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ABSTRACT

Mobile and wireless technologies (MWTs), such as wireless laptop computers, personal digital assistants (PDA), mobile phones, smart phones, etc., have deeply penetrated our lives. Government agencies use MWTs to enhance their managerial effectiveness and provide high-level services to citizens taking advantage of its characteristics of mobility, ubiquity, provision of other location-based government services, and on-time information delivery. Mobile government (m-Government) is forming diversely within (as well as between) different countries. China currently has 738.57 million mobile phone users and 29 cities are deploying "Wireless City" projects. Within this context, we chose six different cities in China to examine m-Government maturity and assess the deployment of m-Government services. We further explored mobile and wireless technology (MWT) application and implications in conjunction with a special project in Beijing. Results are discussed and conclusions are drawn.

Keywords

Mobile, wireless, m-Government, China.

INTRODUCTION

As information and communication technologies (ICTs) have dramatically developed in the past twenty years, they have greatly impacted government sectors. Before the Internet and personal computers were widespread, the main objectives of technologies used in public sectors were to help enhance managerial effectiveness of public administrators while also increasing government productivity (Yildiz, 2007). Since the 1990s, public sectors across the world have been applying Internet technology and other ICTs in innovative ways to facilitate delivery of their services, improve efficiency (Trimi and Sheng, 2008) and decentralize management in government agencies (Yildiz, 2007). Thus, electronic government (e-government) has been proposed and defined as "utilizing the Internet and the World-Wide-Web for delivering government information and services to citizens" (Szeremeta, 2002).

In recent years, mobile and wireless technologies (MWTs) have boomed and have brought fresh air to e-government. Laptop computers, personal digital assistants (PDA), mobile phones, smart phones and other MWTs that provide access to wireless networks are moving governments toward the deployment of mobile government (m-Government) (Sharma & Gupta, 2004). M-Government refers to the use of MWTs within government administration and its delivery of information and services to citizens and businesses (Kim et al., 2004). A variety of initiatives and applications have been implemented founded on multiple motivations with varying degrees of maturity and impact. Scholars have sought to help organize eGovernment efforts through maturity models (e.g., Andersen and Henriksen, 2006) and project assessment frameworks (e.g., Esteves and Joseph, 2008). However, the extension to, and distinction of, mobile and wireless technologies have not been taken into specific consideration.

In this paper, we report on efforts in six different cities in China to examine the m-Government maturity, and study the deployment of m-Government services. We further explore and assess an MWT application of a special project in Beijing. Results are discussed and conclusions are drawn.

BACKGROUND

By way of background, we begin by examining mobile technology uniqueness followed by maturity model and assessment framework introduction, as well as happenings within China.

Mobile Technology Uniqueness

M-Government also has unique characteristics from an information technology perspective:

1. Mobility and ubiquity. Citizens have access to government information and services anytime and anywhere using wireless networks through their mobile and wireless devices. Government employees can work by using MWTs, regardless of distance, time, place and diverse natural conditions.
2. Provision of location-based government services. As laptop computers, PDAs, mobile phones, etc., are personal, the possibility of locating a person's exact physical location ensures that governments can directly provide their services to each person. This could accelerate reforming government organizational structures to become flatter and more refined.
3. Timely information delivery. Specific benefits of MWTs, such as real-time connection and fast access, make just-in-time information delivery a reality. As third generation (3G) technologies are deployed, data, as well as voice and even video calls, can be transmitted by wireless broadband (Ntaliani et al., 2008).
4. Mobile devices are a common part of daily life. Since 2005, mobile phone penetration in some developed countries, such as Australia, Finland, Germany, has exceeded 100%. In Hong Kong, mobile phone penetration reached over 170% in 2009. Although global positioning systems (GPS) and smart phones are less widespread, they are also increasingly popular worldwide. When public sectors deploy MWTs for service support, government employees and citizens can easily accept this innovation.

Maturity Model and Assessment Framework Introduction

Given the plethora of eGovernment applications and degrees of implementation, scholars have sought to develop maturity models and assessment frameworks. Due to space limitations, we have chosen an example of each to illustrate those that we feel are particularly useful considerations for m-Government.

The World Bank stage model of eGovernment (2003) and Layne and Lee's (2001) "four stage model" are early examples of maturity models. Several researchers have further developed those models into different perspectives. One that we consider to be particularly appropriate for m-Government application is that of Andersen and Henriksen (2006), who introduce a Public Sector Process Rebuilding (PPR) model. Unlike Layne and Lee's (2001) "four stage model" which emphasizes technology integration issues, the PPR maturity model places emphasis on the digitalization of core activities beneficial for end users. A key feature is movement from support for internal users (e.g., government employees) to external users (e.g., citizens) with corresponding transfer of data ownership.

The comprehensive framework for the assessment of eGovernment projects developed by Esteves and Joseph (2008) is especially useful for m-Government evaluation. The framework focuses on post-implementation issues particularly relevant to citizens. The inclusion of not only a variety of stakeholder considerations, but also assessment dimensions and maturity level consideration, gives the framework robust application opportunities. Foundations going back to socio-technical research by Bostrom and Heinen (1977), as well as more contemporary motivations (e.g., Bakry, 2004), give the framework academic credibility and enable further contributions to literature. Maturity level focus on interested parties (innovative leaders, visionary followers, steady achievers and platform builders) related to the Accenture model (Hunter and Jupp, 2001) complements considerations of Andersen and Henriksen (2006).

Happenings in China

Trimi and Sheng (2008) argue that due to the inadequate e-government infrastructure in China, m-Government in China is still at its embryonic stage. However, since the 1990s, starting from three Golden Projects and the Government Online Projects, to the recent "Wireless City" program implemented in 2009, China's efforts have grown quickly. By November 2009, China had 738.57 million mobile phone users, and China's mobile phone penetration rate had reached 54.3% (MIIT, 2009). The number of mobile Internet users was 155 million, accounting for 45.9% of all Internet users (CNNIC, 2009). Moreover, China has deployed 3G networks over the entire country. At the beginning of 2009, three mobile operators in China: China Mobile, China Telecom and China Unicom received 3G mobile phone licenses for domestically-developed TD-SCDMA standard, US-developed CDMA2000 standard, and Europe's WCDMA standard, respectively. By the end of 2009, China Mobile had set more than 100,000 TD-SCDMA base stations covering 238 cities in China and the wireless connection rate had been improved to 98% (MIIT, 2009). Currently, China Unicom's WCDMA network, the largest WCDMA network

in the world, covers 335 large and medium sized cities (People's Daily Online, Jan. 07, 2010). These infrastructure enhancements ensure that government can use advanced MWTs to improve efficiency and effectiveness in providing high-level services.

M-GOVERNMENT IN CHINA

In this section, we illustrate m-Government diversity that is occurring in China through a set of examples. The locations are illustrated in Figure 1.

Figure 1. Map of China

Beijing

Historically, public facilities management has been triggered either through inspections by government officers or reports from citizens. Either way, the time taken from problem discovery to solution would take at least one month, even for a simple incident (e.g., a missing man-hole cover in a street) and had to pass through different levels of public sector administrators. Government departments could not cooperate timely and sometimes passed the responsibility to each other because of the insufficient information from inspectors or citizens. At the beginning of 2004, the Beijing Dongcheng District began to grid its 25.38 square kilometers into 1593 cells, with each cell assigned to an officer responsible for facilities under the auspices of the "Ten-Thousand Meter Unit Network" project to facilitate city management. A thorough survey of public facilities in the district was carried out to map the locations of each public facility in a GIS (Geographic Information System). A handheld MWT device (Cheng Guan Tong) was developed with the ability to take pictures, make calls, and send multimedia messages. Two centers were established: the Supervision Center and the Command Center. At the Supervision

Center, the location of all supervisors at work could be located and displayed on a large screen. Thus, when an officer would find a public facility that was broken, he could take pictures and immediately send the information to the Control Center. The Control Center would then coordinate with different departments at the municipal level to deal with the problem as soon as possible. More recently, citizens have been encouraged to use camera facilities on their GPS-enabled mobile phones to directly transmit problems. By the end of 2009, 47 cities in 20 Chinese provinces had implemented projects similar to that of the Beijing Dongcheng District.

Taiyuan

Taiyuan is the provincial capital city of Shanxi Province. Mobile government has not yet been implemented and is just in the initiation stage in Taiyuan City. The development of E-government in Taiyuan is at a low level, compared to cities such as Beijing and coastal cities in China. The official E-government website for Shanxi Province (of which the information center is located in Taiyuan City) was built in May 2006. It aims to act as a more efficient way of running government functions. However, the website has not been functioning to date. The portal of the website lists only the services that it intends to provide, such as online services for employment, education, transportation, and so on. However, the website displays only those titles, rather than link those to real pages for further use. The local government has now started to build a Ten-Thousand Meter Unit Network modeled after that of Beijing. On April 9, 2009, the project passed expert system evaluation and has now been put into practice. The implementation covers 107 square meters and grids this area into 20 to 30 cells. Government supervisors are equipped with handheld MTW devices (with capabilities similar to the devices used in Beijing) to monitor and report in urban-management problems. They visit a problem site, take real-time pictures and send them back to the center. When there is a public celebration, the Sanitation sector is also equipped with a mobile video vehicle to monitor the surrounding environment.

Jinzhong

Jinzhong is adjacent to Taiyuan city. Although it is not the provincial capital of Shanxi Province, the local government has made some M-government progress. The M-government project began implementation in June 2006. The project aims to provide an online administrative office system through which it can instantly deliver documents to government officers. The system sends SMS to government officers about meeting information. Accordingly, the officers receive these notices, regardless of their physical locations. In 2007, the system implemented a mobile phone conference system which allows several users to be connected to the system at the same time to communicate with each other. The government officers can log on to the system to search for useful information about upcoming meetings or the content of previous meetings, etc. The Jinzhong government has not yet implemented any specific citizen m-government services, e.g., in healthcare. The current services they are providing are via the government portal where they have a specific column for "healthcare." Citizens can search for information on allocations of hospitals, pharmacies and the policies on insurance in healthcare from local government.

Xiamen

Similar to the "mCity" project in Stockholm, the largest municipality of Sweden (Hallin, 2007), Ximen has proceeded with its "Wireless City" program (through a TD-CDMA network in cooperation with a commercial service provider, China Mobile) since 2009. It covers not only the public sectors, but also every individual and every organization. Xiamen has started the program from small scale projects. For example, the transportation department manages the cars and traffic by using combined GPS with short message services (SMS). Citizens can access the WAP site of the Price Bureau through their mobile phones and get real-time information regarding prices anytime and anywhere. Near field communication technology has turned transportation and payment through mobile phones into reality. The public sector has also used MWTs to reform their work process and greatly improve work effectiveness and efficiency. For example, Xiamen Water Company, which is held by Xiamen Municipal Works and Gardens Administration Bureau and Xiamen Municipal Administration Center, has adopted a wireless meter-reading system (WMRS) developed by China Mobile and Fujian Strong Software Company. Officers collect water consumption using a GPS-enabled mobile phone and upload data to a server that prepares a bill for the user. Since this system adoption, an officer can read more than 700 meters daily, up from 300.

Suzhou

Suzhou in Jangsu province is a Southeastern Chinese city in proximity to Shanghai. Its economy is prosperous. In recent years, the Suzhou municipal committee has paid high attention to information provision to citizens. In 2003, the eGovernment website (www. Suzhou. Gov. cn) was set up as a landmark of eGovernment development in Suzhou. In January 2009, the WAP (Wireless Application Protocol) platform named "China Suzhou" was adopted and applied in Suzhou. The

WAP site of "China Suzhou" was built by the Suzhou municipal office of information infrastructure and is the landmark for m-Government development in Suzhou. Mobile telephone users can log on to the information platform (wap.Suzhou.Gov.cn) by cellphone and get information relevant to the political and economic development of Suzhou. The "China Suzhou" mGovernment platform is characterized by timely delivery, ubiquity and interactivity. When officials receive emails from citizens, they use WAP-push to reply, which improves the efficiency of government. Further, message boards, online transactions, and online complaint support can be used by citizens to interact with the government on the WAP sites.

Hong Kong

Hong Kong is a Special Administrative Region of the Peoples Republic of China. Hong Kong provides live traffic information for mobile devices, as well as real-time weather information, environment and air pollution, government news and press releases. The Hong Kong Government is committed to ensuring broad population benefits from the latest mobile technology developments. With Government support, the Hong Kong Wireless Technology Industry Association has established a wireless development centre responsible for promoting innovative application and service development, testing and marketing. The Government provided HK$210 million (US$28 million) to provide Wi-Fi networks in selected government venues over two years to complement commercial provision of Wi-Fi hotspots. This type of Government synergism with commercial endeavors is a Hong Kong hallmark. Available for free use by the public, the Wi-Fi networks were first installed in all public libraries, major cultural and recreational centers, community halls, and large parks as well as government offices frequently visited by the citizenry.

INTERVIEW SUMMARY RESULTS

As previously noted, Beijing has begun consideration of mobile government services in city management with the "Ten-Thousand Meter Unit Network" project put into operation in the Dongcheng District. The MWT-based system was created in response to frustrations of service levels associated with hygiene (e.g., piles of garbage) and personal safety (e.g., stolen man-hole covers), as well as concerns over unlicensed peddlers and other violators. The situation was exacerbated by neighborhoods with narrow alleyways and general inability to patrol in a traditional fashion.

With GPRS connection to the supervision center through the mobile handset, supervisors (surveillants) can receive instruction from (or make phone calls to) a central point for efficient handling. They also receive complaints from the residents (transferred from the call center at the supervision center), confirm them, and send the information back to Supervision Center. If necessary, the supervisors can take photos with their mobile handset and send these back together with the position automatically noted. The Supervision Center then passes on the information to the Command Center with large-screen situational displays (shown in Figure 2) from which appropriate action can be taken and monitored.

When the residents first saw the supervisors taking photos with their mobile devices near their residence, they were initially suspicious and reluctant to believe that this would work. When they found that local environmental problems had really been solved in a much more efficient way, the residents were very happy and began to become actively involved. Now, residents are increasingly likely to ask the supervisors in their community for help if they encounter any problem, and sometimes even invite the supervisors to their house to have a talk. This active involvement of citizens has led to unintended consequences, as indicated through interviews with project staff at various levels in the organization. For example:

- MWTs can increase government efficiency by helping governmental agencies inform each other. For instance, when a surveillant finds a problem (e.g., a citizen dumping a great deal of garbage in a park) in "A" block, he will use the Chengguantong (special mobile phone) to take a picture as evidence. He will also record the problem in detail, including time and location. Then the picture and description of the problem will be sent as a message to the Supervision Center. The receptionist will let another surveillant check it, if necessary. If the problem is accurate, the information will be uploaded to a City management database to be shared among relevant leaders of the city management. The leaders of each block (or community or district of Beijing city) can log on and see the problem. Publicizing city-management problems obliges the leader of A block and relevant agencies to be concerned. When the problem is made public, the only choice of the agency leader is to resolve it. By contrast, without the mobile technology to collect problem information, agencies can choose to ignore it, even if the leader of A block knows about the problem.

- MWT can also flatten the G2G (Government to Government) or G2C (Government to Citizen) network structure. In m-Government, MWT flattens the structure of G2G and G2G networks and increases the connection frequency between agencies and citizens or among agencies. This facilitates the information flow in these networks and, therefore, increases the effectiveness and efficiency of government. For example, m-Government is characterized by mobility, interactivity, synchronicity and presence. These characteristics will reduce the number of hierarchical

levels of government. If a problem is found, citizens can call the hotline, and there is no need to report it sequentially from low to high level departments. Further, MWT also increases the density, centrality and the range of G2G or G2C networks. Thus, MWT goes quickly beyond aspects of efficiency as an anticipated and intended outcome to include many unanticipated and unintended outcomes that begin to come into play and raise a number of issues which warrant discussion and further research.

Figure 2. Command Center

In summary, Beijing's Dongcheng District project was initiated with aspects of scientific management in mind and efficiency-oriented goals that have been achieved. As noted by one employee, *"The time used to resolve a city management problem was reduced from one week to 6.5 hours. On the average, 3,000 cases were handled successfully every month, which are six times previous number."* Another noted that *"mobile technology enhances the level of government information construction. M-Government service allows civil servants to provide better and more efficient service to citizens, reduces the cost of public administration, and improves citizens' participation in public affairs."* The project has, indeed, evolved into a much richer (and more impactful) demonstration of citizen and government interaction and cooperation. The associated head of this center has noted that *"since the mobile technology was applied in city management in the past five years, 2200,000 cases of city management were effectively resolved. The rate of ending cases is 95%."* The end result has been a sustained harmonious demonstration of community improvement that is now being rolled out in over 30 other districts in Beijing, and is also under consideration in other cities in China. The further evolution of commercially available location-sensitive MWT, combined with local infrastructure and 3G coverage, enables relatively easy (and low cost) implementation.

DISCUSSION

The possibility to dramatically influence a number of aspects of government provides a fertile ground for consideration of a multitude of issues. Towards that end, we will utilize the e-government maturity model contributions of Andersen and Henriksen (2006) and the framework for e-government project assessment proposed by Esteves and Joseph (2008) to

organize our discussion with a focus on factors that may influence the development, impact and diffusion of m-Government. Due to space limitations, our discussion can only be cursory.

What Stage is m-Government Really In?

The stage that m-Government is really in is a function of what is being observed. There is a wide variety of m-Government initiatives in various phases of maturity and a large number of stakeholders, each of whom can be expected to view the situation from a somewhat different perspective. Towards this end, considerations include financial variances of local governments and geographical constraints. It is hard to digitalize on a nation-wide level, but municipal or district level initiatives are increasingly commonplace. If we look more closely at the Beijing application previously described, we see evidence of movement toward higher levels of both customer and activity centricity in keeping with the PPR maturity model (Andersen and Henriksen, 2006). Towards that end, citizens can now use their mobile phones to create and transmit data to the government which is then shared and used for corrective purposes by appropriate agencies. Andersen and Henriksen (2006) label this as phase IV (revolution) in their maturity model.

The ubiquitous and differentiated features of MWTs (e.g., location sensitivity) provide a catalyst for achieving higher levels of maturity. Even when eGovernment applications appear stalled, introduction of MWT-based services can enable movement away from applications that are internal and Intranet focused, and move towards those that are more mature in reaching out to citizens with higher levels of transparency. In terms of government innovation, it is unclear as to what the diffusion model will be for m-Government in China. A sampling of different cities, e.g., Beijing (central government), Shanghai (economic area), or Hong Kong or Shanxi province (northwest) illustrates no robust patterns. At best, we can say that multiple explorations are underway. Much remains to be learned in this area. Most likely, that which is a sustaining innovation to some will also be a disruptive innovation to others (Christensen, 2002; Christensen et al., 2004).

Assessment Framework Application

The framework for e-government project assessment proposed by Esteves and Joseph (2008) provides strong capability for m-Government evaluation. For example, technological, strategic, organizational, operational, services and economic assessment dimensions are all apparent in MWT applications. 3G mobile technology may lower the cost of e-Government implementation. The cost of implementation of hardware, such as fiber Internet connection and computers as terminal devices is higher than that of implementation of mobile devices and wireless technology. 3G technology will provide much higher transmission rates and therefore provide additional kinds of services such as video uploading, quick downloading, etc. As such, technological assessment dimensions are especially relevant. Collaboration with commercial information service providers has strategically been applied in a number of m-Government examples. This brings up a number of issues relative to corporate and government cooperation and collaboration. Governments need to consider a long term profitability plan for m-Government system implementation that is compatible with information service providers. The system needs continual investment to keep updating and innovating. This can easily extend beyond normal government expectations.

MWT application can have substantial organizational and operational impact. Traditionally, a plan needs to go through departments individually to get approved. One of the obvious drawbacks of this point-to-point serial connection among departments is low work efficiency. It is also difficult for collaboration between different departments and for subsequent allocation of appropriate duties. Very often, a problem pointed out by citizens cannot be solved because one department will push the duty to another, and eventually nobody is in charge. The m-Government issue is not only about IT transformation, it is about the organizational transformation within the government. As witnessed in the case of Beijing, MWT application can facilitate process improvement and new ways of working that transcend tradition. Citizens can not only be directly involved in solving problems of personal importance but also raise the visibility of issues in a way that encourages quick response cutting across traditional organizational boundaries and operational procedures. Services with high degrees of economic impact can result as reported.

The Beijing "Ten-Thousand Meter Unit Network" project illustrates Esteves and Joseph's (2008) maturity level and stakeholder considerations. Innovative leaders, visionary followers, steady achievers and platform builders have all been involved in project implementation, thus extending efforts to make the service used and be useful to the citizenry. Further, employees from numerous government agencies, as well as businesses, have all been involved, as witnessed in the China Mobile collaboration. IS/IT personnel and special interest groups have all played a role. As Esteves and Joseph (2008) note, "The transition from agency-oriented to citizen-centric eGovernment can be a challenge requiring high-level leadership." The same situation exists for m-Government, as illustrated in the Beijing case. However, MWTs become a mechanism by which more fluid transition can be achieved, especially as technology advances are applied in the spirit of socio-technical development, as researched by Bostrom and Heinen (1977) long before today's technologies were even envisioned.

Limitations

The dimensions and issues associated with m-Government implementation and impact are many, and go far beyond the scope of any single study. At this point, we clearly do not have a comprehensive image of that which is currently happening in China, much less do we have the ability to "join the dots" and draw meaningful conclusions with implications for policy. The cities illustrated in this paper are all concentrated on China's eastern fringe that is well noted for leading the nation in innovation. Although considerable e-commerce activity exists further west (see Davision and Vogel, 2005 for examples), m-Government penetration is currently unknown. We suspect, though, that examples exist (or are envisioned), with the rapid and broad-based nature of MWT diffusion in China. Given the lack of technological alternatives, future m-Government applications may be even more pronounced in Western China than the examples illustrated in this paper.

Directions for Future Research

We have only begun to scratch the surface in terms of understanding the nuances of MWT in m-Government contexts. By nature, this is long-term research with many facets of investigation. Among those are ongoing efforts in identifying projects and surveying stakeholders at all levels to further illustrate that which is currently happening and its impact. Additional focused studies will explore specific concepts and constructs. For example, MWT increases supervision in city management processes, so it is expected that surveillance theory (Lyon, 1993) can be used as a framework to explain its effects. Based on this theory, we can isolate some MWT functions and explore how (or if) these functions increase surveillance in city management, which may (or may not) increase the efficiency and effectiveness of government. It is also suggested that mobile technology can affect guanxi (relationships), and aspects of social translucence induced by system characteristics (Erickson and Kellogg, 2000) could be adopted to explain these effects. Much remains to be researched and a stream of studies is currently underway.

CONCLUSION

The purpose of this paper has been to report on efforts in six different cities in China to examine the maturity of m-Government and assess the deployment of m-Government services. We have explored MWT application of a special project in Beijing. Results are discussed and conclusions are drawn. Towards that end, the best we can say at this point is that much variety exists and much remains for future research. However, the results so far are intriguing. For example, the Jinzhong government has built a platform for m-Government, has achieved some service success and is in a leading position in Shanxi province in M-government. However, it is not a nation-wide pattern. Beijing is currently transforming into a digital city. For example, the Beijing Dongcheng district government has implemented m-Government services not only in information delivery, but also in interactive participation from citizen to government. MWT makes city management processes more effective, as well as more efficient. We found how MWT functions increase information sharing not only among government officials but also between citizens and civil servants in city management, which, in turn, increases transparency as well as the efficiency and effectiveness of government. MWT also uncovers problems and reduces malpractice of leaders. To some extent, it reduces unfair phenomena in city management. Much, however, remains to be researched and learned.

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