

Review of TAM used in Educational Technology Research: A Proposal

Kai-Yu TANG^{a*}, Chun-Hua HSIAO^b

^a*Graduate Institute of Library & Information Science, National Chung Hsing University, Taiwan*

^a*Innovation and Development Center of Sustainable Agriculture, National Chung Hsing University, Taiwan*

^b*School of Business, Kainan University, Taiwan*

*ky.nctu@gmail.com; kytang@dragon.nchu.edu.tw

Abstract: Since the research on user acceptance of information technology was introduced by Fred D. Davis in the 1980s, two critical constructs (perceived usefulness and ease of use) and the technology acceptance model (TAM) have generated significant impacts on information science and management information system literature. In the early 2000s, educational technology researchers began to adopt TAM-related concepts to explain teaching and learning contexts. For example, Selim (2003) conducted research to empirically examine students' acceptance of course websites and published on *Computers & Education*. Accordingly, this proposal paper extends the authors' previous works (Hsiao & Yang, 2011; Hsiao, Tang & Liu, 2015; Tang, Hsiao & Chen, 2019; Tang, Hsiao & Hwang, 2022) to trace the latest development of educational technology research using TAM-related framework. In this proposal, we have identified a total of 366 articles with 20,242 citations. For the data analysis, we proposed a series of analyses (e.g., bibliometrics, main path analysis, document co-citation analysis, and social network analysis) to examine the knowledge trajectory in this field. This study is the first attempt to propose a research framework with a series of analyses to systematically analyze and review the longitudinal development of research using a TAM-related framework in educational technology. With this attempt, some significant turning points (e.g., theoretical converging and diverging points) can be further explored in the network diagram to identify the critical constructs, models, and theories in educational technology research. Overall, established on a large number of citation data, the results of this study aim to provide a platform for academic discussion and to make a prediction for the future trend of educational technology research.

Keywords: Technology acceptance, TAM, educational technology, bibliometric features, citation-based network analysis

1. Introduction

Fred D. Davis introduced the user acceptance of information technology in 1989. He proposed the theoretical framework of the technology acceptance model (TAM) in the same year (Davis et al., 1989). Since then, TAM has become one of the dominant research models in the technology management discipline (Venkatesh, Davis, & Morris, 2007). Recently, according to the Web of Science (WoS), Davis's original paper titled "Perceived usefulness, perceived ease of use, and user acceptance of information technology" has been cited over 22,473 times (the search was conducted on April 29, 2023).

The theoretical model was originally developed for technologies in the context of organizations (Davis, 1989), which hypothesized that the actual use of a certain technology is directly influenced by a person's behavioral intention to use, which in turn, is determined by perceived usefulness (PU) and attitude toward the technology. Moreover, PU and attitude are affected by perceived ease of use (PEOU). Previous researchers have suggested that the main strengths of TAM are its parsimony and strong generalizability (Lee et al., 2003;

Plouffe et al., 2002; Hsiao & Yang, 2011; Hsiao et al., 2015). The model has evolved and been widely applied to various technology-related adoption behaviors.

Up to the date of this research, over three thousand journal papers ($n = 3,298$) are conducting technology acceptance-related research in the social science citation index (SSCI) database. Among which, a total of 366 articles published in core educational technology journals were selected for analysis. The top ten educational technology journals were *Computers & Education*, *Educational Technology & Society*, *British Journal of Educational Technology*, *Interactive Learning Environments*, *Education and Information Technologies*, *Australasian Journal of Educational Technology*, *Educational Technology Research and Development*, *International Review of Research in Open and Distributed Learning*, *Journal of Educational Computing Research*, *Journal of Computing in Higher Education*. Each journal has published at least 14 TAM-related articles and has been cited more than 493 times.

Many review papers conducted meta-analysis and content analysis for the literature. While meta-analysis is useful in distinguishing the interrelationships among TAM factors across different settings, content analysis is based on coding schemes from existing literature to identify and categorize patterns and themes in the research of interest. This present study extends and modifies the authors' previous works (Hsiao & Yang, 2011; Hsiao, Tang & Liu, 2015; Tang, Hsiao & Chen, 2019; Tang Hsiao & Hwang, 2022) by proposing a series of bibliometric and citation-based network analyses to map the intellectual structure and synthesize the trends of technology adoption research.

Specifically, based on extensive literature citation data, this research proposal aims to: (1) identify key bibliometric features of the literature in the educational technology domain, including keywords, core journals, productive countries, and authors. (2) identify the most critical paths on the citation network of various adoption theories using main path analysis. (3) based on the result, further classification and exploration within subfields and important theories will be examined using co-citation network analysis. To obtain the above goals, a series of following analyses will be conducted: bibliometric and citation analysis, main path analysis, co-citation analysis, social network analysis, and statistical analysis.

This proposal paper offers valuable contributions. First, this present study is a few of the studies that apply bibliometric techniques to the technology acceptance research literature. Second, the integrated analyses, including citation-based network, co-citation analysis, and statistical clustering analysis, complement and improve the findings of other studies that have approached the subject from both qualitative and quantitative perspectives.

2. Past bibliometrics and citation-based analyses on TAM and TAM-related research in educational technology domain

The previous meta-research did help researchers revalidate the importance of PU and PEOU in the model and distinguish the interrelationships among other TAM factors across different settings. However, only a few provided citation-based evidence to support the development and progression of TAM to respond to Venkatesh et al.'s (2007) concerns. Using citations can show how knowledge disseminates within scientific disciplines (Garfield et al., 1964). Furthermore, the count of citations is currently treated as one common means to demonstrate the general acceptance of an academic research article.

Hsiao and Yang (2011) adopt a co-citation analysis and other statistical analyses to identify core documents within the same discipline or field by analyzing the references. Their results concluded three main trends of TAM: task-related systems, e-commerce systems, and hedonic systems. Hsiao et al. (2015) conducted a citation-based analysis of technology acceptance research. They used main path analysis and edge-betweenness clustering analysis. Results identified five distinct research fronts, including e-learning, mobile-commerce, e-health, e-tourism, and technology post-acceptance research, and provides a research-based platform for further scholarly discussions on the theoretical development trajectories and most active research fronts in the field. Following previous studies, Tang et al. (2019) reviewed the characteristics of electronic commerce innovations using bibliometric and keyword analysis. The findings show that in the first decade (2000-2009), the top 10

papers in electronic commerce innovation focused on traditional IT adoption, while in the recent decade (2010-2018), researchers showed more diverse interest in innovative EC applications such as RFID, cloud computing, and crowdsourcing. Along with these innovation contexts, researchers adopted more theories, such as signaling theory, in addition to general attitude-intention theories. More recently, Tang et al. (2022) continued the survey to explore the scholarly network of artificial intelligence (AI)-related research in the information science (IS) domain using co-citation network analysis. The findings indicate that both researchers from Global North (GN) and Global South (GS) focused on technology adoption research throughout the investigated period (2010-2020). While GN researchers in the IS domain focused on applied research involving intelligent systems between 2010 and 2015, GS researchers focused on big data applications between 2016 and 2020.

According to the above review studies of TAM, this paper proposed a series of bibliometric and citation-based network analyses to analyze the extensive bibliographic citations of TAM research papers published in well-recognized journals. The finding is expected to provide insights into tracing the trajectory of TAM literature development and visualize the most critical citation routes in the citation network of technology acceptance research.

3. Proposed Methodological Framework

3.1 The process of data inclusion

The data inclusion of this research was as follows. First, an initial search using the full model name of the technology acceptance model is conducted on the Web of Science (WoS) to have an overview of technology adoption studies. The WoS is one of the reputed sources for searching academic literature, covering the most high-quality journals and research papers in the technology management field, including education and educational research. A series of key terms, including perceived usefulness, perceived ease of use, technology acceptance, and technology adoption, were used for the topics search (title, keywords, and abstract) in the WoS.

Up to the date of this research, over three thousand journal papers ($n = 3,298$) are conducting technology acceptance-related research in the social science citation index (SSCI) database. Among which, a total of 366 articles published in core educational technology journals were selected for analysis (Chang et al., 2022; Hwang & Tsai, 2011; Hwang & Wu, 2014). The top ten educational technology journals were *Computers & Education*, *Educational Technology & Society*, *British Journal of Educational Technology*, *Interactive Learning Environments*, *Education and Information Technologies*, *Australasian Journal of Educational Technology*, *Educational Technology Research and Development*, *International Review of Research in Open and Distributed Learning*, *Journal of Educational Computing Research*, *Journal of Computing in Higher Education*. Each journal has published at least 14 articles related to TAM theories, constructs, and research models in educational contexts. In total, 366 articles have received over 20,242 citations, demonstrating their significant impact in the field.

3.2 Bibliometrics and citation analysis

Bibliographic analysis is a popular research approach that involves quantitative evaluation of various scientific publications like books, conference proceedings, and journal articles. It provides crucial insights into the research productivity and impact of researchers, institutions, and countries, as well as the trend of the field (Tang et al., 2023). Policymakers, funding agencies, and researchers use bibliographic analysis to evaluate research impact and productivity. Citation analysis is a crucial component of bibliographic analysis as it helps to identify highly cited or influential documents within a specific field. This is based on the assumption that heavily cited papers have a greater impact on the subject matter than those less frequently referenced. Citation analysis is considered "the field's view of itself" as it traces the links and interactions between researchers and different research fields (White &

Griffith, 1981). Despite some limitations, such as negative citation, citation analysis is a valuable and cost-effective tool to evaluate scientific performance.

3.3 Main path analysis

Main path analysis has been proposed as a useful quantitative and citation-based approach for analyzing significant trajectories, identifying significant papers, and depicting recent active research areas. This method represents scientific papers as nodes in a citation network, with links established based on citation information. The 'source' nodes are papers cited but do not cite any other papers, while the 'sink' nodes are papers that cite others but are not themselves cited. Sources represent the origins of knowledge flow, while sinks represent the end nodes of current knowledge dissemination.

Hummon and Doreian (1989) introduced the 'local main path' concept, which uses a 'priority first search' algorithm to identify the only path representing the main path of a citation network. Liu and Lu (2012) proposed the 'global main path,' which determines the path with the most significant accumulated SPC value. While the local main path emphasizes progressing significance, the global main path emphasizes overall importance. Liu and Lu also introduced the concept of a 'key-route main path' to identify structural patterns, particularly the divergence-convergence pattern of knowledge diffusion flows. The key-route main path often includes local and global main paths and has several merits for large citation networks. Several recent studies have demonstrated that MPA is a well-valid approach applied in various scientific disciplines, such as in technology management (Cho et al., 2021), public health (Huang et al., 2021), and corporate governance (Hung et al., 2022).

3.4 Co-citation network analysis

Co-citation network analysis is based on the calculation of citation times that two documents or authors are cited together in the same work (Small, 1973). In particular, periodical papers with peer review have shown their reliability after careful evaluation, which further confirms the value of co-citation analysis (Ramos-Rodríguez & Ruiz-Navarro, 2004). Co-citation analysis is often used to measure the network or the degree of relationships between documents according to the counts of their joint citations (Small, 1973). Co-citation counts can be statistically analyzed and processed to produce maps showing the relative closeness between documents. The more counts of co-citation two documents receive, the higher their co-citation strength, and the more likely they are to be bibliographically related. In other words, these highly co-cited papers are assumed to have a higher degree of similarity.

Network researchers suggested that social network analysis provides a novel approach to visualizing a network's most prominent documents (Wasserman & Faust, 1994). This visualization technique helps realize and map interdisciplinary scholarly communications in various academic disciplines. Recently, researchers have combined the methods (i.e., co-citation network analysis) to explore the relationships in multiple domains, such as information literacy (Chen et al., 2022), virtual reality education research (Cheng et al., 2022), STEM education (Hsu et al., 2023), and AI in e-learning (Tang et al., 2023).

To conclude, bibliometric and citation-based network analyses are effective methods to identify the most influential documents, analyze the relational links between them, and identify the intellectual structure of documents that belong to the same discipline within the TAM literature. A proposed analytic framework is summarized and illustrated in Figure 1.

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