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The intellectual development of the technology acceptance model: A co-citation analysis

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ABSTRACT

The goal of this paper is to present a visual mapping of intellectual structure in two-dimensions and to identify the subfields of the technology acceptance model through co-citation analysis. All the citation documents are included in the ISI Web of Knowledge database between 1989 and 2006. By using a sequence of statistical analyses including factor analysis, multidimensional scaling, and cluster analysis, we identified three main trends: task-related systems, e-commerce systems, and hedonic systems. The findings yielded managerial implications for both academic and practical issues.

1. Introduction

The investments in information systems (IS) for today's organizations have expanded dramatically, accounting for about 50% of new capital investment (Venkatesh, Morris, Davis, & Davis, 2003). Despite the considerable investments in IS, about 74% of IS and software engineering projects are delayed, exceed budget, and fail to meet the functional expectations (Schepers & Wetzels, 2007). Therefore, identifying influential factors on technology acceptance across different settings have been an important and focal interest in IS for both researchers and practitioners.

Among numerous theories, the technology acceptance model (TAM) was considered to be the most influential and valid model for describing an individual's acceptance of information systems (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989). Two specific behavioral beliefs – perceived ease of use (PE) and perceived usefulness (PU) – determine an individual's behavioral intention to use (BI) a technology. Derived from the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975) which posits that human behavioral intention is affected by attitude and subjective norm, TAM is specialized for the use of information systems.

In the early stages, information systems were designed to improve task performance and efficiency. Those job-related information systems can be categorized as automation software (e.g., spreadsheet, text-editor), office systems (e.g., word processor, spreadsheet, database programs), system developments (e.g., programming tools, software maintenance tools), and communication systems (e.g., e-mail, voice mail, mobile phone, face-to-face meeting) (Legris, Ingham, & Collerette, 2003; Lim, Lee, & Nam, 2007). The rapidly increasing tendency of Internet usage and worldwide e-commerce has led researchers to work on the general topic of e-commerce (Gefen, Karahanna, & Straub, 2003b; Heinze & Hu, 2006; Lin, 2006; Morgan & Hunt, 1994). Major theoretical and empirical studies have attempted to identify influential factors such as trust and other innovation factors in attracting web users and in consuming products via websites (Venkatraman & MacInnis, 1985; Yiu, Grant, & Edgar, 2007). Therefore, perceived usefulness (PU) and perceived ease of use (PE) may not fully explain the Internet users' motives, as Davis (1989) argued that research studies on any new IT acceptance need to address how other variables affect PU, PE, and the end users' acceptance.

The popularity of TAM research studies can be found from journal citations in the ISI Web of Knowledge database whereby Davis's (1989) article received 424 journal citations by the beginning of 2000, 698 journal citations by 2003, and currently nearly 2000 journal citations. Even though literature reviews and meta-analyses have been conducted to test the convergence of TAM relationships across difference settings and provide an objective statement in TAM (King & He, 2006; Schepers & Wetzels, 2007), previous researches have not yet answered the following addressed questions: what intellectual subfields have emerged from TAM research? In which reference disciplines are these subfields grounded? To what extent do these subfields represent active areas of current research? Additionally, what are the emerging research areas in TAM?

To answer the above questions, bibliometrics, a mathematical and statistical analysis, was used to detect the homogeneous areas

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in research networks and to assess the movement and interactions within and between fields (Small, 1973; Sugimoto, Pratt, & Hauser, 2008; White & Griffith, 1981; Zitt & Bassecoulard, 1996). One of the best-known structuring methods of bibliometrics is co-citation analysis (Borgman, 1989).

A co-citation analysis was used to interpret the similarity of content between two documents by counting the number of documents which have been cited in a pair (Garfield, 1979; Small, 1973). Its premise is that bibliographic references of a scientific paper are often considered to be important in the development of research and signal their influences, so they can serve as the theoretical and empirical foundations of the study (Ramos-Rodriguez & Ruiz-Navarro, 2004). Therefore, it is possible to identify networks of authors or documents belonging to the same discipline or field by analyzing the references. More elaborately, frequently cited documents are likely to have a greater influence on the discipline than those less cited (Culnan, 1986). If two documents are frequently jointly cited, then they are likely to share similar or related concepts (White & Griffith, 1981). By counting and analyzing the frequency of two documents or authors cited in the same work, we can identify groups of closely related documents which address the same research questions (Price & De Solla, 1965; Small, 1973).

The goals of this paper are in line with the co-citation method: (1) identify the subfields within TAM; (2) analyze the relational links between the subfields; (3) graphically map the intellectual structure in a two-dimensional space; and (4) recognize the main trends within TAM. To the best of our knowledge, this paper is the first to apply bibliometric techniques in the field of TAM. Therefore, the major contribution of this paper is to provide an intellectual structure and trends within the field of TAM from an objective and quantitative perspective.

2. Literature review

In order to document the current subfields and the emergence of new research areas in TAM, this section reviews both the general TAM literature and literature on co-citation analysis.

2.1. Technology acceptance model

Information technology (IT) offers a great opportunity to improve job performance; however, the benefits gained from it often depend on the users' willingness to accept and use these available systems. Various theories have been presented to investigate factors affecting an individual's acceptance toward a new information system. Among those studies, the technology acceptance model (TAM) has received considerable attention in the information systems (IS) field and has been tested and extended by many researchers who specialize in IS usage (Mathieson, Peacock, & Chin, 2001). It was developed from the social psychology Theory of Reasoned Action (TRA) which posited that human behavioral intention is affected by attitude and subjective norm (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). The original TAM did not include subjective norm. However, Venkatesh and Davis (2000) found that it influences both perceived usefulness and intention after conducting four longitudinal field studies, so they included the subjective norm into TAM2.

The technology acceptance model (TAM) explains user acceptance of a technology based on user perceptions (Davis, 1989; Davis et al., 1989). The mediating roles of perceived usefulness (PU) and perceived ease of use (PE) are examined in the relationship between external variables and the intention of system usage. While PU is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance," PE is defined as "the degree to which using the technology will be free of effort" (Davis, 1986, 1989). Both PU and PE influence the individual's attitude toward using an information system. Attitude and PU, in turn, predict the individual's behavioral intention to use it. Among these beliefs, PE is hypothesized as a predictor of PU (see Fig. 1).

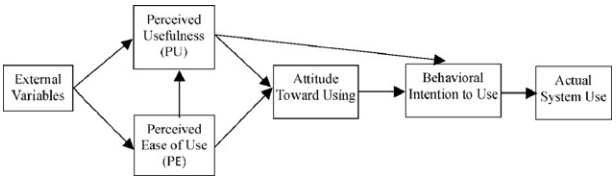

Fig. 1. Original technology acceptance model (Davis et al., 1989).

IS research has long focused on how and why individuals adopt new information technologies. Since the mid-eighties, IS researchers have concentrated their efforts in developing and testing models that could help to predict system use (Chau, 1996; Cheney, Mann, & Amoroso, 1986). Among which, TAM has been widely recognized as a robust, powerful, and economical model for predicting the acceptance of information technology. However, after conducting a review of 22 articles according to some criteria from six MIS leading journals between 1980 and 2001, Legris et al. (2003) presented that either TAM or TAM2 explains only 40% of system use. This indicates that there are other significant factors affecting PU, PE, and user intention of new technology. Nevertheless, results from two recent meta-analysis studies still show that TAM is a valid and robust model with wide application under various conditions such as user types, usage types, or types of information systems (King & He, 2006; Schepers & Wetzels, 2007).

Recently, TAM research studies have turned into an important issue – moderating effects, because by including moderators, the limited explanatory power of TAM can be enhanced and the inconsistent relationships among studies can be solved (Sun & Zhang, 2006; Venkatesh et al., 2003). For example, King and He (2006) conducted a meta-analysis examining the moderating effects of user types and usage types. The results show that Internet usage was different from other types of usage such as task applications, general use (such as e-mail and telecommunication), and office applications. Schepers and Wetzels (2007) discussed three types of moderators: individual-related factors (types of respondents), technology-related factors (types of technology), and contingent factors (culture). Their results confirmed the roles of all moderators especially with the significant influence of subjective norm on perceived usefulness and behavioral intention to use. Therefore, other moderation variables, such as age, experience, personal innovativeness, or computer self-efficacy, are suggested for further investigation.

2.2. Co-citation analysis

In this study we intend to identify the subfields characterized by the intellectual nature of specialties and the main trends within TAM. Co-citation analysis can provide an objective and quantitative means to meet our goals. There are different levels of co-citation analysis: document co-citation analysis, author co-citation analysis (ACA), and journal co-citation analysis. Small (1973) introduced document co-citation analysis by evaluating the network created when documents are linked according to their joint citations by subsequent documents. Author co-citation analysis, by contrast, uses authors instead of documents to produce maps of prominent authors within a selected field by means of computational and graphic display techniques (White, 1990; White & Griffith, 1981). McCain (1991a, 1991b) introduced journal co-citation analysis, which treats representative journals of each field as the units

of analysis. These studies focused primarily on the journal–journal relationship to evaluate the importation and exportation of citations between all given pairs of journals (Sugimoto et al., 2008). The current study adopts document co-citation, because articles from research journals have gone through a critical review of fellow researchers, and this can enhance the reliability of results (Ramos-Rodriguez & Ruiz-Navarro, 2004).

Small (1973) presented the document co-citation method and defined it as a measure of the relationship degree between papers as perceived by the population of citing authors. It is under the assumption that bibliographic citations are an acceptable proxy for the actual influence of various information sources on a research project (Culnan, 1986). Citations were more potent concept symbols than words because a high citation rate reflected peer recognition (Small, 2003). Since the highly cited documents, or "concept symbols," represent the key concepts, methods, or ideas shared by the citing documents in a field, then the co-citation patterns can be used to map out in great detail the relationships between these key ideas (Small, 1973). Franklin and Johnston (1988) suggested that co-citation could identify coherent research problem areas by classifying and grouping current scientific papers through their common referencing to clusters of highly cited and highly co-cited works. Accordingly, numerous studies have demonstrated that the co-citation method is a valid approach to explore the intellectual structure of a scientific discipline (Acedo, Barroso, & Galan, 2006; McCain, 1999; Nerur, Rasheed, & Natarajan, 2007; Ramos-Rodriguez & Ruiz-Navarro, 2004; Small, 1973; White & Griffith, 1981; White & McCain, 1998).

Co-citation could be used to establish a cluster or "core" of earlier literature for a specialty structure of science (Small, 1973). The pattern of linkages among key documents establishes a structure of map for the specialty in a field. Co-citation patterns change when new papers continually appeared in the clusters due to their increasing citation or co-citation and old papers dropped out. Through studying these changing structures, the co-citation method provided a mean to monitor the development of scientific fields and to assess the degree of interrelationship among specialties (Small, 1973). Thus, changes in co-citation patterns over time may be used to document the scientific trend within a field (Sullivan, Koester, White, & Kern, 1980).

3. Methodology

In this section, we introduced the co-citation method and statistical analyses to delineate the intellectual structure of TAM. After retrieving the co-citation matrix with document co-citation method, a sequence of statistical analyses was performed. First, we adopted factor analysis to extract the key conceptual specialties in TAM. Then, followed by cluster analysis and multidimensional scaling (MDS), an intellectual mapping of TAM based on citation patterns was developed.

3.1. Co-citation method

The co-citation method is based on a frequency count that two documents or authors are cited in pairs in the same work (Small, 1973). Its goal is to identify groups of closely related documents which can be considered as the same 'research front' (Price & De Solla, 1965). Using the method of document co-citation analysis, we started from a set of source documents that make up the core of the discipline or base literature, from which the co-citation matrix is obtained. Therefore, there are two sets constituting a co-citation cluster within our model: (1) a set of source documents which represent highly cited and co-cited referenced works, and (2) a set of citing documents which cite those source documents. Identifying the source documents is a critical stage, for the set of source documents must be as large as possible to cover all the development within the theory (Acedo et al., 2006). Once the source documents are selected, we can form a set of citing documents which cite those source documents. From the analysis of another larger set of citing documents, we can collect more perceptions into the theory's trends, dissemination, and related issues.

3.1.1. Selection of source documents

To obtain a collection of representative research papers related to TAM, we retrieved our data from the ISI Web of Knowledge database for the following reasons: (1) it is the world's leading citation database and enjoys a great reputation; (2) its citation database is abundant in covering more than 10,000 high impact journals; (3) it is highly regarded and receives great popularity from researchers; (4) it provides a systematic and objective means to trace related information efficiently. In addition, many researches on co-citation analysis also retrieved their core documents from the ISI database (Acedo et al., 2006; McCain, 1990; Nerur et al., 2007; Small, 1973; White & Griffith, 1981).

We retrieved the set of all documents with the key word "technology acceptance model" or "TAM" in ISI for the year 2008. This procedure resulted in a list of 518 documents. In order to ensure that only influential articles with a significant impact are selected, we selected only those documents with 30 or more citations. The threshold of 30 citations has been used by other research studies (Acedo et al., 2006; Culnan, 1986). As a result, an initial 66 papers constituted the set of source documents, but only one document published after 2005. This was a drawback of the citation frequency threshold. It favors older documents over new ones because the latter are unlikely to reach the threshold due to publication lags. Therefore, we decided to add documents published after 2005 by lowering the threshold to 20 citations. The different threshold strategy is adopted by other bibliometric studies (Acedo et al., 2006; Culnan, 1986; Rowlands, 1999). We then included six more documents, resulting in five documents published in 2005 and one in 2006. In sum, 72 articles made up the set of source documents.

3.1.2. Retrieval of co-citation matrix

After the retrieving of source documents, the next stage was to perform a co-citation matrix based on the above 72 most cited documents. From ISI, we retrieved a total of 7133 articles (the master set of citing documents) that cited the above 72 source documents. Next, each of the 72 documents was paired with every other document within this set and the co-cited frequency of each pair was computed. These counts then formed a 72×72 square co-citation matrix in which the main diagonal is simply considered as missing data, because there is no point in counting the co-citation frequency of a document with itself (McCain, 1990; Ramos-Rodriguez & Ruiz-Navarro, 2004). This co-citation matrix was then transformed into Pearson's correlation matrix for the following statistical analyses.

There is considerable debate over Pearson's correlation matrix. The major critique of Pearson's r is from the study of Ahlgren, Jarneving, and Rousseau (AJ & R) (2003) in which Pearson's r was used as a measure of similarity between authors, but it failed two tests in stability of measurement. However, White (2003) rebutted their results by starting with a single set of authors, obtaining a correlation for each pair by using the data from the study of AJ & R. Despite r's fluctuations, results of clusters and maps based on Pearson's r showed no difference between the combined and separate groups. Moreover, the results were also very similar to those based on a cosine similarity measure and a chi square dissimilarity measure. White (2003) then concluded that r performs well enough for the purposes of ACA.

3.2. Factor analysis

Factor analysis allows us to study the quality of data reduction in more dimensions with precise numbers, and it is commonly used in co-citation analysis (Leydesdorff & Vaughan, 2006; Nerur et al., 2007; White & McCain, 1998). With an orthogonal (Varimax) rotation of the extracted factors, factor analysis produces the uncorrelated factors. Most documents have high loadings on only one factor. In document citation analysis, a factor is interpreted or defined by those documents with high loadings greater than ±0.7. Thus, each factor reveals the underlying subject matter. The amount of variance explained by a factor may represent its contribution to the conceptual foundation of the field (McCain, 1990).

Documents in specialized areas tend to cite some researchers' concepts and be co-cited by others within the field (McCain, 1990). Therefore, those documents are prone to load on the same factor. Each subfield corresponding to the extracted factor represents an intellectual specialty that is defined by authors who load highly on that subfield/factor (Nerur et al., 2007).

3.3. Hierarchical cluster analysis and multidimensional scaling

The goal of cluster analysis is to develop subgroups so that objects within a particular subgroup are more alike than those in a different subgroup. In co-citation analysis, cluster analysis is used to group documents on the basis of shared attributes, so they can provide insights into the intellectual organization of a given field (McCain, 1990).

Multidimensional scaling (MDS) is a data reduction procedure to generate a map which shows the relative positions of the papers or authors. The mapping principle is that the more similar two papers are, the closer the two papers will be located in the map (Leydesdorff & Vaughan, 2006). MDS uses the stress measure and R^2 (proportion of variance) as indicators of how good the fit is. In

Table 1
Set of source documents.

No.	Author (year)	Source	No.	Author (year)	Source
1	Davis (1989)	*MIS Quarterly*	37	Davis and Venkatesh (1996)	*International Journal of Human–Computer Studies*
2	Taylor and Todd (1995b)	*Information Systems Research*	38	Van der Heijden (2004)	*MIS Quarterly*
3	Venkatesh and Davis (2000)	*Management Science*	39	Chau and Hu (2002)	*Information & Management*
4	Venkatesh et al. (2003)	*MIS Quarterly*	40	Plouffe et al. (2001)	*Information Systems Research*
5	Venkatesh (2000)	*Information Systems Research*	41	Doll, Hendrickson, and Deng (1998)	*Decision Sciences*
6	Gefen et al. (2003a)	*MIS Quarterly*	42	Wixom and Todd (2005)	*Information Systems Research*
7	Venkatesh and Davis (1996)	*Decision Sciences*	43	Bhattacherjee (2001a)	*Decision Sciences*
8	Venkatesh and Morris (2000)	*MIS Quarterly*	44	Grandon and Pearson (2004)	*Information & Management*
9	Gefen and Straub (1997)	*MIS Quarterly*	45	Gefen et al. (2003b)	*IEEE Transactions on Engineering Management*
10	Szajna (1996)	*Management Science*	46	Van der Heijden (2003)	*Information & Management*
11	Igbaria et al. (1997)	*MIS Quarterly*	47	Briggs, De Vreede, and Nunamaker (2003)	*Journal of Management Information Systems*
12	Taylor and Todd (1995a)	*MIS Quarterly*	48	Hsu and Lu (2004)	*Information & Management*
13	Moon and Kim (2001)	*Information & Management*	49	Bagozzi, Davis, and Warshaw (1992)	*Human Relations*
14	Agarwal and Prasad (1999)	*Decision Sciences*	50	Al-Gahtani and King (1999)	*Behaviour & Information Technology*
15	Koufaris (2002)	*Information Systems Research*	51	Hong et al. (2001)	*Journal of Management Information Systems*
16	Straub, Limayem, and Karahanna (1995)	*Management Science*	52	Hackbarth, Grover, and Yi (2003)	*Information & Management*
17	Hu, Chau, Sheng, and Tam (1999)	*Journal of Management Information Systems*	53	Vijayasarathy (2004)	*Information & Management*
18	Venkatesh (1999)	*MIS Quarterly*	54	Gefen and Keil (1998)	*Data Base For Advances in Information Systems*
19	Legris et al. (2003)	*Information & Management*	55	Pavlou and Fygenson (2006)	*MIS Quarterly*
20	Bhattacherjee (2001b)	*MIS Quarterly*	56	Bruner and Kumar (2005)	*Journal of Business Research*
21	Lederer, Maupin, Sena, and Zhuang (2000)	*Decision Sciences*	57	Morris and Dillon (1997)	*IEEE Software*
22	Chin and Todd (1995)	*MIS Quarterly*	58	Yi and Hwang (2003)	*International Journal of Human–Computer Studies*
23	Devaraj et al. (2002)	*Information Systems Research*	59	Sussman and Siegal (2003)	*Information Systems Research*
24	Jackson, Chow, and Leitch (1997)	*Decision Sciences*	60	Riemenschneider, Harrison, and Mykytyn (2003)	*Information & Management*
25	Karahanna and Straub (1999)	*Information & Management*	61	Luarn and Lin (2005)	*Computers in Human Behavior*
26	Dishaw and Strong (1999)	*Information & Management*	62	Shih (2004)	*Information & Management*
27	Pavlou (2003)	*International Journal of Electronic Commerce*	63	Amoako-Gyampah and Salam (2004)	*Information & Management*
28	Chen et al. (2002)	*Information & Management*	64	Nysveen et al. (2005)	*Journal of Management Information Systems*
29	Igbaria and Iivari (1995)	*Omega-International Journal of Management Science*	65	Ong et al. (2004)	*Information & Management*
30	Agarwal and Venkatesh (2002)	*Information Systems Research*	66	Featherman and Pavlou (2003)	*International Journal of Human–Computer Studies*
31	Straub, Keil, and Brenner (1997)	*Information & Management*	67	Carter and Belanger (2005)	*Information Systems Journal*
32	Venkatesh and Brown (2001)	*MIS Quarterly*	68	Shang et al. (2005)	*Information & Management*
33	Chau and Hu (2001)	*Decision Sciences*	69	Saade and Bahli (2005)	*Information & Management*
34	Lucas and Spitler (1999)	*Decision Sciences*	70	Lee et al. (2005)	*Information & Management*
35	Lin and Lu (2000)	*International Journal of Information Management*	71	Yu et al. (2005)	*Information & Management*
36	Wu and Wang (2005)	*Information & Management*	72	Lai and Li (2005)	*Information & Management*

Table 2
Factors, conceptual theme, source documents.

Factor Conceptual theme	Factor 1 Theory development of TAM	Factor 2 e-Commerce	Factor 3 Multi-purposes of TAM
Major source documents	Lucas and Spitler (1999) Davis and Venkatesh (1996) Igbaria et al. (1997) Jackson et al. (1997) Taylor and Todd (1995b) Agarwal and Prasad (1999) Szajna (1996) Straub et al. (1997) Igbaria and Iivari (1995) Hu et al. (1999) Gefen and Keil (1998) Karahanna and Straub (1999) Venkatesh (1999) Doll et al. (1998)	Pavlou and Fygenson (2006) Wixom and Todd (2005) Gefen et al. (2003b) Pavlou (2003) Devaraj et al. (2002) Agarwal and Venkatesh (2002) Van der Heijden (2004) Featherman and Pavlou (2003) Bhattacherjee (2001a) Carter and Belanger (2005) Koufaris (2002) Sussman and Siegal (2003) Bhattacherjee (2001b) Venkatesh and Brown (2001)	Shang et al. (2005) Yu et al. (2005) Nysveen et al. (2005) Lai and Li (2005) Vijayasarathy (2004) Shih (2004) Bruner and Kumar (2005) Hsu and Lu (2004) Van der Heijden (2003) Saade and Bahli (2005) Wu and Wang (2005) Lin and Lu (2000) Luarn and Lin (2005)
Eigen values	44.57	10.12	6.62
Percent of variance explained	59.12	14.06	9.19

Total variance explained: 82.40%.
Only 14 out of 52 documents with higher loading in factor 1 were reported.

general, the more dimensions in the solution, the lower the stress and the higher the R^2. However, co-citation analysis has primarily focused on the two-dimensional solution for the benefit of visualizing the conceptual distance between various intellectual strands of research without losing its explanatory power (McCain, 1990).

4. Results

4.1. Results of the co-citation analysis

There are 72 articles in the set of our source documents as seen in Table 1. Deriving from the set of source documents, a 72×72 co-citation matrix was formed, among which the rows and columns are the source documents and the figures in the cells represent the frequency of co-citations obtaining from each pair of documents. Based on this co-citation matrix, we estimated Pearson's correlation matrix as an input for the subsequent statistical analyses.

We used Person's r as a measure of similarity rather than the raw co-citation frequency for three reasons (Acedo et al., 2006; Ramos-Rodriguez & Ruiz-Navarro, 2004). First, it serves as measure of the degree of similarity which may indicate the likeness or close relationship across all documents. Second, it overcomes differences of scale when the cited frequencies between two similar documents show extreme discrepancy (Kerlinger, 1973; White & McCain, 1998). Finally, its standardized scale can avoid the scale effect.

The Pearson's correlation matrix then served as an input for subsequent statistical analyses (e.g., factor analysis, multidimensional scaling (MDS), and cluster analysis) (Rowlands, 1999; White, 2003; White & Griffith, 1981). Multidimensional scaling or factor analysis allows us to project the *n*-dimensional data in a space into lower dimensionality. These statistical analyses are depicted in the following sections.

4.2. Factor analysis

Based on the correlation matrix, we conducted factor analysis with a Varimax rotation to extract the key conceptual themes in the TAM field. Table 2 shows that three factors are extracted with 82.40% of the explained variance. Factor 1, constituting nearly two-thirds of our source documents, represents the theory development of TAM. It contains most of the early representative works in theory development of TAM research, including theory introduction (Davis, 1989), validation (Igbaria, Zinatelli, Cragg, & Cavaye, 1997; Taylor & Todd, 1995b), extension (e.g., TAM2 (Venkatesh & Davis, 2000)), and critical review (Legris et al., 2003). At the initial stage of TAM development, researchers had made any efforts to enhance the applicability and predicting power of TAM by incorporating additional variables (e.g., self-efficacy, subjective norm, motivation and involvement) and other theories (TRA, TPB, IDT, etc.).

Factor 2 represents the view of e-commerce with documents dating from 2001 to 2006. Approximately 20% of our source documents were constituted by factor 2. The flourish of e-commerce has attracted lots of researchers to work on this topic with the application of TAM. Corresponding variables such as trust or perceived risk have been acknowledged to be the most important variable in this emerging e-commerce research among TAM (Gefen, Karahanna, & Straub, 2003a; Stewart, Pavlou, & Ward, 2002). In the same way, trust-related variables are also incorporated into other intention-based models (e.g., TPB and TRA) (Devaraj, Fan, & Kohli, 2002; Pavlou, 2003).

Factor 3 was named as a multi-purpose group, among which various electronic devices are used. It contains about 18% of our source documents, most of which were published in 2005. The purposes for using those electronic devices vary from web-navigating, communication (Nysveen, Pedersen, & Thorbjornsen, 2005), payment (Shang, Chen, & Shen, 2005; Wu & Wang, 2005), gaming (Hsu & Lu, 2004), and online learning (Lin & Lu, 2000; Saade & Bahli, 2005). The most critical element appearing in factor 3 is the concept of perceived 'enjoyment' or 'fun.'

4.3. Hierarchical cluster analysis and multidimensional scaling

In order to graphically delimit the groups and subgroups of TAM, a hierarchical cluster analysis with Ward's method and multidimensional scaling (MDS) were carried out. All documents were analyzed into Dendrogram and MDS was seen in Figs. 2 and 3, respectively (except documents 44 and 47 due to the fact that the factor loading was less than 0.5). The stress value (0.189, lower than an acceptable value 0.2) and R^2 (0.92 for two-dimensions) showed an outstanding fit for the data (McCain, 1990). As a result, two large groups emerged from left to right on the horizontal axis. Group 1 with most documents from factor 1, and group 2 with documents from factors 2 and 3. Each group was then divided by two subgroups to thoroughly investigate within the specialties of TAM.

The horizontal axis in Fig. 3 represented the chronological development of TAM including theory introduction, validation, and extension (from left to right along the *x*-axis). On the other hand, the vertical axis indicated the extensions or applications of TAM from tradition (below the *x*-axis) to novelty (above the

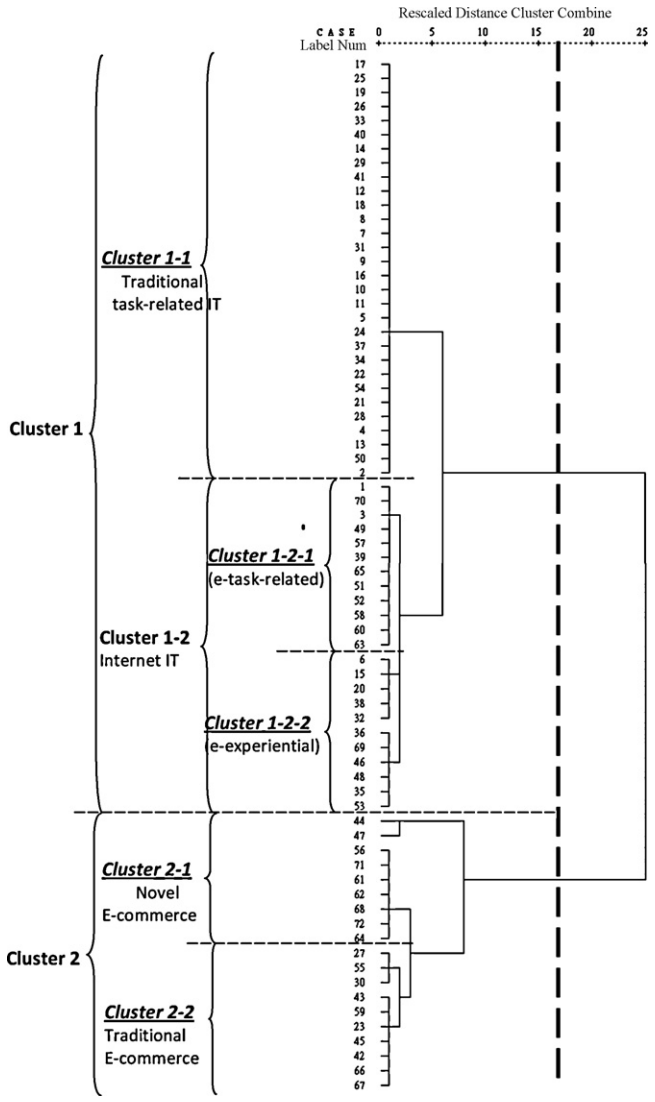

Fig. 2. Hierarchical cluster analysis.

x-axis). Group 1 showed the fundamental works of TAM, comprising some early representative works of TAM (e.g., Davis, 1989; Venkatesh & Davis, 1996, 2000; Venkatesh et al., 2003). Within group 1, most documents were identified as task-related information systems. For more detailed information, we divided group 1 into two subgroups: traditional 'task-related' information systems and 'Internet-related' information systems. Traditional task-related subgroup represents offline IS, including office automation (e.g., spreadsheet and word processing) and software development (e.g., accounting and financial management systems) (e.g., Agarwal & Prasad, 1999; Moon & Kim, 2001; Venkatesh & Brown, 2001). The other 'Internet-related' group can be separated into two subgroups. The Internet task-related subgroup involves tasks related to online learning, digital library, and organization learning (e.g., Hong, Thong, Wong, & Tam, 2001; Lee, Cheung, & Chen, 2005; Ong, Lai, & Wang, 2004). The Internet 'experiential' (or 'hedonic') subgroup, includes online gaming, online surfing, online shopping, and even online learning while perusing enjoyment at the same time (e.g., Lin & Lu, 2000; Saade & Bahli, 2005; Van der Heijden, 2004).

Group 2 was comprised of e-commerce documents which can also be divided into two subgroups. The larger one located below the axis was called 'traditional' e-commerce, and the small one called the 'novel' e-commerce. In the traditional e-commerce subgroup, trust-related variables (trust, perceive risk, and credulity) were found to be essential and incorporated into TAM (e.g., Gefen et al., 2003b; Pavlou, 2003). The other emerging subgroup was 'novel' e-commerce. It was entitled as the following because all documents were published in 2005, and also because some new devices such as interactive televisions, PDAs, or mobile phones were applied to e-commerce (e.g., Bruner & Kumar, 2005; Nysveen et al., 2005; Yu, Ha, Choi, & Rho, 2005).

5. Discussion

5.1. Summary

By using document co-citation analysis, the current paper intends to provide intellectual development of TAM and identify its dissemination and main trends. Seventy-two of the most frequently cited papers in the field of TAM were collected and analyzed. Synthesized from factor analysis, cluster analysis, and multidimensional scaling, three main trends in the applied context of TAM were

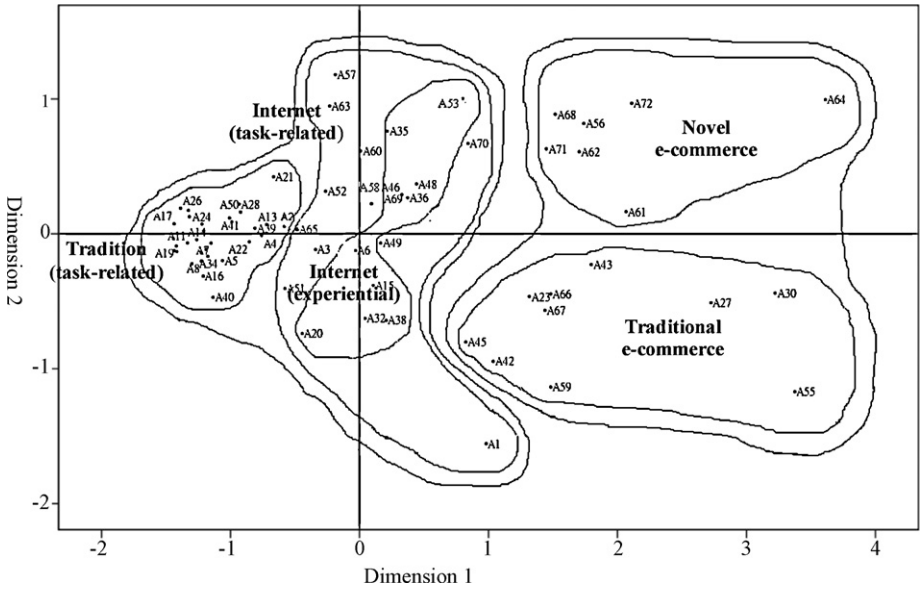

Fig. 3. Multidimensional scaling.

identified: (1) task-related systems; (2) e-commerce systems; and (3) hedonic systems.

First, in the early theory development stage, TAM was mostly applied to task-related (or productivity-oriented) information systems including both offline and online IS. While the offline (or traditional) task-related IS was involved in office automation systems, the online task-related IS was more connected to knowledge or learning based systems via the Internet.

The second stream of research focus was e-commerce. The high Internet penetration has facilitated e-commerce development and caused interest of researchers in the application of TAM. Therefore, substantial amounts of TAM research have been focused on the general topic of e-commerce.

Last, the third and recent trend of TAM – hedonic systems – emerged. The concept of 'hedonic,' similar to the concept of 'experiential,' denotes pleasure or happiness (Novak, Hoffman, & Duhachek, 2003). Van der Heijden (2004) classified some types of information systems as hedonic and productivity information systems. The 'hedonic' IS was usually connected to home and leisure activities, focusing on the fun or novel aspect of information systems, such as fashion or amusement websites, instant messenger services, online games, online shopping, or mobile services. The accompanied devices which are suitable for enjoying the above purposes are interactive televisions, PDAs, or mobile phones.

5.2. Discussion

Three main trends of TAM were obtained from this study and were discussed as follows. The first emerging trend of TAM is task-related or utilitarian information systems, including job-related systems, e-learning, and management information systems. Since the purpose and functions of task-related IS are to enhance users' task performance while concurrently encouraging efficiency, we can expect that it will continue to play a dominant role within TAM. In the task-related IS such as training programs or e-learning systems, perceived usefulness and self-efficacy are considered to have stronger positive effects on usage than perceived ease of use (Hong et al., 2001; Igbaria et al., 1997; Igbaria & Iivari, 1995; Karahanna & Straub, 1999; Ong et al., 2004). One possible explanation is that individuals are likely to accept a new technology if they recognize that it can help them to build computer efficacy and improve their work performance. In TAM2 and other research, subjective norm was suggested to be included in TAM (Legris et al., 2003; Venkatesh & Davis, 2000; Venkatesh & Morris, 2000). Other variables such as organizational factors or management support also have a direct influence on both ease of use and perceived usefulness, and indirect effects on usage (Igbaria et al., 1997; Igbaria & Iivari, 1995).

The second trend in TAM research is e-commerce. Even though e-retailing could serve as an alternative to traditional brick-and-mortar shopping channels by overcoming time and spatial barriers, by providing an abundance of product information, and by processing orders faster (Devaraj et al., 2002; Vijayasarathy, 2004), the critical issue is how to identify, attract, and retain customers since online shoppers are typically regarded as less loyal (Jarvenpaa & Todd, 1997; Stewart et al., 2002). Nevertheless, trust appears to be the most important factor in the context of e-commerce for it is the key to many relationships (Morgan & Hunt, 1994). Previous research also indicated that online shoppers' purchase behaviors were influenced by their assessments of the website for such web-based stores using Internet technology for communications and transactions (e.g., Agarwal & Venkatesh, 2002; Gefen et al., 2003b; Koufaris, 2002; Van der Heijden, 2003). Thus, except for trust building, a vendor's website requires some attractive mechanisms and ease of use to entice customers to visit the website.

Finally, the third and recent trend of TAM – hedonic systems – emerged. In this trend, intrinsic motivational factors such as perceived playfulness or ease of use have a more powerful effect than perceived usefulness has on building positive attitude toward IS (Moon & Kim, 2001; Van der Heijden, 2004). Different from utilitarian IS, the concept of hedonic systems focuses on the fun-aspect of using information systems, and often involves seeking multiple sensory channels through fancy websites, interactive televisions, PDAs, and especially mobile phones (Bruner & Kumar, 2005; Holbrook & Hirschman, 1982; Hsu & Lu, 2004; Van der Heijden, 2004; Yu et al., 2005). The popularity of mobile phones have captured the attention of researchers to test the applicability of TAM on mobile phones for various purposes from m-commerce (mobile commerce) such as shopping or banking to entertainment service (Luarn & Lin, 2005; Nysveen et al., 2005; Wu & Wang, 2005). Within the hedonic trend, interactive websites and visual attractiveness are important characteristics in empowering people to truly enjoy engaging in activities such as online games, web surfing, or simply browsing and shopping (e.g., Hsu & Lu, 2004; Lin & Lu, 2000; Nysveen et al., 2005; Saade & Bahli, 2005; Shang et al., 2005; Van der Heijden, 2004). Moreover, since virtual stores are regarded as an innovative business model compared to traditional brick-and-mortar retail stores, innovation related theories (e.g., Innovation Diffusion Theory (IDT), Perceived Characteristics of Innovating (PCI)) were also suggested to be incorporated into TAM (Chen, Gillenson, & Sherrell, 2002; Plouffe, Hulland, & Vandenbosch, 2001).

These trends are not mutually exclusive. Some documents may be involved with more than one factor. These documents are perceived to be useful in more than one specialty, revealing a cross-boundaries phenomenon (White, 1990). For example, the study of Van der Heijden (2004) loaded on both factor 2 (e-commerce) and factor 3 (multi-purpose) with factor loadings of 0.43 and 0.76, respectively. It shows that online consumers are not solely utilitarian, emphasizing on efficient online shopping, but they also enjoyed the process of surfing and shopping online. This joyful perception often makes them to revisit the e-vendor's website, and probably leads to additional shopping (Koufaris, 2002). In the same way, some task-related activities such as online learning are also connected to the hedonic nature (Lee et al., 2005; Saade & Bahli, 2005; Yi & Hwang, 2003). Therefore, the hedonic nature of an information system is an important boundary condition to the validity of the technology (Van der Heijden, 2004).

5.3. Limitations

There are some limitations which should be addressed. First, the co-citation method is flawed with a publication lag even though it claims to be a quantitative and objective statistical approach, because it is difficult for new papers to accumulate enough citations to enter the set of source documents. Even though we have reduced the threshold after 2005, some influential documents might not be included in our initial core set. Second, all citations are treated alike without considering the ranking or influence of source documents which implies some artificial limitations of the study (Acedo et al., 2006; Hicks, 1988; Nerur et al., 2007; Zitt & Bassecoulard, 1996). Finally, not all journals are included in the ISI Web of Knowledge database. For example, some of the major accounting journals are not included, such as *Advances in Management Accounting*, the *Journal of Management Accounting Research*, *Accounting and Business Research*, etc. Likewise, some TAM papers are published in journals which are not included in the ISI database, such as *Journal of Information Technology Theory and Application*, *Journal of Electronic Commerce Research*, or *Electronic Commerce Research*. Even though our source documents are published in leading IS journals, future research might consider including some influential documents from journals not included in ISI.

5.4. Conclusions

TAM has come to be one of the most widely used models for describing an individual's acceptance of information systems. Though many studies including literature review and meta-analysis have tested the applicability and the convergence of TAM relationships across various contexts, TAM in our sense has never been used in co-citation analysis to study its intellectual structure and identify current main trends.This study differs from other review studies in that it attempts to develop an intellectual mapping of TAM based on co-citation analysis. We accomplished this study by identifying three main trends of TAM: task-related information systems, e-commerce information systems, and hedonic information systems. In our great expectation, this study may serve as a benchmark for future research to investigate changes in the TAM field and to record the emergence of new research areas by incorporating more newly published papers over time.

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