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THE INTELLECTUAL CORE KNOWLEDGE OF THE MOBILE INFORMATION SYSTEM

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Abstract

Recent advances in mobile technology have led to a newly emerging and gigantic market with billions of mobile users, and research focused on the issues of mobile information systems has increased dramatically. However, there remains a lack of core knowledge of mobile information systems. This paper collected a total of 1684 mobile information system related articles and 43064 references from the Web of Science. We identified 8 core knowledge of the mobile information system, as follows: (1) technology acceptance; (2) information system success; (3) value of mobile continuance usage; (4) technology adoption; (5) user behavior on the World Wide Web; (6) measurement and evaluation of mobile commerce; (7) innovation and usage of mobile commerce; (8) opportunities and challenges of mobile technology. This study intends that these results will stimulate researchers and practitioners for future mobile information systems.

Keywords: mobile information system, citation analysis, co-citation analysis, information systems research.

1   INTRODUCTION

In recent years, the significant growth rate of mobile devices has prevailed across the world to become one of the most frequently-used technological tools (Kumar and Kaliyaperumal 2015). This trend will bring unprecedented operation models and commercial values, and with such strong demand, mobile devices will become increasingly essential. Nowadays, almost everyone has a smart phone, and tablets have become increasingly popular. Mobile devices have changed the lifestyle and consumption behaviors of society, and its role has become more important than that of the computer in the previous century. In 2014, there were approximately 2.6 billion smart phone users around the world, and as the price of smart phones become ever lower, the Asian-Pacific region, the Middle East, Africa, and Latin America will become promising markets for smart phones in the coming years. According to the statistics of the International Telecommunication Union (ITU), there is still huge potential for great progress in mobile broadband, and the number of mobile phone users exceeded 7 billion for the first time this year; however, the increase in the number of mobile phone users and Internet users has begun to slow noticeably, which has brought us to a turning point in the development of the Internet. The number of mobile phone users soared in 2005, and though the increase slightly slowed in 2015, the number hit 7 billion in the same year. Of all these mobile phone users, those from developing countries accounted for about 79%, as shown in Table 1.

	The Number of Users in Developed Countries (Million)	The Number of Users in Developing Countries (Million)	The Number of Global Users (Million)
2005	992	1,213	2,205
2006	1,123	1,618	2,745
2007	1,243	2,125	3,368
2008	1,325	2,705	4,030
2009	1,383	3,285	4,640
2010	1,404	3,887	5,290
2011	1,411	4,453	5,863
2012	1,447	4,785	6,232
2013	1,481	5,185	6,666
2014	1,504	5,450	6,954
2015	1,517	5,568	7,085

Table 1.   Source: ITU (2015)

There is a growing number of people who link their mobile devices to the Internet for shopping, communicating with others, planning routes, and searching tour information. Smart phones have served as a convenient tool for instant communication with family members. In addition to being crucial to the public, smart phones can change our life (Barnes 2002). You can make a phone call at any place that is covered by telecommunication signals. Those who get lost or need help would be able to find their way through the global positioning system in their phone (Das and Alam 2014). Moreover, many phones are equipped with the service of first aid, meaning a built-in service that operates without the Internet or telecommunication signals. Mobile phones support a vast number of applications and are furnished with many functions similar to that of laptops, thus, they do not need extra accessories or devices (Ren et al. 2014). Following digital and mobile development, big data and mobile application has become new emerging fields. As mobility is attracting ever greater attention in academic, there has been many articles related mobile information systems. However, few studies focus on the core knowledge of mobile information systems. This study fulfils this gap by analysing the knowledge structures of mobility, and summarizes the 8 core knowledge of mobile information systems. The rests of this article are organized as follows. Section 2 reviews mobility information system and co-citation analysis. Section 3 describes the research methods used in this study. Section 4 result and discussion. Section 5 presents conclusion of this paper.

2   LITERATURE REVIEW

2.1   Mobile information system

Surfing on the Internet through mobile devices has become a part of daily life. Driven by the different lifestyles of consumers, the mobile revolution has generated different demands for technological advancement and improved daily life. In addition to being a basic communication tool, the modern smart phone also works as a media tool, a portable entertainment tool, and a marketing tool, and when connected to the Internet, it can be used for shopping, bookings, and payments (Öztaş 2015). With the advent of mobile business, enterprises actively consider how to enhance their competitiveness and productivity through mobile devices, in order to become acquainted with customer demands in an accurate manner and improve the delivery of services (Varshney and Vetter 2002). Moreover, many business models have changed; in addition to attracting more prospective consumers and reducing labor costs, mobilization can promote the growth of enterprises, strengthen their competitiveness, increase profits, curtail costs, thus, optimizing their business models. Meanwhile, the Online-to-Offline model has also emerged, where shopping and marketing in the virtual network is brought into the actual stores. In this model, consumers can pre-purchase services on the Internet, and enjoy the services offered in actual stores through a mobile phone or tablet (Fangfang and Shuyun 2014). Governmental departments have also joined in wave of mobilization by developing smart cities, which offer Wi-Fi hot spots and other services, such as mobile payment and smart payment (Scholl et al. 2014). With such online services, civilians can pay fees, make inquiries about governmental taxation, and manage electronic receipts on their mobile phones, and tourists can enjoy convenient services and save the time of seeking information. Mobile information systems have become important part of human life, including smart city, healthcare, communication, and electronic commerce (Mata et al. 2016). In short, they can facilitate people's daily life, save energy, and reduce carbon dioxide and social cost (Neirotti et al. 2014).

3   RESEARCH METHOD

In 1973, Small put forward co-citation analysis (Small 1973). In the field of information management, co-citation analysis has been regarded as one of the methods for exploring and summarizing the knowledge structures and core knowledge of different fields (Grover et al. 2006). According to previous studies, co-citation analysis is a process where concepts, as shared by two articles, are used to calculate the frequency of their being cited in a third literature; the more the concepts are cited, the higher correlation there will be between the two articles; it also indicates that they have high value (Kessler 1963). The "high value" indicates that the two articles are of certain importance in the field, and may even be a core knowledge structure. A greater number of shared citations means a stronger correlation between the two, i.e. it is possible to make the hypothesis that there is a stronger relevance between the two articles. Co-citation analysis can identify authors, key words, and even the relation between two papers in an objective manner, and illustrate the correlation between the two. The three most frequently-seen dimensions of co-citation analysis are, as follows: the co-citation analysis of literatures, the co-citation analysis of authors, and the co-citation analysis of journals (Hsiao and Yang 2011). In the co-citation analysis of literatures, the frequency of the paired citation between cited papers is used to determine the relation between literatures (Small 1973); in the co-citation analysis of authors, the frequency of the paired appearance of cited authors is employed to judge the relation between literatures; in the co-citation of journals, the frequency of the paired appearance of cited journals is adopted to evaluate the relation between literatures. Co-citation is often used to discuss the knowledge structure of subjects and explore the core knowledge of various fields. Co-citation analysis has long been adopted to elaborate the cores of all industries (Culnan 1987; Hsiao and Yang 2011; Pratt et al. 2012; Shiau et al. 2015).

As information technology rapidly advances, electronic databases have become a source of a vast number of literatures for researchers. Through the Internet, researchers can obtain access to these papers. In this way, more and more researchers can obtain academic resources through the Internet platform. The database adopted in this study is the Web of Science -- an essential database of academic information across the world. It includes over 9,000 famous and influential research journals and over 12,000 online databases of academic conferences from around the world. Moreover, as SCI and SSCI have strict standards for journal selection, it is accepted by all scientists and research management sectors around the globe (http://concert.stpi.narl.org.tw/fdb/wos/index.html). The above facts show that the ISI Web of Knowledge is powerful and authoritative (Galvagno 2011; Shiau et al. 2015; Shiau and Dwivedi 2012; Shiau et al. 2016). In this study, the online database is taken as a source of information, "Mobile" is taken as the key words, and time is from the period of 1996 to October 2015. We collected 1,684 articles and 43,064 references. Citation and co-citation are used to identify high cited articles, 47 studies. Cluster analysis is used to classify 47 high cited articles (Culnan 1987; Hsiao and Yang 2011; Pratt et al. 2012; Shiau et al. 2015; Small and Griffith 1974).

4   SHOWS RESULT AND DISCUSSION

In this study, cluster analysis and cross comparison of the multi-dimensional scaling analysis were utilized to analyze a co-citation matrix consisting of 47 frequently-cited literatures. Then, 8 core knowledge of mobile information systems were found, namely, (1) technology acceptance, (2) information system success, (3) value of mobile continuance usage, (4) technology adoption, 5) user behavior in the World Wide Web, (6) measurement and evaluation of mobile commerce, (7) innovation and usage of mobile commerce, and (8) opportunities and challenges of mobile technology.

Cluster 1 is the technology acceptance. In the cluster, users' expectations and views of technology are discussed. The cluster elaborates on users' views and perceptions of technologies according to the technology acceptance model or the theory of planned behavior. Researchers use technology acceptance model to study mobile information systems. Davis (1989) adopted perceived usefulness and perceived ease of use to reflect on users' acceptance of information technology, and thought that the relevance between perceived usefulness and usage was more significant than that between perceived ease of use and usage. Venkatesh et al. (2003) reviewed the literature regarding user acceptance, and demonstrated eight famous models. Moreover, they compared the models, and their expansion, and created and demonstrated a comprehensive model that integrated the eight models. The eight famous models include the rational behavior theory, the technology acceptance model, the encouragement model, the theory of planned behavior, a combination of the technology acceptance model and the theory of planned behavior, the PC adoption model, the innovation expansion theory, and the theory of social cognition. According to Davis et al. (1989), a person's competence of using a computer could be predicted from his/her purposes; perceived usefulness was the dominant factor in a person's purpose of using a computer, and perceived ease of use was another factor of this kind.

According to Ajzen (1991), the theory of planned behavior was a popular model that provided a large amount of information; the information was important for learning these behaviors and taking intervention measures, and would effectively change intention, perception, and behavioral attitude; subjective norms disclosed the different aspects of behavior. Faith offered dominant factors regarding behaviors, thus, we can motivate a person to perform some behaviors that interested him/her. Venkatesh and Davis (2000) developed and tested a technology acceptance model of theoretical expansion, and interpreted the cognition of perceived usefulness and the purposes of usage in influencing society. They found that the process of influencing society and perceiving tools had significant impact on user acceptance. Taylor and Todd (1995) compared the technology acceptance model with the theory of planned behavior in order to determine which mode was more helpful in the understanding of information technology. The results showed that the theory of planned behavior offered deeper understanding of behavioral purposes. According to Venkatesh (2000), increased experience would enhance the perceive ease of use of a system; the concept of the usage of computer

needed to be adjusted to reveal the usability of objectives. Moore and Benbasat (1991) advanced the five features of innovation and offered a new scale to measure the views on achieving innovation through information technology. With the technology acceptance theory, Venkatesh and Morris (2000) investigated the differences in the adoption of technology in the workplace between women and men regarding the continual usage of technology. For men, usefulness had a stronger influence on the decision of technology usage; for women, ease of use and subjective norm had a stronger impact on perception, and the role of subjective norms would weaken with the passage of time. According to (Mathieson 1991), both the technology acceptance theory and the theory of planned behavior were rather effective in prediction: the former had advantage in experience, but merely offered common information about the system, while the latter provided more detailed information about development.

Cluster 2 is information system success. This cluster aims to propose a model that measures user satisfaction and information system success in order to determine factors influencing information system success. To undertake different studies, DeLone and McLean (1992) put forward a comprehensive view of the concept of the success of the information system, and suggested identifying the success of the information system according to six aspects, namely, system quality, information quality, usage, user satisfaction, individual influence, and organization influence. The concepts of taxology and experience studies were used for review and organization. Cronin Jr et al. (2000) demonstrated that quality, value, and satisfaction had direct effect on behavioral purpose. Fornell and Bookstein (1982) applied LISREL and PLS, which were different in structure and objective. LISREL offered stricter hypotheses, while PLS achieved the effectiveness of the prediction of simple hypotheses at the cost of parameters. The two were also different in the measurement of residual: PLS started with the structure of the model, while LISREL integrated certain variances and measurement errors in a single estimate and made necessary adjustment; LISREL required accurate estimate, and was thus suitable for large samples, while PLS was applicable to the estimate of small samples and testing. According to the model proposed by Oliver (1980), expected function and life expectancy indicated consumer satisfaction, which influenced attitude and intention to shop. DeLone and McLean (2003) renewed the information system success model by regarding "service quality" as an important factor for the success of the information system. In particular, customer service is crucial in the electronic business environment. Moreover, they proposed to add "system adoption" to measure information system success.

Cluster 3 is the value of mobile continuance usage. This cluster seeks to determine what factors or concepts would affect the continual usage of users. With the expectation confirmation theory, Bhattacherjee (2001) discussed the influence of cognitive faith on users' continual usage of the information system, and believed that users' continuance purpose was determined by their satisfaction with the information system and the perceived usefulness of the system. According to Kim et al. (2007), perceived value was an important variable among users' interest, sacrifice faith, and usage willingness in the usage of mobile networks. Turel et al. (2007) thought that mobile added services, including picture information and games, had increased greatly in recent years to enhance the acceptance of these services, thus, it is vital to become acquainted with the potential motives of users' behaviors. According to Hong et al. (2006), the technology acceptance theory could be applied to the simplest general model to explore the initial and continual usage of information technologies; the expanded ECM-IT could help us understand the continual usage of information technologies; while ECM-IT and the expanded ECM-IT models could offer more information to deepen our understanding of the continual usage of information technologies.

Cluster 4 is technology adoption. The papers in this cluster focus on the influence of the adoption of different technologies. van der Heijden (2004) believed that the enjoyment of an information system was an important boundary condition for the effectiveness of the technology acceptance model, and that the adoption and usage of information technologies were vital for gaining the advantage of information technologies. According to Karahanna et al. (1999), the behavioral purpose and attitude of the potential users of information technologies were influenced by subjective norms; where potential adoption was determined by norm pressure, while user purpose was determined by attitude. Hong and

Tam (2006) thought that perceived usefulness lost the dominant position, while ease of use and enjoyment dominated the prediction value. Defining a new information technology and innovative technology was called a multi-functional information apparatus, and developing a model revealed its specialty and the environment under which such a multi-functional information apparatus was used. According to Davis et al. (1992), usefulness and enjoyment regulated the influence of perceived output quality and perceived ease of use on usage purpose; if it was a task-oriented environment, it was influenced by the usefulness of usage and output quality. Venkatesh et al. (2003) proposed a model that introduced mobile commerce, and he encouraged enterprises to undertake studies on usability and become acquainted with the general weight calculation scheme through customers.

Cluster 5 is user behavior on the World Wide Web. All three papers in this cluster concentrate on the factors influencing usage of networks. With emphasis on strong enjoyment, control, and curiosity, Agarwal and Karahanna (2000) assumed two important beliefs regarding technology usage: perceived usefulness and perceived ease of use, and they argued that personality interest and individual innovation were critical factors for cognitive absorption of influence. According to Koufaris (2002), a person had two identities -- a shopper and an online consumer -- and would develop a strong purpose of network usage according to the enjoyment and usefulness of shopping. Moon and Kim (2001) believed that perceived ease of use and perceived usefulness had been proved important for the users of the global information network system, and that cognitive entertainment was another factor to be considered in the future design of the global information network system.

Cluster 6 is measurement and evaluation of mobile commerce. This cluster discusses the evaluation and measurement of mobile commerce, proposes new measurement methods, and examines previous evaluation and measurement methods for suggestions or improvement. To examine the variables that could not be observed and the structural equation model that measured errors, Fornell and Larcker (1981) adopted Chi-square testing to detect defaults, and found that the errors might be serious. To solve such problems, they proposed a testing system based on the variables in the structural model, the measurement model, and the general model. Podsakoff et al. (2003) examined the influence of method deviation, defined the potential sources of method deviation, and evaluated different programs and statistical technologies. These technologies could be used to control method deviation, offered suggestions on different research settings, and provided appropriate programs and statistical remedies. Anderson and Gerbing (1988) provided researchers with the guidance of theoretical testing and the development of structural equation modeling, and adopted a series of models and Chi-square test difference tests. Bagozzi and Youjae (1988) reviewed the standard definition of the structural equation model with potential variables, and put forward an explanation-based focus and divergence evidence model to evaluate the general scheme. According to Gefen et al. (2003), consumer trust was essential for online commerce and the technology acceptance theory was widely applied, including usage, perceived usefulness, and perceived ease of use. Online trust was built upon (1) faith that suppliers had been checked for reliability, (2) faith that it had a built-in Web security mechanism, (3) a typical interface, and (4) ease of use. Baron and Kenny (1986) found the properties of the differential adjustment variables and intermediary variables on several layers, and proposed making full use of the adjustments and intermediary differentiation analysis procedure. Podsakoff and Organ (1986) defined six types of self-reports and discussed the shared methods of solving problems regarding variance, consistency, and social approval; moreover, they put forward evaluation statistics, some post-event remedies, and some methods for handling and defining prejudice. Cyr et al. (2006) promoted the application of TAM (DEFINE) in the field of mobile commerce, and found that the visual design aesthetics had significant influence on perceived usefulness, perceived ease of use, and enjoyment, which influenced users' loyalty and purpose in mobile services. Lin and Wang (2006) developed and demonstrated the model of customer loyalty of mobile commerce, and found that customer loyalty was influenced by perceived value, trust, habit, and customer satisfaction, and that customer satisfaction played a key intervention role in perceived value, loyalty, and trust.

Cluster 7 is innovation and usage of mobile commerce. This cluster elaborates on the innovative factors and user acceptance of mobile commerce. Wu and Wang (2005) proposed an expanded

technology acceptance model, which integrated the innovation expansion theory, cognition risk, and cost, in order to understand what determined users' acceptance of mobile commerce. Perceived ease of use had significant influence on users' behavioral purpose, especially compatibility. What slightly confused them was that perceived risk had significant influence on behavioral purpose. Luarn and Lin (2005) expanded the adaptability of the technology acceptance theory to mobile banks and added the trust-based architecture of "perceived credit", as well as the models of two resource foundation structures -- "sense of self efficacy" and "perceived financial cost", thus, greatly promoting the role of the expanded technology acceptance theory in predicting user purpose in mobile banking. Chin et al. (2003) offered a new modeling method of potential variables to estimate related measurement errors, and provided more accurate interactive effects. The real influence of cumulative regression was shown in the Monte Carlo Method and table forming, which aimed to stimulate the data set. According to Goodhue and Thompson (1995), if an information technology has positive effects on personal performance, then the technology (1) must be used and (2) must support tasks. They underlined the importance of technology and user for enhancing the influence of personal performance in information technology on the collaboration among tasks. Task technology adaptability was a powerful diagnostic tool that could evaluate if it offered an information source system and services to a given organization, and if it could meet the needs of users. Agarwal and Prasad (1998) proposed a new structure, elaborated on its relation with the technology acceptance model, and stated that the structure had ideal operation measures of psychological properties. In the field of information technology, personal innovation referred to the assumed role of antecedent and adjustment, and to a personal view of new information technologies. Herbjørn et al. (2005) discussed the overall influence of the willingness of usage: the influence of motivation, the influence of attitude, norm pressure, and the sense of control. They showed great support for the influence of motivation, the influence of attitude, the influence of norm pressure, and for users' perceived control in the usage of mobile services. Lu et al. (2005) proposed several potential structures for models and tests at places free from work, such as the relation among wireless mobile technology, social influence, and personal innovation. Structural equation analysis disclosed the strong causal relations among social influence, personal innovation, faith, practicability, and ease of use. According to Kuo and Yen (2009): (1) the usage rate of the current 3G added value services was still low; (2) enhancement of personal innovation in the direct promotion of the perceived ease of use of the 3G added value services; (3) a stronger perceived usefulness would lead to a higher level of consumers' perceived ease of use of added value services; (4) perceived usefulness enhanced consumers' behavioral purpose of using 3G mobile added value business, and then perceived ease of use and perceived cost; (5) the most important factor was attitude, which was followed by perceived ease of use, perceived cost, and perceived usefulness.

Cluster 8 is the opportunity and challenge of mobile technology. This cluster explores the cross-environmental properties of mobility, and its freedom from any spatial obstacle, and then focuses on the relations among them and their influence in the future. Lyytinen and Youngjin (2002) believed that information environment was linked with technology, society, and organization, and could do the calculation among organization doers, offer communication services, and achieve social mobile heterogeneous portfolios across organizations and boundaries. Moreover, it could analyze basic mobility, digital combinations, large-scale popular features, and the interdependence among them. Balasubramanian et al. (2002) thought that commerce could occur at anywhere, anytime, and at anyplace in the mobile world, thus, it was called mobile electronic commerce. It revealed the influence of mobile technologies, the spatial and time matrix of the classification of mobile electronic commerce applications, and officially conceptualized the influence of the mobile technology.

5   CONCLUSION

With the rapid development of information technology, the fast delivery of information and the quicker rhythm of environmental change, the mobile information system has played an essential role in large, medium, and small enterprises, and even in governments. As a result, the system has been used in an increasing number of enterprises and industries. In recent years, the core knowledge of the

mobile information system has seldom been summarized. To grasp the core knowledge of the mobile information system, this study elaborates on the core of the mobile information system during the period ranging from 1996 to October 2015. The literatures in this study come from the Web of Science. A total of 1,684 papers and 43,064 references was collected. Through cluster analysis and multi-dimensional scaling analysis for cross comparison, 47 frequently-cited papers were used to form a 47*47 co-citation matrix. Finally, eight core topics were extracted from literature regarding the mobile information system during the period, including (1) the technology acceptance model, (2) information system success, (3) the value of mobile continuance usage, (4) technology adoption, 5) user behavior on the World Wide Web, (6) the measurement and evaluation of mobile commerce, (7) innovation and usage of mobile commerce, and (8) the opportunities and challenges of mobile technology. In the current network era, mobile devices have become increasingly diverse with the advancement of information technology, meaning highly portable devices and wireless network communication technologies can be used to establish an environment of a mobile information system in order that users can quickly store and obtain information anywhere, anytime, and at anyplace. The establishment of the system can facilitate the life of users and replace the information that is stored, obtained, and delivered in written form, which saves resources and spreads information in a more accurate, timely, and convenient manner. In the future, it can be integrated with the Internet of Things, large data, and other technologies to attain more diverse development of the mobile information system. This study summarizes the core knowledge of the mobile information system during the period ranging from 1996 to October 2015, and defines the important topics of the period, with the intention of deepening future scholars' understanding of the system, informing them of the important issues about the information system in recent years, and offering insights for future research.

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