# THE VALUE AND IMPACT OF MOBILE INFORMATION AND COMMUNICATION TECHNOLOGIES

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Abstract: The use of mobile information and communication technologies (mICTs) in enterprises is a slowly emerging reality. While the significance of mobility is understood, only little theoretical understanding of the potential value and impact of these technologies exists. This research fills the gap by defining the general concept of mobility, discussing the unique characteristics of mICTs, and identifying key value propositions for enterprises. The paper concludes with a discussion of future research opportunities. 

Keywords: Telecommunications, Decision Making, Socio-Technical System Design

## 1. INTRODUCTION

Over the past few years, mobile information and communication technologies (mICTs) have generated a significant amount of hype and interest. Led by substantial improvements in spectrum utilization, advances in network and device technologies, and rapid proliferation of mobile and wireless devices, the vision of providing "always-on" connectivity and delivering personalized products and services to both consumers and enterprises when, how, and where needed, seemed to rapidly turn into reality.

However, the reality of the "anywhere, anytime" paradigm to date has fallen well short of its hype. In most cases, enterprise adoption of mICTs has been much slower than originally anticipated. This trend is often attributed to technological limitations, security issues, and significant economic investments associated with implementing mICT (Deans, 2002). Despite these issues that must be overcome, the main reason for the lack of enterprise adoption stems from the fact that current mobile applications fail to deliver a sufficiently compelling value proposition to corporate decision makers (Heck, 2004). While mICT promises to fundamentally change the "way" business will be done, the "way" is still emerging and the path to get there is still unclear. This research addresses these issues and suggests future research opportunities.

## 2. DEFINING MOBILITY

There is ample evidence of the significant interest in mobility and the issues related to 'being mobile'. The

explosive growth in mobile devices, the emergence and convergence of information and communication technologies (ICTs), and substantial investments in wireless infrastructures are some of the many indicators of a society becoming increasingly mobile. A rising interest in the issues surrounding mobility can also be found in the academic community, where the design of mobile information systems, value of mobile applications, use of mobile geographical positioning systems, and the impact of mobile communications are some of the research domains examined (Varshney, 2003).

While the importance of mobility and potential value of 'being mobile' are understood, issues surrounding mobility are still explored without a clear understanding of mobility itself. In many cases, the term "mobile" is used in place of "wireless" and "portable" such as mobile devices and mobile applications; other frequent uses of the term include "remote" such as mobile office or "flexible" such as mobile lifestyles (Kakihara & Sorensen, 2001). These examples illustrate the diverse ways that the terms are being used today. An understanding of what mobility means, how it has been used, and its underlying dimensions (see Figure 1) are, therefore, critical pre-cursors to determining its enterprise value.

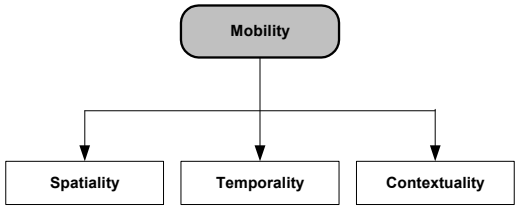


Fig. 1. Dimensions of Mobility

In general, the issue of mobility has been studied from two separate viewpoints, namely from a (1) social and (2) technical perspective. The social perspective on mobility concerns itself with the social issues of "movement" and examines the mobility of people, objects, and work in terms of place, space, and time (Kakihara & Sorensen, 2001). Examples of this type of research include geography, urban sociology, and public policy. On the opposite end of the spectrum is the technical perspective of mobility. This stream of research focuses its analyses on the design, use, and functionality of ICTs related to mobility. It therefore draws its knowledge primarily from the engineering, computer science, and human-computer interaction disciplines and is driven by the notion of "anytime, anywhere" access to people and information (Perry, 2001).

The two-pronged approach to mobility research has thus led to various definitions, beliefs, and usages. The origins of the terms "mobile" and "mobility" come from the Latin word *mōbilis*, which generally refers to "move". Some commonly accepted notions are (MerriamWebster, 2004):

Mobile
1. Capable of movement; movable; not fixed or stationary.
2. Characterized by facility of movement.

Mobility
1. Ability to be moved or to be moved; capacity of change of place.
2. Ability to change quickly or easily; instability, fickleness.

These definitions lead to the conclusion that "mobile" refers to the state where an entity - whether physical, non-physical, tangible or intangible - can move or be moved and "mobility" refers to the ability for achieving it. In addition, (Perry, 2001) argues that mobility inherently changes the way entities interact. Similarly, (Kakihara & Sorensen, 2001) propose that human interaction, transformed through "mobility", should be defined along spatial, temporal, and contextual dimensions. This paper expands on these ideas and suggests how they apply to achieving enterprise value.

### *2.1 Spatiality*

Spatiality is the most immediate dimension that comes to mind when discussing mobility (Kakihara & Sorensen, 2001). Most studies related to spatial mobility involve the examination of human behavior in relation to geographical locations. Examples of some of the studies within this domain include the investigation of factors driving human nomadicity, urban growth due to population migration, and the social aspects of transportation, travel, and tourism. More recently, human mobility studies have analyzed the issues surrounding telework and remote business environments.

Mobility, however, is not limited to human movement only; in today's world, a large number of objects are being moved as well. Examples of object mobility include the movement of documents, letters, packages, and freight. Similarly, advances in ICTs have led to another form of non-human mobility, often termed information mobility. Information mobility refers to the movement of information, such as television signals, images, sounds, and data via information and communication technologies and infrastructures. The Internet is a good example of a domain in which information travels and moves from one location to another (Shapiro & Varian, 1999).

Information movement on the Internet leads to another separate spatial reality, namely the mobility of space itself (Kakihara & Sorensen, 2001). The computers and networks that connect millions of

people are interconnected through a mesh of computers and networks bringing forth a virtual spatiality, which often is called cyberspace or virtual communities (Shapiro & Varian, 1999). The concept of physical location in cyberspace has fundamentally changed, as geographical distances and boundaries have been dissolved.

### *2.2 Temporality*

In addition to the "where" aspect, an equally important dimension of mobility includes the identification of the "when", or temporal, aspect of human activity. Some attributes of temporality include the sequence, duration, and recurrence as well as the time allocation of activities (Lee, 1999). With the emergence of new ICTs, these attributes have been significantly transformed. (Hammer & Mangurian, 1987) refer to this phenomenon as "time compression". More specifically they argue that the use of ICTs not only accelerates the pace with which human activities are performed, but also enables time savings and allows conducting multiple activities simultaneously and instantaneously. In other words, human activity has shifted from a linear clock-time perspective to one with multiple temporal modes, in which human activities are mobilized from the traditional temporal constraints (Lee, 1999).

### *2.3 Contextuality*

While spatiality and temporality have been discussed extensively in a number of research studies, an emerging dimension of mobility is the importance of contextuality (Tarasewich, 2002). In general, contextuality refers to the situation and environment in which humans perform their activities. More specifically, contextuality provides an understanding in what way and circumstance the activity is being performed. Traditionally, activities were limited to a certain set of contexts. With the emergence of new ICTs, however, activities are mobilized from contextual constraints (Perry, 2001).

In summary, the value of mobility reaches far beyond mere geographical movement of humans, but provides a complete new mindset on human interaction and should be considered from spatial, temporal, and contextual dimension. The new perspective on mobility implemented in emerging technologies offers enterprises a plethora of compelling value propositions and are discussed next.

## 3. THE ENTERPRISE VALUE OF MOBILE ICT

The potential value of mICTs in enterprises is tremendous. Enabling access to information and people anywhere and anytime, enhancing decision making capabilities, and creating a user-centric environment are some of the exciting examples of mICTs in enterprises (Heck, 2004; Kalakota & Robinson, 2002). While mobility itself offers tremendous value to enterprises, there are several other aspects that make the enterprise adoption and infusion of mICTs compelling. The use of mICT promises to make specific enterprise processes more efficient and effective, and create a more personalized approach to information access, decision making, and communication than traditional wired environments (Gribbins, Shaw, & Gebauer, 2003).

### *3.1 Unique Characteristics of mICTs*

mICTs exhibit a number of unique characteristics, which include ubiquity, connectivity, accessibility, reachability, portability, and localization, as shown in Figure 2 below (Junglas & Watson, 2003).

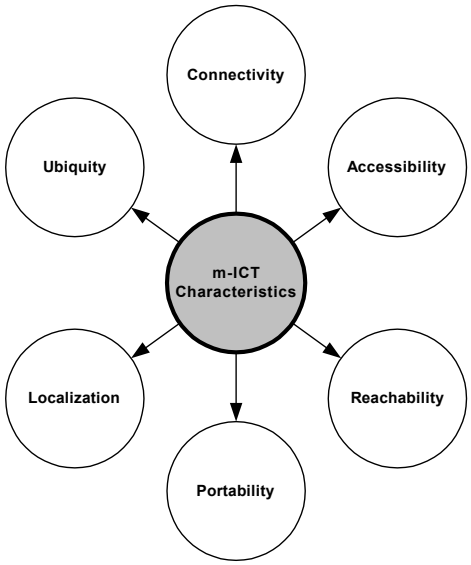


Fig. 2. mICT Characteristics

*Connectivity.* Mobile connectivity is one of the fundamental aspects of mICTs. Mobile connectivity refers to the capability of connecting users to machines (U2M), machines to machines (M2M), and users to users (U2U). In comparison to the wired network environment, people and users are not constrained by the location and availability of network plug-ins. Today, mobile connectivity is constrained by limited wireless network coverage. However, as mICTs continue to advance, network coverage and bandwidth will be abundant, and users will remain permanently connected anywhere.

*Accessibility and Reachability*. Accessibility and reachability are results of mobile connectivity. A necessary precursor to both accessibility and reachability is that sufficient wireless network

coverage is available and that the mobile device is switched on. Reachability builds on the assumption that users and machines have the capability to be in touch and be reached by other entities, while accessibility refers to the capability of access to a wireless network at any place and any time.

*Portability*. The most unique and distinguishing characteristic of m-ICTs is the ability to physically move computing and communications products and services with the user. Traditional wired computing environments limited users to the location of the device and network plug-in.

*Localization*. Localization refers to the ability to locate the geographical position of a user or mobile device. Similar to portability, localization is one of the unique characteristics of mICTs. Localization is particularly important when the user requires location-specific information, or the location context itself wants to provide feedback to the user.

*Ubiquity*. The ultimate form of mobility includes the integration of all the aforementioned characteristics. Users have the capability to access the network at any place and any time, and be in touch, be reached, and located at any place and any time using always connected portable devices. Ubiquity therefore exemplifies the ultimate form of spatial, temporal, and contextual mobility (Junglas & Watson, 2003).

### *3.2 Value Propositions of mICTs*

Based on these unique characteristics, mICTs provide enterprises a number of different value propositions. (Perry, 2001) found that mobile users valued convenience and efficiency as the main advantages of mICTs. (Anckar & D'Incau, 2002) identified cost-savings, flexibility, device familiarity, and the ability to address time-critical, spontaneous, and mobility-related needs as distinct value offerings. Similar statements are made in the popular press where it is suggested that mICTs improve operational efficiency and productivity, enhance user communications, and provide higher user flexibility (Heck, 2004).

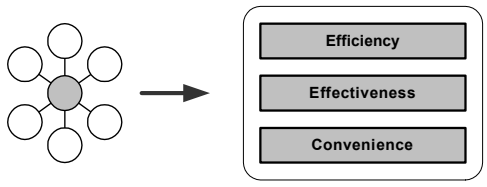


Fig. 3. Value Propositions of mICTs

While the value propositions of mICTs are plentiful, they broadly fall into the following three categories: (1) efficiency, (2) effectiveness, and (3) convenience – see Figure 3.

*Efficiency*. It is human nature to try to make everyday activities as efficient as possible. With the use of mICTs enterprises provide a mean to utilize work time more efficiently. Users who are away from their desks and on-the-go are capable of having access to information and people from anywhere, raising the overall productivity level. Mobile professionals that travel frequently can utilize their "dead time" at airports or hotels more efficiently by checking, updating, and viewing important corporate information (Kalakota & Robinson, 2002). Fundamentally, mICTs change the way people work and interact. In addition to being able to address time-critical and instantaneous needs, mICTs also enable enterprises lower cost expenditures. Using a single device to perform a variety of tasks reduces the overall equipment costs an enterprise often has to bare with traditional wired network environments and computing services (Anckar & D'Incau, 2002). In essence, mICTs applied in the right functional areas and deployed to the right users therefore lead to a more agile, adaptive, real-time, and cost-efficient enterprise (Gribbins, et al., 2003).

*Effectiveness*. An equally significant contribution of mICTs is the contribution to task effectiveness. Time-critical and location-sensitive tasks are excellent candidates for mobilization. By providing information at the point-of-action, task effectiveness improves (Tarasewich, 2002). In this paper, the author goes one step further and proposes that a higher potential of task and decision-effectiveness is achieved when the right information is delivered to the right place, at the right time and to the *point-of-thought.*

*Convenience*. mICTs offer several conveniences. First, it delivers a whole new way of interacting. The convergence of wireless communications and the Internet allows users to interact and communicate via voice, data, or multimedia (Deans, 2002; Shapiro & Varian, 1999). Users can check their voice mail, send an e-mail or view the latest video conference, all from a mobile device. This leads to the second convenience of mICT. The use of mobile applications often involves the operation of only a single, integrated device. The ability to perform several different tasks with a single device increases a user's familiarity, proficiency and utilization (Anckar & D'Incau, 2002). While personalization of services has been used extensively in the traditional wired environment, it is an even more important condition in the mICT domain. This is mainly due to the limited screen size and computing capabilities of today's mobile devices, where personalized and localized information adds significant value to the user (Tarasewich, 2002).

It should be cautioned that the mere adoption of mICTs does not necessarily lead to increased levels of efficiency, effectiveness, and convenience. In fact, there are some tasks that are more suitable than

others for enablement through mICTs. (Gribbins, et al., 2003) argue that mICTs implemented in the right enterprise functions and processes, and made available to the right set of users, will provide the greatest value. The implementation of mICTs, hence, requires a detailed understanding on which types of tasks, functional areas, and users will benefit from it. Other challenges exist as well. Security, privacy, and user identification are some examples. Adoption and implementation strategies will therefore differ from enterprise to enterprise (Ward & Peppard, 2002). The next section discusses some of the critical issues that enterprises should consider when planning to adopt, implement, and infuse mICTs.

## 4. RESEARCH ISSUES

Strategic planning for new ICTs adoption and implementation encompasses a number of challenges (Ward & Peppard, 2002). These generally fall into three broad categories, namely technical, organizational, and economic issues. Technical issues include the assessment of current IT assets, evaluation of technology options, and integration into existing processes (Cooper & Zmud, 1990). Organizational challenges include the change in organizational culture and structure, and development of new alliances and partnerships (Decanio, Dibble, & Amir-Atefi, 2000). Examples of economic issues are justification of large technology investments, risk assessment of emerging technologies, and management of current IT assets.

Each of these issues is often considered as part of an overarching enterprise technology transformation process (Rouse, 2004). The multitude of different criteria illustrates the complexity of ICT adoption and implementation decisions. The complexity is further amplified when the technology is starting to emerge as its value is often poorly understood. This is clearly the case with mICTs. Following is a discussion of select research issues surrounding mICT adoption and implementation that deserve further attention.

### *4.1 Assessing Enterprise Mobile Readiness*

Understanding whether an enterprise is ready to adopt mICTs is an important precursor to the actual adoption and implementation process. Organizational readiness has been investigated for innovations, both product and process-related, management changes, and other transformational events. Assessing an enterprise mobile readiness level should be based on objective indicators. These can be broadly classified across the following four areas:

- Organization
- Processes
- Technology
- Environment

Each area requires an in-depth analysis with regards to the mICT maturity level. Among organization-related factors are the size of the enterprise, managerial risk orientation, budget availability, and general attitudinal readiness for mICTs (Decanio, et al., 2000). Workflow analysis and roles and responsibility identification are process-related readiness issues. Technology-related readiness refers to capability of current IT infrastructure to support new mICTs. This can be assessed by evaluating whether technologies are based on open systems, standards, and flexibility (Parasuraman, 2000). Environment-related issues such as market demand to adopt new technologies, competitor strategies, level of technological maturity and regulatory and policy-related factors also impact readiness. An assessment of mobile readiness will thus enable enterprises to determine both their preparedness and potential to adopt and implement mICT (Decanio, et al., 2000; Ward & Peppard, 2002).

### *4.2 Identifying Mobile Business Processes*

While the potential and conceptual value of mobility is understood, the real value of using mICTs is often hard to quantify. It is argued that not all enterprise areas require or benefit from the use of mICTs. Identification of appropriate functional and process areas is therefore critical to achieving value through mICTs (Gribbins, et al., 2003). This is achieved by developing a process identification framework, which quantitatively and qualitatively assesses the value of mICTs for business processes. A prominent model from the IS literature includes the theory of task and technology fit (Dishaw & Strong, 1999). Similar theories are provided by the HCI literature, in which technology design has to match specific user needs.

### *4.3 Understanding the m-ICT User Base*

Based on the mobile process identification framework, it may become evident that not every user in an enterprise may require the use of mICTs. Identifying the various types of users and their corresponding usage patterns are therefore important criteria in the adoption and implementation process. Knowledge of the user base will aid enterprises in developing and deploying mobile applications and services more efficiently and effectively.

### *4.4 Determining Adoption & Implementation Strategies*

All of the aforementioned issues have to be considered as part of the overall mICT adoption and implementation strategy. However, analyzing these issues in isolation does not adequately describe the complex environment in which adoption and implementation strategies must be made. The use of

simulation techniques will enable decision makers visualize the dynamics of the process and make more informed decisions on which path to take. A simulation model of mICT adoption and implementation will provide decision makers a computational tool with which various scenarios, policies, and strategies can be evaluated prior to actually making significant budgetary and time investments. The dynamic models will also provide decision makers a more holistic view of their actions taken and their impacts on the desired outcomes of efficiency, effectiveness, and convenience improvement by mICTs.

## 5. CONCLUSION

Understanding the value of mobility is a critical step when planning to adopt and implement mICTs. This research argues that mobility fundamentally changes the way users and enterprises interact. Mobility is not constrained to geographic movement, but also applies to spatial, temporal, and contextual aspects. As mICTs continue to advance, mobility provides enterprises with a number of important value propositions. When integrated and deployed appropriately, mICTs can deliver higher levels of efficiency, effectiveness, and convenience. However, the discussion above also illustrates the complexity and challenges of successfully adopting and implementing mICTs. These challenges are what require further analysis and which provide a number of exciting research opportunities.

## REFERENCES


Anckar, B., & D'Incau, D. (2002). Value Creation in Mobile Commerce: Findings from a Consumer Survey. *Journal of Information Technology Theory and Application,* **4**(1), 43.

Cooper, R. B., & Zmud, R. W. (1990). Information Technology Implementation Research: A Technological Diffusion Approach. *Management Science,* **36**(2), 123-139.

Deans, C. (2002). *Global Trends and Issues for Mobile/Wireless Commerce.* Paper presented at the Eighth Americas Conference on Information Systems.

Decanio, S. J., Dibble, C., & Amir-Atefi, K. (2000). The Importance of Organizational Structure For The Adoption of Innovations. *Management Science,* **46**(10), 1285.

Dishaw, M. T., & Strong, D. M. (1999). Extending the Technology Acceptance Model with Task-Technology Fit Constructs. *Information & Management,* **36**(1), 9.

Gribbins, M. L., Shaw, M. J., & Gebauer, J. (2003). *An Investigation into Employees' Acceptance of Integrating M-Commerce into Organizational Processes.* Paper presented at the Ninth Americas Conference on Information Systems.

Hammer, M., & Mangurian, G. E. (1987). The Changing Value of Communications Technology. *Sloan Management Review,* **28**(2), 65.

Heck, M. (2004). Mobilizing the Enterprise. *InfoWorld, 26,* 24-26.

Junglas, I. A., & Watson, R. T. (2003). *U-Commerce: A Conceptual Extension of E- and M-Commerce.* Paper presented at the International Conference on Information Systems, Seattle, WA.

Kakihara, M., & Sorensen, C. (2001). Expanding the 'mobility' concept. *ACM SIGGROUP Bulletin,* **22**(3), 33-37.

Kalakota, R., & Robinson, M. (2002). *M-Business: The Race to Mobility*: McGraw-Hill.

Lee, H. (1999). Time and information technology: Monochronicity, polychronicity and temporal symmetry. *European Journal of Information Systems,* **8**(1), 16.

MerriamWebster. (2004). from http://www.m-w.com/

Parasuraman, A. (2000). Technology Readiness Index (TRI): A Multiple-Item Scale to Measure Readiness to Embrace New Technologies. *Journal of Service Research,* **2**(4), 307.

Perry, M., O'Hara, K., Sellen, A. Harper, R. & Brown, B.A.T. (2001). Dealing with mobility: understanding access anytime, anywhere. *ACM Transactions on Computer-Human Interaction,* **4**(8), 1-25.

Rouse, W. B. (2004). *Enterprises (as) Systems.* Paper presented at the International Federation of Automatic Control, Atlanta, GA.

Shapiro, C., & Varian, H. R. (1999). *Information Rules*: Harvard Business School Press.

Tarasewich, P., Nickerson, R., and Warkentin, M. (2002). Issues in Mobile E-Commerce. *Communications of the AIS,* **8**, 41-65.

Varshney, U. (2003). Mobile and Wireless Information Systems: Applications, Networks, and Research Problems. *Communications of AIS,* **2003**(12), 155-166.

Ward, J., & Peppard, J. (2002). *Strategic Planning for Information Systems* (3rd ed.): Wiley.