Task-Technology Fit in Mobile Work: Exploring the Links between Task Attributes and Technology Characteristics

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***Abstract*—Based on reviewing the extensive research on the task-technology fit (TTF) theory, we suggest a more natural perspective which focuses on the relations between task attributes and technology characteristics, instead of human perception about the abstract concept of "fit". Our study is then aimed at identifying the characteristics of emerging mobile technologies and applications as well as the typical attributes of tasks in modern mobile business environments, and further exploring the corresponding fit between task attributes and technology characteristics. An initial framework for linking task attributes with technology characteristics is proposed based on existing literature, and a field case study with regard to mobile applications in municipal administration in Beijing, China, is presented to tentatively validate and improve the framework. This exploratory study postulates a conceptual model which reflects the pair-wise links between five types of task attributes and five dimensions of mobile technology characteristics. Drawing upon the findings, we also present our further research plan for empirically testing the task-technology fit model for mobile applications that we have formulated, using more quantitative methods.**

Keywords-mobile business, task-technology fit, task attributes, mobile technology characteristics, exploratory study.

I. INTRODUCTION

During the past several years, the rapid development of mobile technologies has been altering the modern business environment and shaping the life styles of contemporary people. Mobile communication devices, including cell phones, laptops, netbooks, and tablets, have provided people with new approaches to accessing web contents, emails, instant messaging, and commerce services in a convenient and flexible way which fully takes advantages of mobility and timeliness [1]. Meanwhile, mobile technologies also enable new possibilities for customized service and location-based work support, since mobile network offers the ability to distinctly identify its mobile users, as well as to determine their current location and time of usage [2]. With the support of the emerging technologies, people may fully leverage their "fragmentized" time to conduct business affairs, commerce transactions, and entertainments activities anytime, anywhere, which could enhance their work efficiency and increase their general well-being.

Mobile networks have achieved remarkable development in China. In December 2010, among the current 457 million Internet users in China, 303 million are using mobile phones to access the Internet, accounting for about 66.2% of the total number, with an annual growth of 23% [3]. It is reasonable to expect that such a large population of mobile network users may create massive business value and continuously promote innovations in mobile applications and related business models.

In this context, a large number of mobile commerce applications emerged in such sectors as insurance, healthcare, banking, real estate, public welfares, manufacturing, and government agencies [2]. However, the paradox which provoked controversies during the first wave of Internet booming also plagues mobile commerce. It is often questioned whether and in what situations mobile technologies may support people's work more effectively and lead to higher efficiency [4]. In other words, it is worthwhile to examine whether mobile technologies really fit with our work requirements and, furthermore, what kind of technologies may fit better with some specific work characteristics.

In this regard, the classical theory of task-technology fit (TTF) offers an ideal theoretical basis. The theory states that those technologies that fit better with the tasks will receive higher evaluation and better utilization in organizations [5]. Accumulated research based on TTF has provided significant empirical support for the theory. Using the lens of task-technology fit, in this paper, we will investigate the links between mobile technology characteristics and typical task attributes in modern work environments.

While most existing studies have treated the concept of "fit" as a human behavior construct, which can be measured directly with self-report questions (e.g., [6; 7]), some other research argued, explicitly or implicitly, that "fit" should be considered as a relatively stable link between a particular technology and a specific type of tasks (e.g., [4; 8; 9]). Based on a critical review on related literature, we believe that the second approach would be more promising, since it well captures the essential concept of task-technology fit and

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provides an insightful perspective beyond self-report perceptions.

Therefore, this paper is aimed at identifying the characteristics of emerging mobile technologies and mobile applications as well as the typical attributes of tasks in modern mobile business environments, and further exploring the corresponding fit between task attributes and technology characteristics. An initial framework for linking task attributes with technology characteristics was proposed based on examining existing literature, and a field study with regard to mobile applications in municipal administration in Beijing, China, was conducted to tentatively validate and improve the framework. This exploratory study postulates a conceptual model which reflects the pair-wise links between five types of task attributes and five dimensions of mobile technology characteristics. Based on the findings of this paper, further research plans can be designed to empirically test the task-technology fit model for mobile applications that we have formulated in our current study, using more quantitative methods such as surveys and experiments.

II. THEORETICAL BASE AND RESEARCH FRAMEWORK

This study is drawn upon the classical TTF theory. In this section, we will first briefly review related literature, before presenting our research map with regard to technology characteristics and task attributes.

A. Task-Technology Fit

As information technology exerts more and more profound and extensive influences on the work of individuals and the operation of organizations, since the 1980s, scholars have been keen on exploring the relations between user behavior and technology use, and the consecutive introduction of theoretical models and research methods in such disciplines as sociology, psychology, behavior, and economics has greatly reinforced the theoretical basis of relevant studies. These studies have given rise to theory of reasoned action (TRA) [10], theory of planned behavior (TPB) [11], technology acceptance model (TAM) [12], unified technology acceptance and use theory (UTAUT) [13] and other widely cited models.

In the same period, Goodhue and Thompson (1995) proposed the task-technology fit theory, which focuses on the fit between technology and task, namely, the support capacity of information technology towards work. In the original version of TTF, "task" refers to a user's behavior of utilizing tools to transform investment into performance, while "technology" refers to the tools employed by users when executing the tasks, which specifically refers to the computer system here, including hardware, software and data, as well as the process of facilitating users to finish the tasks such as user support and trainings [5]. The choice to use a certain technology and the degree to which the users can leverage such technology shall be subject to factors such as trainings, computer use experiences and motivations. "Task-technology fit" refers to the degree of assistance that a technology provides for the user to complete a certain task [5].

Unlike social-psychological models, such as TAM, which focus on users' intention to adopt or accept a certain technology, TTF actually evades the issue of whether to adopt, but attempts to explore the influences on individual or organization performance by a task-technology fit or unfit during the process of practical employment of technologies. Hence, TTF is more realistic during the period of the post-adoption.

Since the emergence of TTF, the follow-up literature focuses on the use scope of the TTF model, and the examination of TTF toward different tasks and different technologies. It has been revealed that the TTF model has a certain degree of explanatory power in different task and technology environments [5; 6; 14-16]. The rise of mobile technologies also introduced relevant TTF research on mobile commerce or mobile government in different empirical situations and with different research methods [17-20]. Some researcher also conducted related empirical studies in Chinese mobile commerce contexts [7; 21].

It should be noted that scholars have long been plagued by the measurement of the degree of task-technology fit, the core variable of TTF. In the preliminary researches conducted by Goodhue [5], the measurement was based on the actual fit results and was famous for its sophisticated composition, which not only imposed difficulties on empirical examination, but also constrained its expansion in different application fields. Some follow-up researches employed a pure cognition-based fit measurement, which, easy as it was, inevitably undermined the significance of the research. There is also a paper published on ICIS2010 which is devoted to the exploration of TTF measurements [22]. By far, however there is still not a generally agreed set of items for TTF measurement, and this has to some extent restricted the theory from being more widely adopted.

Some scholars attempted to directly explore the relations between tasks and technologies, instead of measuring the "fit" variable itself [4; 8; 9]. From this point of view, the central proposition in terms of "fit" is that when technology A fits with task B, a person undertaking task B would usually feel that technology A is useful [4]. Enlightened by this interpretation, in our study, we try to explore the relations between individuals' task attributes and their evaluation on the different characteristics of emerging mobile technologies, so as to conceptually formulate a model which essential capture the matrix of relations between tasks and technologies.

B. Task Attributes and Technology Characteristics

As described above, this paper is aimed at uncovering the relations between task attributes and technology characteristics in terms of mobile applications. In this regard, it is of crucial importance to conceptualize the typical task attributes and the representative technology characteristics. Drawn upon an extensive review on relevant literature, the initial sets of task attributes and technology characteristics are constructed.

With respect to task attributes, existing literature largely discusses factors such as mobility, location-dependence, time-criticality, ubiquity, personalization or uniqueness, and

identifiability, among which the first three are the most widely addressed. Details about the attributes discovered from literature are shown in Table I.

TABLE I. TASK ATTRIBUTES DISCUSSED IN LITERATURE

Variable	Meaning	Related Literature
Mobility	the extent to which a task was being performed in different locations	[4; 18; 19]
Location-dependency	the extent to which dynamic location-related information is required to perform the task	[4; 19; 23-25]
Time-criticality	time flexibility(extent the tasks must be performed on time); urgency (the degree of rigidity in time structuring and task completion).	[4; 23-25]
Ubiquity	The ultimate form of reachability, accessibility, and portability.	[19]
Personalization /Uniqueness	Users are allowed to have personalized settings and information	[25]
Identifiability	Service can identify the users by the unique SIM card or UIM card.	[19; 25]

With respect to technology characteristics, in the literatures we have found multiple perspectives for classification, as well as discussions in different dimensions ([4; 17; 23-26]). The details of technology characteristics classification in mobile applications are shown in Table II.

TABLE II. TECHNOLOGY CHARACTERISTICS DISCUSSED IN LITERATURE

Literature	Technology Characteristics		Note
[26]	Location sensitive		
	Time critical		
	Initiated/controlled by recipient or user		
[17]	Information retrieval and analysis, document creation		
	Data processing		
	Communication		
	Messaging		
[25]	Ubiquity		
	Convenience		
	Instant connectivity:		
	Personalization:		
	Localization		
[23]	Characte-ristics of mobile IS	Functionality	Two dimensions: 1) Primary focus; 2) Direction of interaction. Four quadrants are subdivided accordingly.
		UI	A set of features that together describe the experience to use an IS ("look & feel").
		Adaptability requirements	1) location-dependency; 2) identity-dependency
	Characte-ristics of mobile use environment	Distraction	the level of interference with the use of the mobile system caused by activities and people in the use environment
		connection quality	network availability, bandwidth, and stability
		Mobility	the extent to which a mobile IS is being used at different geographic locations or while the user is in motion
[24]	Function-related characteristics	Basic communication	Phone service, SMS, MMS, Email Service
		Advanced information process	Internet access, office applications
		Entertainment	Camera, video, game and ringtones
	Non-function-related characteri-stics	Operational-function related	Size, weight, LCD display size, resolution, hard keyboard status of comfort, internet access of the device, as well as the compatibility with other devices.
		Scope-of-use related	Places where the device can be used, such as airport, highway, and subway.
[4]	Mobile notification		
	Location tracking		
	Navigation		
	Real-time mobile job dispatching		

C. *Research Map*

The research map of this paper is shown in Fig. 1. After listing all the task attributes and technology characteristics that have been mentioned in existing literature, we will first screen the list of task attributes through interviews with actual mobile workers, and then the list of technology characteristics through interviews with mobile device/application manufacturers. When critical task attributes and technology characteristics are both identified, we will further explore the links between each pair of them by more in-depth interviews with regard to the perception of mobile workers.

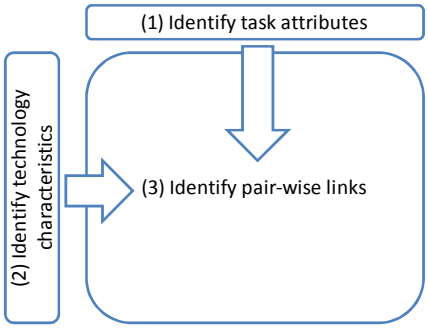

Figure 1. Research Map

By identifying the pair-wise links between task attributes and technology characteristics, we will be able to present a complete model which reflects all the corresponding task-technology fits in mobile work environments. A series of testable hypotheses could be derived from the model and subsequent studies may conduct empirical surveys to statistically validate the links.

III. RESEARCH METHOD

To develop a theoretical model that reflects the task-technology fit in mobile business environments, we conducted a field case study in Beijing, China, which includes a series of interviews with various practitioners. In this section, we will briefly describe our research site and present the research method that we adopted.

A. Research Site

Our exploratory field study was conduct in the context of municipal administration in Beijing, China. Municipal administration work is generally regarded as an important interface where government and public are connected. Given that Beijing has successfully hosted the 2008 Olympic Games and has set a development target of becoming a "World City", municipal administration plays an increasingly key role in public affairs. Due to the wide coverage of citizens and high mobility of the supervision and law-enforcement work of municipal administration, Beijing Municipal Bureau of City Administration and Law Enforcement (BMBCALE) has adopted mobile government technology to support their work. By 2007, BMBCALE has uniformly equipped nearly 10,000 staff with PDA terminals connected to a centralized information system, which is called "Chengguantong", for their daily work. The PDA interface for "Chengguantong" is shown in Fig. 2.

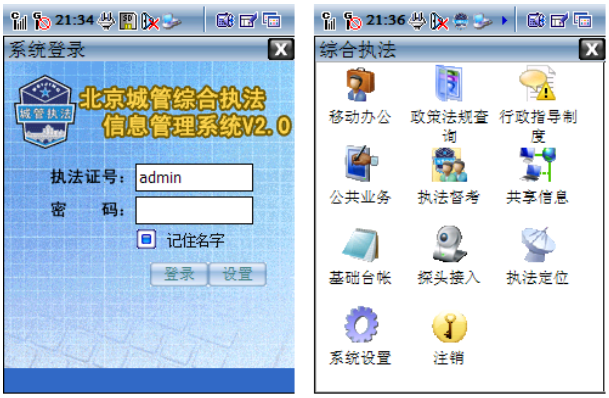

Figure 2. PDA Interface for "Chengguantong"

In 2010, the system was upgraded to a new version based on the 3G technology. As the use of "Chengguantong" grows, more and more mobile-terminal-based function modules become available (See Table III for the function modules of "Chengguantong"). Meanwhile, the diversity of routine tasks of BMBCALE employees in different areas have resulted in highly diversified levels of system acceptance and use. Most of the employees usually use a very small portion of the functions provided by the system.

TABLE III. FUNCTION MODULES OF "CHENGGUANTONG"

Function Modules	Introduction
Mobile Office	This module mainly enables a PDA user to access the OA system with PDA regardless of time or location to deal with multiple issues. A user can log in to the OA system and get the unified authorization from the platform, and then inquire, navigate, edit, examine and approve, issue notices and view official documents.
Basic Records	This module mainly assists a PDA user in inquiring the information of the person who violates laws and the violation as well, so as to ensure the correctness and fairness of law enforcement. When a user logs in to the system via the PDA terminal, he/she could inquire the status of the responsibility system of city administration, and basic information of the people subject to its jurisdiction and of the city administration components (including illegal taxis, construction sites and outdoor advertising etc.)
Public Business	This module mainly secures the real-time communication between officers and realizes the inquiry of fines/punishments as well as relevant laws and regulations. In the system, a user can inquire about and navigate notices and circulars, and also other information such as case brief and case causes of law-enforcement, relevant laws and regulations, and functions of other departments of city administration as well.
Shared Information	This module mainly helps officers to inquire information of other government committees/offices/bureaus when handling cross-functional work so as to improve work efficiency. A user could, after log in to the OA system via PDA terminal, inquire about revenant laws, regulations and policies of relevant government departments such as Beijing Municipal Commission of City Planning, Beijing Municipal Commission of Housing and Urban-Rural Development, and Beijing Municipal Bureau of Parks and Forestry.
Law-enforcement Supervision	This module helps law-enforcement officers to take necessary records of their daily work, and also facilitates supervisors' assessment. A user could, after log in to the OA system via PDA terminal, inquire about and navigate law-enforcement officers' basic information according to their names and number etc.; inquire about, navigate and edit personal work log, and inquire about and edit the tasks assigned to them and give corresponding feedbacks.
Surveillance Access	This module mainly enables a PDA user to access the real-time surveillance video of specific place/venue in the first time. A user could, after log in to the system, access the real-time surveillance video of multiple probes.
Law-enforcement Positioning	This module mainly helps officers inquire about relevant position information in a timely manner, and meanwhile provides visualized inquiry operations. A PDA user could locate him/herself via GPS positioning system, view current position information, and use built-in digital map.

In such a context, it is worthwhile to ask how the various functions of the "Chengguantong" system fit with the different task of different employees. Therefore, it provides

us with an ideal scenario for examining the fit between task attributes and mobile technology characteristics. On the other hand, our research may provide insightful practical findings for further development and promotion of the system.

B. The Interviews

Although it was also possible and reasonable to directly ask the end users about their evaluation on the task attributes and technology characteristics, such actions, once conducted, would expose us to a higher vulnerability to the errors caused by subjective judgments of interviewees, because the task characteristics and technology characteristics abstracted in our model do not necessarily equal to the work tasks and function modules they experience in reality. In fact, a routine task may involve different task attributes to different degrees, and a function module of "Chengguantong" may also involve different technology characteristics to various degrees. In the light of this consideration, in our research design, we did not require the interviewees to differentiate and judge the differences and relations on their own. Instead, the results were expected to be induced from integrating the multiple interviews with various user groups.

In order to identify the task attribute set and the technology characteristics set, as well as to evaluate the attributes of specific tasks and the technology characteristics of function modules, we conducted interviews with three types of people: (1) Chief of the Information Equipment Centre of BMBCALE and 2-3 staff members, as they are familiar with the daily work of municipal administration and law enforcement, and have a good understanding of each function module because they are responsible for promoting the use of "Chengguantong"; (2) 5-7 Chiefs of law-enforcement units of BMBCALE, as they are highly acquainted with the daily work of municipal administration and are responsible for assigning specific tasks to BMBCALE employees; (3) the Chief engineer and 2-3 technicians of the system provider company of "Chengguantong", as they are most familiar the function modules and technology characteristics of "Chengguantong". We induced the evaluations for task attributes and technology characteristics based upon the interview records. Therefore, an evidence triangle was constructed with data from different sources, which would guarantee good validity of the process of the qualitative research method [27].

IV. Results and Discussions

A. TTF Matrix

By integrating the records from the interviews, we identified the critical task attributes and technology characteristics for developing a complete task-technology fit model. In the results, task attributes include non-routineness, interdependence, time-criticality, location-relevance, and mobility. Among them, non-routineness and interdependence are the two most studied and generally accepted attributes in existing literature, while time-criticality, location-relevance and mobility, can best reflect the special feature of mobile business environments. On the other hand, technology characteristics finally identified include information acquisition, information interaction, information analysis, location-based services, and multimedia, which are mostly function-related.

Furthermore, a task-technology fit matrix of relations (TTF matrix) was derived through the analysis of interview records, as illustrated in Table IV. In the table, a "+" mark in a cell indicate that the technology characteristic shown at the corresponding row significantly fit with the task attribute shown at the corresponding column.

TABLE IV. The Task-Technology Fit Matrix

Task Attributes / Technology Characteristics	Non-routineness	Interdependence	time-criticality	Location-relevance	Mobility
Information acquisition	+	+	+		+
Information interaction	+	+	+	+	+
Information analysis	+				
Location-based services			+	+	+
Multimedia data collection			+	+	+

It is worth noting that the TTF matrix proposed here is intended to reflect the links between task and technologies in general mobile business contexts. In practice, however, it is likely that the TTF matrix is subject to such factors as specific cultural background of the application situation, education background of personnel, and technology background of personnel. Consequently, to some extent, the exploration of TTF matrix of specific environment exhibits more significance than the examination of a general model hypothesis does. Future empirical work of this research can be seen as a process of examining relevant hypothesis, and also a process of exploring the TTF matrix in specific environments of mobile government.

B. Testable Hypotheses

Based on the TTF matrix shown above, as set of testable hypotheses can be formulated, as follows:

- H1-1: *People that often assume tasks with high non-routineness shall hold positive evaluation for information acquisition.*
- H1-2: *People that often assume tasks with high non-routineness shall hold positive evaluation for information interaction.*
- H1-3: *People that often assume tasks with high non-routineness shall hold positive evaluation for information analysis.*
- H2-1: *People that often assume tasks with high interdependence shall hold positive evaluation for information acquisition.*
- H2-2: *People that often assume tasks with high interdependence shall hold positive evaluation for information interaction.*

- H3-1: *People that often assume tasks with high time-criticality shall hold positive evaluation for information acquisition.*
- H3-2: *People that often assume tasks with high time-criticality shall hold positive evaluation for Information interaction.*
- H3-3: *People that often assume tasks with high time-criticality shall hold positive evaluation for location-based services.*
- H3-4: *People that often assume tasks with high time-criticality shall hold positive evaluation for multimedia data collection.*
- H4-1: *People that often assume tasks with high location relevance shall hold positive evaluation for Information interaction.*
- H4-2: *People that often assume tasks with high location relevance shall hold positive evaluation for location-based services.*
- H4-3: *People often assume tasks with high location relevance shall hold positive evaluation for multimedia data collection.*
- H5-1: *People that often assume tasks with high mobility shall hold positive evaluation for information acquisition.*
- H5-2: *People that often assume tasks with high mobility shall hold positive evaluation for Information interaction.*
- H5-3: *People that often assume tasks with high mobility shall hold positive evaluation for location-based services.*
- H5-4: *People that often assume tasks with high mobility shall hold positive evaluation for multimedia data collection.*

In subsequent studies, these hypotheses could be empirically tested using survey or experiment method in various mobile business contexts, targeting at various kinds of mobile technologies or applications.

C. Design for Further Empirical Validation

Our on-going research includes the design of further empirical validation of the TTF matrix model derived above. The empirical study will still be conducted in the application context of "Chengguantong". The survey will be conducted among BMBCALE employees, namely the actual users of "Chengguantong". The questionnaire will be designed according to the postulated model, as well as the definition and measurement items of each variable in existing literatures. Specifically, the measurement of the technology characteristics and task attributes will be largely drawn upon previous studies about TTF, especially those for mobile business contexts [4; 8; 9; 17; 23-25], while the measurement of user evaluation will be based on accumulated literature with regard to user attitude and adoption (e.g., [12; 28-30]).

The survey shall be conducted simultaneously in different units of BMBCALE, and the samples shall be selected with full consideration of the task differences between multiple units so as to cover the municipal administration work at the broadest scale. In the survey, we plan to collect around 400 responses. After reliability test and validity test [31], the research model will be validated using partial least squares (PLS), a structural equation modeling (SEM) technique which is more suitable for highly complex predictive models. All SEM analysis in the research will be done by the PLS-Graph 3.0. In addition, the interaction analysis (moderator analysis) will be conducted by the same software. All these analysis will follow some classical guidelines in literatures of QPR methodologies [31; 32].

V. CONCLUSION

Based on the extensive research on TTF, this paper is aimed at exploring the TTF model in the context of mobile communication technology from a more natural perspective which focuses on the relations between task attributes and technology characteristics, instead of human perception about the abstract concept of "fit". By this means, mobile business environments and mobile communication technologies are no longer deemed as merely nominal and general concepts, but are subdivided into many specific aspects. We assume that people who often assume tasks with certain task characteristics shall more favor certain technology characteristics of mobile communication technology, and on this assumption we subsequently establish our TTF matrix.

Based on the analysis of previous studies, as well as a field case study, this paper develops a task-technology fit model for mobile business environments, in the form of a TTF matrix. Based on the model, a series of testable hypotheses are formulated, and a research plan for empirically testing these hypotheses is also presented.

This research bears significant meaning in enriching and developing the TTF theory as well as its related models and empirical methods. If the empirical research part can be successfully completed in line with the research design, its examination results shall serve as an important reference to the future practice of China's mobile government, especially the future deeper application and customized development of mobile government terminals in the area of city administration and law enforcement.

On the other hand, this research can also be seen as a preliminary attempt of this completely new idea. There are a number of important issues to be resolved step by step in future studies. One of the most important issue is whether there exists conflicts between the examination of several hypotheses proposed in this paper and the exploration of TTF matrix in specific application situations, as the former appears to be a typical empirical way of "hypothesis-verification", while the latter more resembles that theory is concluded from data, bearing a notion of grounded theory [33]. An effective combination of these two ideas to address specific research questions shall be the issue for not only us, but also many researchers in IS and e-commerce fields to confront with and to seriously consider. Ongoing studies may in the future produce clearer and more convincing answers to these questions.

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