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Xiuzhen Feng
School of Economics and Management, Beijing University of Technology, China

Yang Peng
Department of Computing, The Hong Kong Polytechnic University, Hong Kong SAR

Haoran Xie
Deparment of Computer Science, City University of Hong Kong, Hong Kong SAR

Ang Sha
Deparment of Computer Science, The University of Hong Kong, Hong Kong SAR

Looking into the Environmental Factors Affecting the Performance of Ubiquitous Technologies Deployment: An Empirical Study on Chinese Information and Communication Technology Companies

Xiuzhen Feng[1], *Yang Peng*[2], *Haoran Xie*[3]*, *Ang Sha*[4]
[1]School of Economics and Management, Beijing University of Technology, China
[2]Department of Computing, The Hong Kong Polytechnic University, Hong Kong SAR
[3]Deparment of Computer Science, City University of Hong Kong, Hong Kong SAR
[4]Deparment of Computer Science, The University of Hong Kong, Hong Kong SAR

Abstract: Effective deployment of ubiquitous technologies can help companies improve the business efficiency, especially for those ICT (Information communication technology) companies who are involved in M-business, M-commerce, and etc. However, there are many factors could affect the performance of the ubiquitous technologies deployment, such as the company's management, the employee's coordination, and etc. In this paper, we are focused on the environmental factors that would have an impact on the performance of organizations which have deployed or is deploying ubiquitous technologies, and investigate more than 50 Chinese ICT companies. According to our findings, in the context of China, a sensible, dependent, and interactive business relationship with the outside environment will have a positive impact on their ubiquitous technologies deployment's performance, while the decentralization and hierarchism within organizational structure in the inside environment will have a negative impact on their ubiquitous technologies deployment's performance.

Keywords: Pervasive computing, Ubiquitous technologies, Information communication technologies

1. INTRODUCTION

Ubiquitous technology is the trend towards increasingly ubiquitous, connected computing devices in the environment, a trend being brought about by a convergence of advanced electronic, particularly the wireless technologies and the Internet [1]. Normally, there are three kinds of ubiquitous technologies, which are automatic identification (e.g., barcode system, RFID, etc.), localization (proximity, ultrasonic signals, etc.), and sensor technology (e.g., MEMS (micro electro mechanical system), wireless sensor network, etc.) [2]. With the emergence of 3G network, the potential business values of ubiquitous technologies have been realized by more and more people. Therefore, many companies are trying to deploy the ubiquitous technologies into their business processes for gathering ad hoc information in anytime and anywhere, which is essential for improving the efficiency of business in this information-explosion era.

In the context of China, the commercial applications of ubiquitous technologies are still in a low developing stage compared with U.S., meanwhile, a new industrial called "Mobile Internet" arose and is growing very fast with the development of ubiquitous technologies (particularly the wireless networks) in China. Consequently, many Chinese ICT companies are moving or expanding to the "Mobile Internet" to grab the benefits of "ubiquity". However, most of them can't get the full benefits from the ubiquitous technologies because their ubiquitous technologies deployments are ineffective or not effective enough. The reason probably lies in two aspects as below:

- **UT itself:** Ubiquitous technologies have their own deficiencies, such as high cost, not stable, and etc. So

*The corresponding author. Email: hrxie2@student.cityu.edu.hk (Haoran Xie)

when the ubiquitous technologies are deployed into the organizations, the deficiencies of them will be revealed and influence the whole deployment.

- **Deployment environment:** The deployment environment could be divided into two parts, one is the outside environment of the company, which is including the society, market, competitors, and etc., and the other is inside environment of the company, which including the management, employees, and etc. Consequently, different environments will have different impacts on the fit between ubiquitous technologies deployment and organizations.

In this paper, we are focused on exploring the environmental factors related to the characteristics of ubiquitous technologies. Based on the identified environmental factors, we develop a multi-dimensional framework to evaluate the performance of those Chinese ICT companies that have deployed or are deploying the ubiquitous technologies. Thus the reminder of this paper is organized as follows: In section 2, we review the related works on ubiquitous technologies and their applications in organizations, and in section 3, a multi-dimensional framework of evaluating the performance of Chinese ICT companies will be provided. For the section 4, we collected the data and presented the data analysis. Finally, we draw the conclusions and provide the directions for future works in section 5.

2. RELATED WORKS

2.1 Pervasive Computing

"Pervasive computing" has become a hot research field since introduced by Weiser [3] in 1991, and many researchers have done their researches on the ubiquitous technologies and their applications through the years. Hansen et al. [4] have introduced ubiquitous technologies into hospitals to facilitate the communications between doctors and patients. Another research is done by Fleisch and Mattern [5] to introduce the "Internet of things", which is created by ubiquitous technologies such as RFID tags, Closed Circuit TV cameras, GPS navigation system, and etc. Meanwhile, the mobile wireless network, which is included in the ubiquitous technologies, is playing a more and more important role in today's society as the mobile phone has become a necessary part in people's lives. Accordingly, many researchers are trying to integrate the "mobility" into the organization's business information system to grasp the ubiquitous benefits. In [6], a comprehensive model of mobile ERP system has been presented by Dabkowski and Jankowska. Alternatively, Zheng et al. [7] have designed a mobile E-business system, which is based on open source software to deal with the end-to-end security problems.

2.2 Ubiquitous & Business Value

Aside from developing the ubiquitous technologies and expanding their applications, some researchers have focused on exploring the business values that ubiquitous technologies could bring to organizations. For example, Oertel et al. [8] assessed the potential values including of ubiquitous computing for improving business management performance on the organizational level in terms of higher customer satisfaction, higher productivity, and more efficient & effective management, and etc. Changsu et al. [9] done an empirical investigation on the factors affecting ubiquitous computing use and business value, and found that the use of ubiquitous computing can create value in terms of enhancing business operations, business processes and customer satisfaction. Kyungmo A. and Juyeon K. [10] done a study in exploring the service quality of ubiquitous mobile tour information in order to find the relationships between the service quality, perceived enjoyment and behavioral intention, so as to facilitate management efficiency and create the business value.

2.3 Ubiquitous Deployment

For the deployment of ubiquitous technologies, Sohan and Harle [11] indicated that "A research environment, with its ill-constrained working hours and tendency to discourage large collaboration groups, is not an ideal deployment candidate". A further research is done by Katharina et al. [12], which suggested that the specific conditions under which ubiquitous technologies emerge will have impact on deploying and using of them. Furthermore, Grover and et al. [13] have empirically documented the impact of organization structure and culture on the information technology deployment.

3. FRAMEWORK DEPLOYMENT

3.1 Discovering of environmental factors

As introduced by Weiser [14] in 1993, the main characteristics of ubiquitous computing systems are invisibility and a focus on communication, mobility, smart tools and new forms of interaction. Based on Weiser's definition, we are trying to identify the relationship between ubiquitous technologies' characteristics and organization's environment.

The environment of organizations could be divided into two parts, which are the external environment and internal environment. In the external environment, there are three components, which are market, partner and customer. Meanwhile, the internal environment is basically concerned about the organizational structure in companies. Based on the components of organization's environment, we discovered five environmental factors to reflect the relationship between characteristics of UT and organization's environment, which are sensitivity, dependence, interactivity, decentralization and hierarchism. The detailed discovering of organization's environmental factors is depicted as Fig. 1.

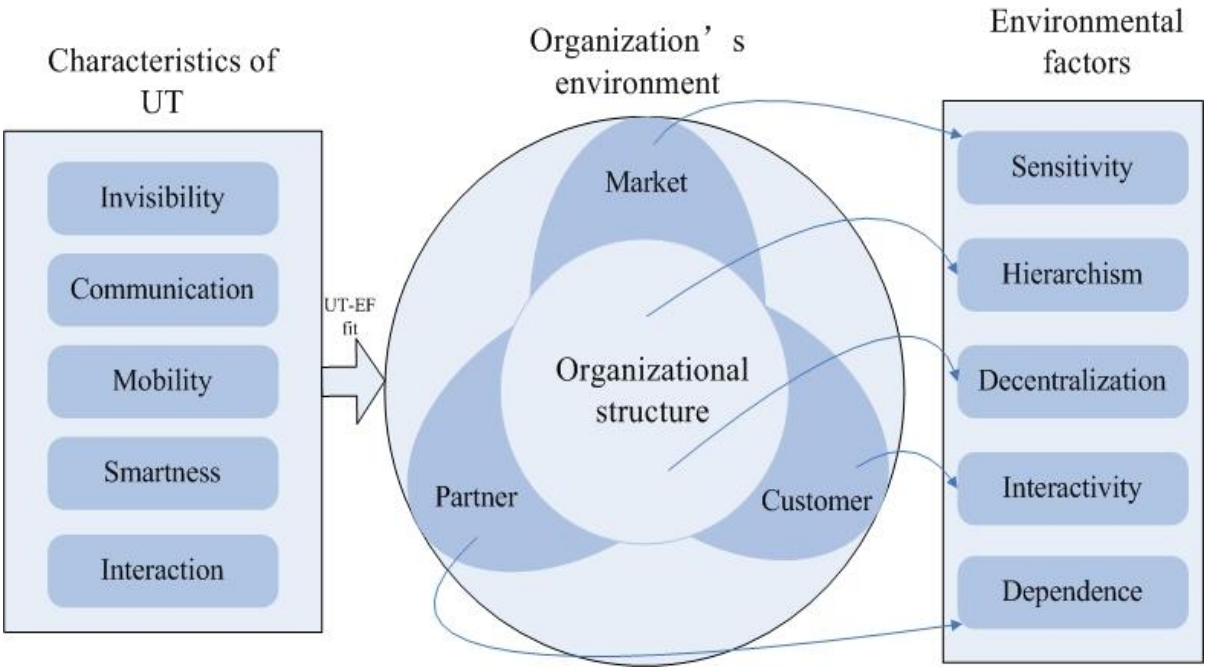

Figure 1. Relationship between UT characteristics and environmental factors

3.2 Discovering of environmental factors

Based on the environmental factors discovered in the 3.1, we propose a multi-dimensional framework to evaluate the impact of UT deployment on organization's performance, which is presented as Fig. 2.

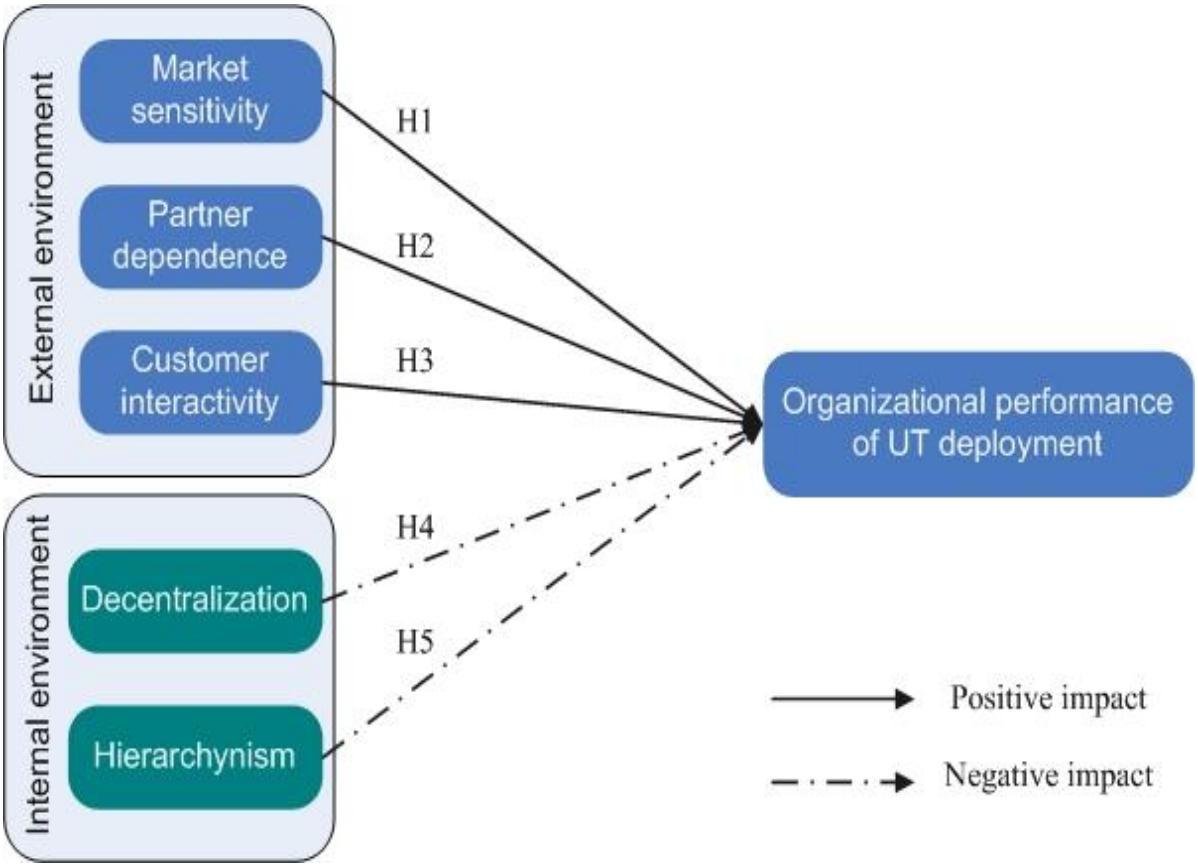

Figure 2. A multi-dimensional framework of UT deployment evaluation

3.3 UT-EF (Ubiquitous technology-environmental factors) fit and hypothesis

Market sensitivity: When there is a major change in the market, it generally results when investors change their opinions about the future of the economy, and some companies are affected more by such changes than are others, which means these companies get higher market sensitivity than others [15]. Market is one of the most important components in the external environment where companies are, therefore, it is significant for companies to get the timely and accurate information from the market in such a changing and competitive environment, especially for those companies which have high market sensitivity, whereas the communication and mobility of ubiquitous technologies can fit this scenario well.

H1: The market sensitivity will have a positive effect on UT deployment performance.

Partner dependence: It refers to the degree that how a company relies on its partners. Normally, companies will have some co operations with others in their business, so the partner is another important part comprises the organization's external environment. Considering that a good partner relationship will have positive effects on the ongoing and continuous co operations, it is important to have timely and effective communications with partners for those companies which are much more dependent on their partners. The communication and mobility of ubiquitous technologies can also fit well in this case.

H2: The partner dependence will have a positive effect on UT deployment performance.

Customer interactivity: When we tell about the external environment of market, the customer is the indispensible part. Understanding customer needs which drive significant product innovation is particularly challenging for new product development (NPD) organizations, and customer interactivity is positively related to information quality for developing highly innovative and highly embedded product [16]. As the ubiquitous technologies is widely considered to be an innovative and embedded technology for organizations, it is

important to keep effective and timely interactions with customers, which is also related to the interactivity and mobility of the ubiquitous technologies.

H3: The customer interaction will have a positive effect on UT deployment performance.

Decentralization: It is the converse term of centralization, which refers to the locus of decision authority and control within an organizational entity [16]. A decentralized system will have more relies on the lateral relationship, but less relies on the command or force [17], so is for organizations. Therefore, the decentralization will weaken the leadership and execution inside an organization, and unclearness in authorities will lead to disputes and conflicts, which are negative for the whole organization. Although the invisibility and smartness of ubiquitous technologies can solve this organizational structure problem to some extent, it is hard to promote the ubiquitous technologies deployment itself.

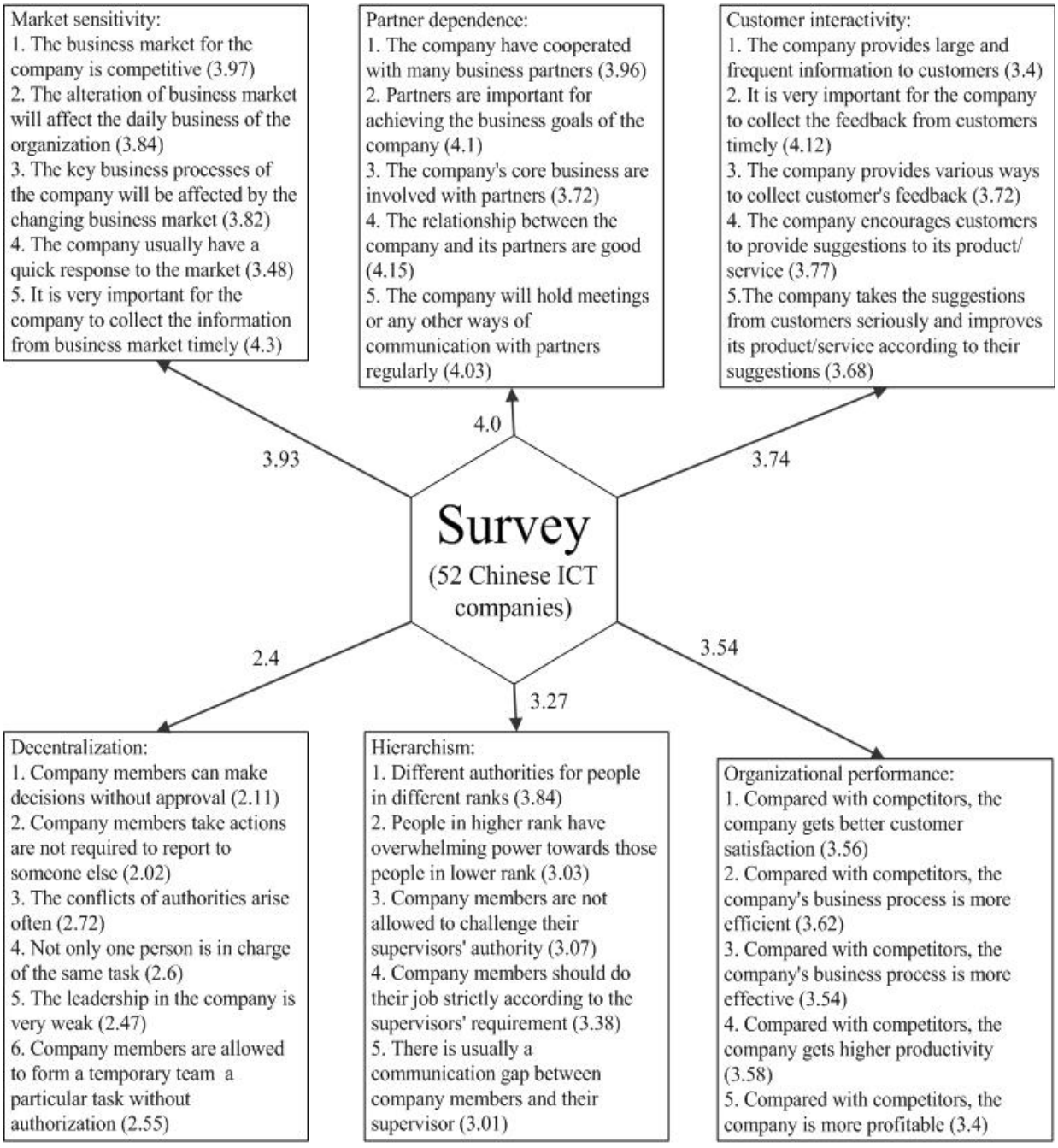

Figure 3. The layout of survey results

H4: The decentralization in structure will have a negative effect on UT deployment performance.

Hierarchism: Currently, it is common for companies to adopt the hierarchical organizational structure in their management since it can reduce communication overheads by the limitation of information flow, however, improper authorization in hierarchical structure could lead to another problem of hierarchism, which means the supervisors have the overwhelming authority over the subordinates in a hierarchical organization so that it would cause the communication problem between people from different ranks despite of the invisibility and communication of ubiquitous technologies.

H5: The Hierarchism in structure will have a negative effect on the UT deployment performance.

4. DATA COLLECTION AND ANALYSIS

The data samples collected for this paper are from 52 representative ICT companies which are moved or are moving to the mobile Internet in the China, e.g., Beijing Kunlun Inc., Kingdee Ltd., and etc. The reason why we select these not large but fast growing ICT companies because their business have covered the fields such as M-commerce, Mobile ERP, Mobile value-adding business, and etc., which are related to the ubiquitous technologies. The respondents of our survey are the middle managers and employees in the IT department since their views are probably more pertinent, and the results are summarized as Fig.3.

We have adopted the regression analysis to test our five hypotheses. The 1-tailed Person correlation method is utilized for conducting the correlation analysis, whose results are summarized in Fig.4.

According to the result of regression test that is illustrated in Fig.5, the external environmental factors (market sensitivity, partner dependence, and customer interactivity) have positive significant effects on the organizational performance of UT deployment, whereas the internal environmental factors (decentralization and hierarchism) have negative significant impact on the organizational performance of UT deployment. Consequently, our five hypotheses are confirmed by the data analysis results.

	V6	V1	V2	V3	V4	V5
V6: Organizational performance	1.000					
V1: Market sensitivity	0.293	1.000				
V2: Partner dependence	0.461	0.339	1.000			
V3: Customer interacitivity	0.478	0.086	0.435	1.000		
V4: Decentralization	-0.316	-0.213	-0.255	-0.245	1.000	
V5: Hierarchism	-0.306	-0.276	-0.153	-0.007	0.300	1.000

Figure 4. Variables correlations matrix

	Unstandardized Coefficients		Standardized Coefficients			Expected	Support for
Model	B	Std. Error	Beta	t	Sig.	Sign	Hypothesis?
(Constant)	2.165	0.891		2.429	0.020		
V1: Market sensitivity	0.115	0.137	0.112	0.838	0.407	+	Y
V2: Partner dependence	0.215	0.145	0.215	1.488	0.144	+	Y
V3: Customer interacitivity	0.244	0.096	0.352	2.546	0.015	+	Y
V4: Decentralization	-0.075	0.115	-0.086	-0.647	0.522	-	Y
V5: Hierarchism	-0.202	0.125	-0.213	-1.619	0.113	-	Y

a. Dependent Variable: V6: Organizational performance

Figure 5. The result of regression test

5. CONCLUSION

In this paper, an UT-EF (Ubiquitous technologies-environment factors) fit is proposed to discover the environmental factors which could have an impact on the performance of ubiquitous technologies employment in organizations. Accordingly, we develop a multi-dimensional framework to evaluate the organizational performance of UT deployment in more than 50 Chinese ICT companies. Based on our research findings, the external environment are found to be significant to the success of organization's UT deployment in the context of China, and a sensible, dependent, and interactive relationship with market, partners, and customers will have positive impacts on their organizational performance. This is mainly because the ubiquitous technologies can enhance the communication between the ICT companies in China and the external environment as well as increase their business mobility. Meanwhile, the internal environment can also affect the UT deployment, and the decentralization and hierarchism in the organizational structure are found to have negative effects on their organizational performance because it will mitigate the effectiveness of UT deployment. In our upcoming research, there are some possible future directions: (i) The scale of investigated companies will be extended from China to other areas; (ii) The relationship between the performance of ubiquitous technologies deployment in organizations and the characteristics organizations like cultures could be studied; (iii) The impacts on the performance of ubiquitous technologies deployment in different levels of the organization could be examined to provide insight on them.

6. ACKNOWLEDGEMENT

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