile TV, Gaming, and Entertainment

Using mobile phones as multi-functional computing, entertainment and communication devices is certainly the new trend in the wireless world. Today mobile phones that integrate voice, video, music, gaming, and web browser in one device are common, mobile phones are increasingly resemble personal computers in terms of functionality. Such devices will undoubtedly provide users with unprecedented convenience to users, and could be disruptive to certain segments of the consumer oriented industries such as digital video and music player manufactures, mass media, and advertising. However, as an extension of existing technologies (computers and personal digital assistant, game console) and applications (music and video player, web browser) with wireless mobility, their services are similar to mobile email and web browsing in the sense that they are more evolutionary than revolutionary, and more a supplement than a substitute to existing technologies and services. Thus we argue that mobile gaming and entertainment services are less likely to become killer apps for mobile commerce as well.

#### 4.4 Mobile Payment and Banking

We define mobile payment and banking as using mobile phones to pay for services (bus, train, movies, entertainments), goods (retails stores, coffee shops, restaurants, vending machines, online stores), bills (electric, gas, credit cards, phone), and transfer funds (bank to mobile, bank to bank, mobile to mobile). While the idea has been around for over a decade, it is believed that the next decade will be decade of mobile

payment, banking, and digital cash [9]. What is remarkable about mobile payment and banking services is that they do not require significant research and development in the existing mobile phone technology since the technologies are largely in-place already, thus making it viable for mass adoption with relatively low cost and short time. By adding an extra chip or modifying the current circuitry and firmware, mobile phones can be transformed into a mobile payment and banking device without significant increase in unit cost.

In fact, users around the world are already embracing mobile banking and payment services. For example, consumers in advanced markets such as Japan, South Korea, Austria, and Norway have been using their mobile phones to receive alerts, manage their accounts, pay bills, and transfer funds. Mobile ticketing, which allows device users to purchase tickets for events, transportation, and parking, have been widely adopted in Europe and Asia, where consumers use mobile devices to feed parking meters and purchase cinema, train, and ski lift tickets online or at unattended point-of-sale (POS) terminals. In Austria, subscribers use their mobile devices to pay for home-delivery

shopping services, vending machine and in-store purchases, taxis, and purchases at fuel stations and other retail outlets. In South Korea, subscribers can pay for purchases by using mobile devices that contain a smart chip linked to their credit card account [27].

However, the impact of such services to retailing, service, banking, and credit card industries could be even more profound [9]. It is well within the imagination that the credit card industry could be transformed into a completely digital world, very much like today's stock brokerage industry, thus opening up for even more intense competition and consolidation. It also has the potential to transform the cash-based financial systems into cash-less, truly digital financial systems in countries across the world, thus creating literally a 'friction-free' global financial system where money can be sent and received by touching a few keys on a mobile phone. Table 3 describes some of the potentials of mobile payment and banking applications from the lens of the killer apps.

Table 3: Killer App Characteristics of Mobile Payment and Banking

Characteristics	Impact	Description
Disruptive	Moderate	<ul style="list-style-type: none"> <li>• Credit card industry most severely affected</li> <li>• Banking industry deals with new business</li> <li>• Retail industry accommodate new technology</li> </ul>
Transformational	High	<ul style="list-style-type: none"> <li>• Efficiency in retail industry</li> <li>• New businesses for banking industry</li> <li>• Digitizing credit card industry</li> <li>• New models for advertising</li> </ul>
Indispensable	High	<ul style="list-style-type: none"> <li>• Diminish the need to carry cash</li> <li>• Replace the need for most credit cards</li> <li>• One device for meeting many daily needs</li> </ul>
Economic value	Moderate	<ul style="list-style-type: none"> <li>• Economic benefits to retailers</li> <li>• Convenience to consumers</li> <li>• Value added for service providers</li> <li>• Mobile device manufactures</li> </ul>
Mass appeal	High	<ul style="list-style-type: none"> <li>• Adoption by retailers: efficiency</li> <li>• Adoption by individuals: convenience</li> <li>• Adoption by banking: new revenue channels</li> </ul>
Unintended consequences	High	<ul style="list-style-type: none"> <li>• Privacy intrusion could be significant</li> <li>• Cashless society is possible but uncertain</li> <li>• Criminal behavior and money laundering</li> <li>• Global standards are possible but challenging</li> </ul>

Inevitably, there are many uncertainties surrounding the issue of unintended consequences of mobile payment and banking services, which in fact have been one of the hallmarks of killer apps. With so many capabilities integrated into one single device, the mobile phone, it may generate higher levels of anxiety in consumers and create greater opportunities for criminals. And it may induce criminal behavior due to its prevalence and easy access by design. The uncertainty is further exacerbated by the fact that, in order for the service to work, retail, banking, and financial service companies must all participate and buy into the systems, in addition to the mobile network carriers and mobile phone manufactures. There must be a mass adoption of the mobile payment terminals in service points at retailers across the world in order to create the economy of scale needed to make economic sense for users and service providers. And banks and credit card companies must integrate their transaction processing systems with mobile networks. Wide-spread adoption of mobile payment and banking services could spawn completely new services or industries which are difficult to imagine at this time. Therefore, it is our conclusion that mobile payment and banking services are most likely to emerge as killer apps for mobile commerce that will take us to a whole new era of e-commerce and global economy.

## 5. Opportunities and Challenges

With more people owning mobile phones than computers and the growth rate of mobile users far exceeding that of the computers around the world, the potential of mobile commerce is almost unlimited. The total number of mobile commerce transactions per year is expected to increase from 498 million globally in 2006 to 4.8 billion in 2010, and the average mobile commerce transaction value is expected to increase from \$7 in 2006 to \$13 in 2010 [27]. What's even more exciting about mobile commerce is that developing countries now have a real opportunity to compete with developed countries at almost equal levels, and in some sense, in favorable conditions. This is because mobile phone network infrastructures can be established fairly quickly and with less intense capital investment, as it has been shown in Asia and Africa. People in these countries seem to be more likely to use their mobile phones for commerce activities perhaps because that's the only device they have: home computers plus Internet access are often too expensive for the majority of the population.

However, the current state of the art of mobile commerce is far behind the expectations. In this paper, we argue that one of the main reasons for this stagnation of mobile commerce growth is the lack of killer apps – innovations or applications that create enormous economic and social impact by altering the rules of the game in businesses and society and spawning completely new products, services, and industries. After examining the emerging mobile commerce services via the lens of killer apps, we further suggest that mobile payment and banking services are most likely to emerge as killer apps, if not the killer apps, that will launch mobile commerce to a whole new level, while shattering the economic rules and constraints of current financial and retail industries alone the way. For any of these to occur, there are still numerous obstacles to overcome. We now attempt to describe some of the challenges. A broader discussion of the challenges facing mobile commerce in general can be found in Tarasewich et al. [25].

### 5.1 Global Standards for Mobile Commerce

First and foremost, compatible mobile communication standards and mobile payment standards must be developed and implemented by the majority of the businesses and institutions involved, including mobile network carriers, financial institutions, retail outlets, and mobile phone manufactures. Any break down in the global supply chain of mobile payment and banking services could severely limit their economic value and impact and hinder their wide-spread adoption and use, which would further diminishes their value. This is because mobile payment and banking systems exhibit the maximum degree of network externality: the value of each participant derives from the network is significantly affected by the addition of new participants to the network [16]. There are sporadic successes of mobile payment and banking in Asia and Europe, but the spread to the rest of the world have been dampened by incompatible systems, standards, and regulations [17].

### 5.2 Sustainable Business Models

The ultimate goal of businesses is to earn maximum return for their investment. Therefore, profitable and sustainable business models must emerge for each stakeholder in the entire ecosystem of mobile payment and banking services. That is, each stakeholder must be clear about a) its services and products; b) its customers and markets, c) its value proposition to customers; and d) its revenue and profit proposition to



shareholders. Only if the business models ensure win-win propositions for all participants, then such business models, thus the services, can be sustained over a long run. Short-term profit opportunities for some parties in the system can only accelerate the demise of the system, such as the push technology in the later 1990's, the online grocery shopping experiment the early 2000's, and the online music sharing applications in the mid-2000's. The quick rise and demise of many telecom firms in the 1990's have clearly demonstrated the critical importance of having a sustainable business model even for the hottest application and technology of the time [13].

### 5.3 Security Risk and Privacy Concerns

Security vulnerability and privacy concerns will become even more acute in mobile payment and banking services than in ordinary e-commerce activities. Theft or loss of mobile phones can be commonplace and user financial assets and identity must be protected in such situations. On the other hand, user location and activities can be easily tracked or recorded legally or illegally by network carriers and service providers, making privacy intrusion a serious concern. While developing security technologies that fit with mobile devices and networks is critical, it is equally important that compatible and visionary laws and regulations be implemented to protect consumers from criminals and malicious individuals or organizations while not hindering the innovation and adoption of the services by individuals and businesses.

### 5.4 Integration with Extant Culture and Infrastructure

Finally, given the potentially enormous economic impact and the highly uncertain social implications mobile payment and banking services could create, rigorous and relevant research on mobile commerce, especially mobile payment and banking, are highly needed. Such complexity and uncertainty about mobile commerce, especially mobile banking and payment applications, are attributed as some of the main reasons why major banks in the U.S. have been slow in embracing mobile commerce [17]. Research on the topics of user attitude and behavior toward mobile payment and banking, organizational level adoption of mobile transaction processing, mobile and back-office systems integration, business models and business process reengineering, evaluation of economic and social impact of mobile commerce, standards and regulations, etc., could yield valuable insight into this nascent yet potentially a killer app that could

ultimately usher in the new era of the digital global economy.

## 6. Conclusion

Killer apps, the applications of a new technology that significantly alter the way we live and do business, have long been recognized as a major factor in the wide-spread acceptance and rapid diffusion of the technology. Though there is still no scientific prove of this thesis, anecdotal evidence is omnipresent in the short history of digital technologies. From that vantage point of view, we argue that the lack of killer apps is the main culprit behind the slow and disappointing development of mobile commerce in the last decade, which supposedly was the decade of mobile commerce, given the rapid deployment of mobile communication technologies across the world.

In this study, we developed six criteria for identifying and evaluating killer apps and applied these criteria for evaluating current and emerging mobile commerce services and applications. We argued that the emerging mobile payment and mobile banking applications are the most likely candidates for mobile commerce killer apps. Although there are still significant challenges ahead, such as the incompatibility of mobile communication and banking standards across the countries and continents, lack of proven sustainable business models, security and privacy concerns, and integration with current banking infrastructure, the opportunities could also be extraordinary: dramatic changes in the way we live and do business, tremendous wealth for entrepreneurs and business visionaries, and perhaps most significant of all, the unintended consequences. All of these issues pose significant challenges and opportunities to academics for research as well.

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## 7. References

- [1] Alani, H., O'Hara, K., and Shadbolt, N. (2005) "Common Features of Killer Apps: A Comparison with Protégé," Proceedings of the 8th International Protégé Conference, July 18-21, 2005, Madrid, Spain.
- [2] Ajzen, I. (1988) Attitudes, Personality, and Behavior, The Dorsey Press, Chicago, IL 60604.

- [3] Bouwman, H., Carlson, C., Molina-Castillo, F. J., and Walden, P. (2007) "Barriers and drivers in the adoption of current and future mobile services in Finland," *Telematics and Informatics*, 24(2), 145-160.
- [4] Carlsson, C., Hyvönen, K., Repo, R., and Walden, P. (2005). "Asynchronous adoption patterns of mobile services." Proceedings of the 38th Hawaii International Conference on System Sciences (HICSS38), Big Island, HI, USA, January 3-6.
- [5] China Daily (2006) "China's mobile phone users top 416m," China Daily, 2006-05-22. Available online at [http://www.chinadaily.com.cn/bizchina/2006-05/22/content\\_596866.htm](http://www.chinadaily.com.cn/bizchina/2006-05/22/content_596866.htm)
- [6] Davis, F. D. (1989) "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly*, 13(3), 319-340.
- [7] Downes, L. and Mui, C. (1998) *Unleashing the Killer Apps: Digital Strategies for Market Dominance*. Harvard Business School Press, Boston, MA.
- [8] Department of Commerce (2006) *E-commerce 2004*. Available at <http://www.census.gov/eos/www/papers/2004/2004reportfinal.pdf>
- [9] Economist (2007) "A Cash Call: The Future of Money," *Economist*, February 15, 2007.
- [10] Goode, A. (2006) *Mobile Commerce Strategies: Ticketing, Retail, Payment & Security, 2005 – 2010 (2<sup>nd</sup> Edition)*, Juniper Research.
- [11] GSM World (2005) "Worldwide cellular connections exceeds 2 billion," GSM World News Release, London, September 15, 2005. Available at [http://www.gsmworld.com/news/press\\_2005/press05\\_21.shtml](http://www.gsmworld.com/news/press_2005/press05_21.shtml).
- [12] Harris, P., Rettie, R., and Cheung, E. (2005) "Adoption and usage of M-commerce: a cross-cultural comparison of Hong Kong and the United Kingdom," *Journal of Electronic Commerce Research*, 6(3), 210- 224.
- [13] Hu, Q. and Huang, C. D. (2006) "Institutional Influences on Organizational Structure and Behavior: An Evaluation of the Business Models of the Telecom Industry," *Information Systems Frontier*. 8(3), 225-239.
- [14] Jarvenpaa, S. L., Lang, K. R., Takeda, Y., and Tuunainen, V. K. (2003) "Mobile Commerce at Crossroads," *Communications of the ACM*, 46(12), 41-44.
- [15] Karjaluoto, H., Leppäniemi, M., Standing, C., Kajalo, S., Merisavo, M., Virtanen, V., and Salmenkivi, S. (2006), "Individual differences in the use of mobile services among Finnish consumers," *International Journal of Mobile Marketing*, 1(2), 4-10.
- [16] Katz, M. L. and Shapiro, C. (1985) "Network Externalities, Competition, and Compatibility," *The American Economic Review*, 75(3), 424-440
- [17] Lai, E. (2006) "U.S. banks slow to embrace mobile commerce," *Computerworld*, August 28, 2006. Available at <http://www.computerworld.com/action/article.do?command=viewArticleBasic&articleId=9002981>
- [18] Nysveen, H., Pedersen, P.E., and Thorbjørnsen, H. (2005) "Intentions to use mobile services: antecedents and cross-service comparisons," *Journal of the Academy of Marketing Science*, 33(3), 330-346.
- [19] Pagani, M. (2004) "Determinants of adoption of third generation mobile multimedia services," *Journal of Interactive Marketing*, 18(3), 46-59.
- [20] Pedersen, P.E. (2005) "Adoption of mobile Internet services: An exploratory study of mobile commerce early adopters," *Journal of Organizational Computing and Electronic Commerce*, 15(3), 203-221.
- [21] Postrel, V. (2004) *Economic Sense*. New York Times, April 22, 2004. Available online at <http://ebusiness.mit.edu/news/Press/NYT4-22-04/index.html?wflid=1805201>.
- [22] Rao, B. and Minakakis, L. (2003) "Evolution of Mobile Location-based Services," *Communications of the ACM*, 46(12), 61-65.
- [23] Rogers, E.M. (1995) *Diffusion of Innovations*, New York, The Free Press.
- [24] Sarker, S., and Wells, J. D. (2003) "Understanding mobile handheld device use and adoption," *Communications of the ACM*, 46(12), 35-40.
- [25] Tarasewich, P., Nickerson, R. C., and Warkentin, M. (2002) "Issues in Mobile E-Commerce," *Communications of the Association for Information Systems*, 8, 41-64
- [26] Urbaczewski, A., Valacich, J. S., and Jessup, L. M. (2003) "Mobile Commerce: Opportunities and Challenges," *Communications of the ACM*, 46(12), 31-32.
- [27] Verisign (2007) *Mobile Commerce Services Driving Mobile Commerce Adoption: Best Practices for a Comprehensive, Secure Mobile Commerce Strategy*. Verisign White Paper, available on line at <http://www.verisign.com/static/DEV040159.pdf>.
- [28] Wang, Y. and Yuan, Y. (2006) "The role of SMS in mobile data service diffusion in China: A longitudinal case study based on actor-network theory," Proceedings of the Twenty-Seventh International Conference on Information Systems, December 10-13, Milwaukee, USA.