

PAPER

Modelling User Behavior Towards Smartphones and Wearable Technologies: A Bibliometric Study and Brief Literature Review

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ABSTRACT

The study employs bibliometric and content analysis to assess the current status of applying technology adoption models (such as the Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), and Innovation Diffusion Theory (IDT)) to the smartphone market, which also encompasses smart wearables. Hereby, the author aims to explore the relationship between smartphone usage and adoption models and contribute to the literature through current trends and methodologies. To achieve the goal, the author applied a two-stage approach. In the first stage, 213 articles were analyzed using citation and bibliographic coupling tools in VOS viewer (version 1.6.20). The papers were selected from the Scopus database, and the search was conducted in the fields of economics, business, and computer technologies. In the second stage, the author conducted a brief literature review of the most influential papers. The results illustrate the situation regarding the implementation of various models in the case of smartphone adoption. Content analyses of the most influential papers were conducted to elucidate and enhance the findings of bibliometric analyses, identify research gaps, and guide future research development.

KEYWORDS

technology acceptance models (TAM), smartphone, bibliometric analysis, unified theory of acceptance and use of technology (UTAUT/UTAUT2), innovation diffusion theory (IDT)

1 INTRODUCTION

Smartphones became one of the essential parts of our lives after 2007. Numbers related to smartphone adoption have increased significantly, and the areas where these devices can be utilized have changed over the last 15 years. Nowadays, everyone uses smartphones for NFC payments, purchasing tickets, participating in meetings, taking notes, and much more. The various applications of mobile handsets have altered perceptions of them. Furthermore, with the rapid advancement of technology, smartphones

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have become pivotal as customers now associate them with smart wearable devices like smartwatches, fitness bands, headsets, or earbuds. The changes in technology have increased the need to understand the purchasing decisions of products. The author of the current study aims to identify and combine the most effective indicators to establish the optimal model for measuring attitudes toward smartphones.

The purpose of the study is to provide a comprehensive summary of current and previous research on the application of three technology adoption models (the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Innovation Diffusion Theory (IDT)), in the context of smartphone usage and diffusion. The author is interested in determining the usage of the three most famous technology adoption models in the context of smartphones, as well as identifying the most influential papers related to each case. Based on the insights gained from bibliometric analyses, the author will conduct a concise literature review focusing on the most cited publications. The author seeks answers to the following research questions for each model:

1. How should the most influential papers be mapped using VOS viewer?
2. How have the papers been connected through citation linkage?
3. How can bibliographic coupling be applied to visualize the relationships between journals?
4. How can the development direction of the studies be generalized?
5. The two-stage analyses yield a comprehensive understanding of contemporary discussions and advancements in research on the practical and theoretical applications of the TAM, UTAUT and IDT in relation to smartphone diffusion and usage.

2 LITERATURE REVIEW

A review of the literature shows that TAM, UTAUT/UTAUT2, and IDT are three main models commonly used in the context of smartphones and portable/wearable devices [1], [2]. All of the models illustrated above focus on the voluntary acceptance of technology and are classified as technology acceptance models.

2.1 Technology acceptance model

The TAM was introduced by Davis in 1986 and is known as one of the most frequently used models in the field of information systems (IS). The model was based on two influential models originating from psychology: the Theory of Reasonable Action (TRA) and the Theory of Planned Behavior (TPB). TRA was proposed by Ajzen and Fishbein [3] to explain rational behavior, which is based on the utilization of information. The theory mostly focuses on explaining behavioral intention rather than attitudes. It had several limitations [4] that Ajzen wanted to address by involving perceived behavioral control. As a result, he developed a new model, TPB [5], to explain behavior even when a person has “incomplete volitional control” [6].

Early versions of the model consider perceived usefulness, perceived ease of use, and attitudes as the main determinants of behavior that explain the voluntary use of any kind of technology [7]. In this version, perceived usefulness and perceived ease of use had a direct impact on the formation of attitudes [8]. However, later, the author provided evidence of an incomplete relationship that resulted in the removal of attitude from the model [9]. Afterward, Davis and his colleagues included new variables and extended TAM [10], [11].

2.2 Unified theory of acceptance and use of technology (UTAUT/UTAUT2)

The early version of the UTAUT was derived from eight theories and was designed to determine the main variables affecting employees' adoption of IT. However, Venkatesh et al. [12] were the first authors to consider the impact of moderators (such as age, gender, experience, and voluntariness of use) in the context of technological products. The original version of the model included independent variables such as performance and effort expectancy, social influence, facilitating conditions, and the aforementioned moderators [12].

The extension of the model (i.e., UTAUT2) was proposed in 2012 [13] and differs from the original version by including additional variables such as hedonistic motivation, price per value, and habit, as well as moderators [14]. The model aims to identify technology usage from the customer/end-user perspective. The customer/end-user perspective and the involvement of moderators are two main aspects that make UTAUT2 a competitor of TAM. Some researchers claim that even though the models include moderators, these variables are not commonly used in the research process [14], [15].

2.3 Innovation diffusion theory

Innovation Diffusion Theory (IDT) was introduced by Rogers in 1962 and is known as one of the most frequently used models in the field of IS [16]. The model was based on the relationship between the five variables and attitudes toward technology use.

These variables include relative advantage, compatibility, complexity, trialability, and visibility, which are collectively categorized under the perceived attributes of the innovation definition. Unlike the models explained earlier, IDT [16] was developed as a component of innovation management to assess the utilization of new technologies. The main weakness that might impact the usage of IDT is connected with the attitude-related aspect of the model [17]. Some authors also point out that the model lacks a connection between innovation properties and expected attitudes [18]. The application of moderators could enhance the exploratory power of the model [15] and expand the body of knowledge with new information.

3 RESEARCH METHODOLOGY: THE TWO-STAGE APPROACH

The application of bibliometric analysis (i.e., performance analysis) to information technology and IS research has rapidly grown. It focuses on assessing research quality, author influence, qualifications, and the impact of journals and organizations in the selected field. It has also been extensively used to understand situations related to the Internet of Things (including smartphones) in specific fields or topics. In the first stage, the author selected studies published in the Scopus database between 2010 and 2022 that focused on the application of various models related to smartphone diffusion and adoption. The main reason for selecting the Scopus database is its extensive number of publications [19] compared to other databases such as WOS. To be able to generalize previous findings, the author utilizes only two types of performance analyses [20], which are named citation analyses (including citation linkage) and bibliographic coupling.

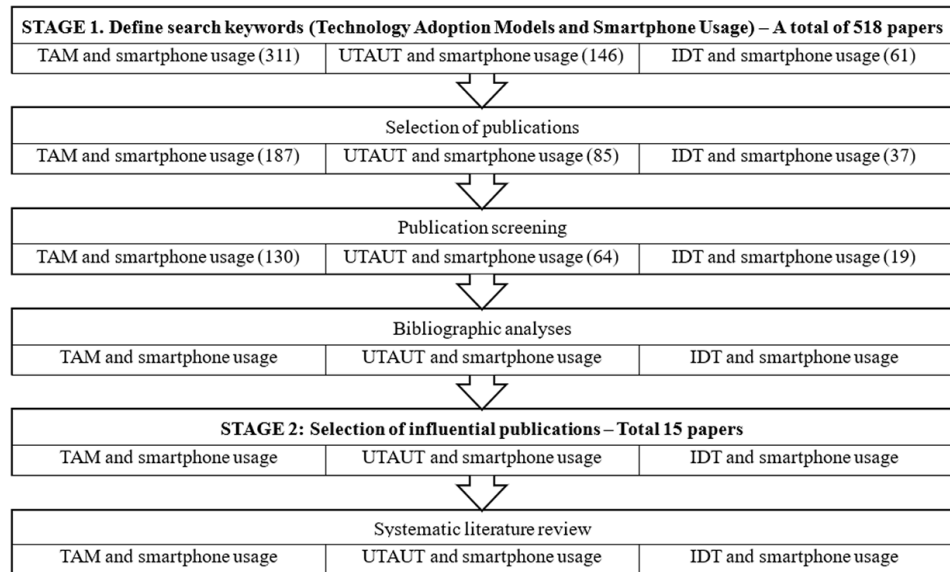


Fig. 1. Structure of analyses

Source: Own editing.

The first stage focused on defining search keywords, selecting and screening publications, and conducting bibliographic analyses. The second stage, however, focused on selecting influential publications and conducting a brief literature review (See Figure 1).

The search query below was utilized to retrieve information on the titles, keywords, and abstracts of all publications in the Scopus collection. After analyzing the results, the author decided to keep only articles and limit publications to the English language. So, only 187 publications remained. After screening, nine papers were deleted because they did not directly relate to the discussed topic. Some of the publications (i.e., 48 papers) used more than one model; therefore, they were excluded from the analyses.

In the case of the TAM:

SUBJAREA (busi) OR SUBJAREA (econ) OR SUBJAREA (comp) AND TITLE-ABS-KEY (“TECHNOLOGY ACCEPTANCE MODEL” OR tam OR tam2 OR tam3) AND (smartphone OR “smart phone”)) AND (EXCLUDE (PUBYEAR, 2023) OR EXCLUDE (PUBYEAR, 2009) OR EXCLUDE (PUBYEAR, 2008) OR EXCLUDE (PUBYEAR, 2007))

Only 85 out of 146 papers were used for analyzing UTAUT/UTAUT2 for the smartphone and/or wearable device market. 64 articles remained after screening and the exclusion of the papers that used more than one model. In the case of the UTAUT:

SUBJAREA (busi) OR SUBJAREA (econ) OR SUBJAREA (comp) AND TITLE-ABS-KEY (utaut OR utaut2 OR “unified theory of acceptance and use of technology” OR “Extension of Unified Theory of Acceptance and Use of Technology”) AND (smartphone OR “SMART PHONE”)) AND (EXCLUDE (PUBYEAR, 2023) OR EXCLUDE (PUBYEAR, 2009) OR EXCLUDE (PUBYEAR, 2008) OR EXCLUDE (PUBYEAR, 2007))

Only 37 out of 61 papers were used for analyzing IDT for the smartphone and/or wearable device market 19 articles remained after screening and the exclusion of the papers that used more than one model (See Figure 1). In the case of Innovation Diffusion Theory (i.e., IDT):

SUBJAREA (busi) OR SUBJAREA (econ) OR SUBJAREA (comp) AND TITLE-ABS-KEY (“innovation diffusion theory” OR idt OR “diffusion of innovations”)

AND (smartphone OR “smart phone”)) AND (EXCLUDE (PUBYEAR, 2023) OR EXCLUDE (PUBYEAR, 2009) OR EXCLUDE (PUBYEAR, 2008) OR EXCLUDE (PUBYEAR, 2007) OR EXCLUDE (PUBYEAR, 2006))

4 DESCRIPTIVE ANALYSIS

Figure 2 shows the number of publications that were published each year using one of the three most popular technology adoption models. It is clear that year by year, smartphones have become increasingly popular, and the number of publications in the field has also been on the rise. Even though TAM was in a leading position from the beginning, the number of UTAUT-based publications increased significantly in the Scopus database after 2018.

Table 1 illustrates the journals that have published the highest number of scientific papers on smartphones and wearables. In the table mentioned, SJR stands for SCImago journal rank and indicates the rankings of various journals based on weighted citations. The higher number of SJRs is also closely related to the popularity of the journal. *The Journal of Theoretical and Applied Information Technology* published the highest number of articles related to smartphone and wearable device adoption, although its SJR for 2022 is not very high. *Computers in Human Behavior*, *Journal of Retailing and Consumer Services*, and *Cyberpsychology, Behavior, and Social Networking* are the journals with SJR scores. Each of the journals published seven, four, and five papers, respectively.

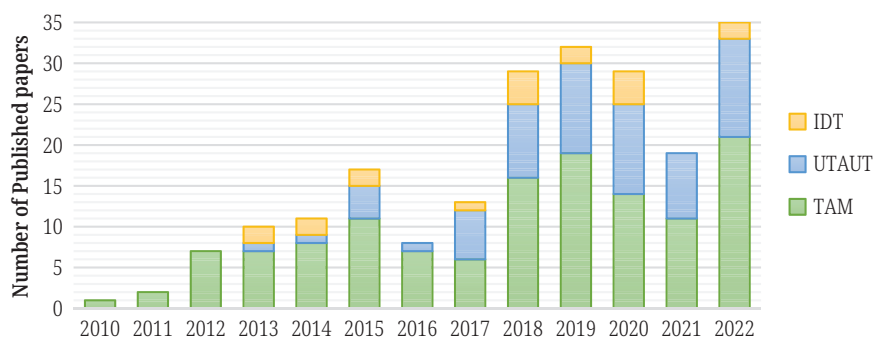


Fig. 2. Papers published on smartphone adoption using TAM/UTAUT/IDT (2010–2022)

Source: Own editing.

Table 1. The journals that published the highest number of scientific papers about smartphones and wearables

| N | Journals | SJR 2022 | TAM | UTAUT/UTAUT2 | IDT | Total |
|----|---|--------------|-----|--------------|-----|-------|
| 1 | <i>Journal of Theoretical and Applied Information Technology</i> | 0.165 | 5 | 4 | 0 | 9 |
| 2 | <i>Computers in Human Behavior</i> | 2.464 | 3 | 3 | 1 | 7 |
| 3 | <i>International Journal of Mobile Communications*</i> | 0.555 (2019) | 0 | 5 | 0 | 5 |
| 4 | <i>Cyberpsychology, Behavior, and Social Networking</i> | 1.466 | 4 | 0 | 0 | 4 |
| 5 | <i>Journal of Retailing and Consumer Services</i> | 2.543 | 3 | 0 | 1 | 4 |
| 6 | <i>International Journal of Interactive Mobile Technologies</i> | 0.409 | 3 | 0 | 1 | 4 |
| 7 | <i>International Journal of Technology and Human Interaction</i> | 0.189 | 3 | 0 | 0 | 3 |
| 8 | <i>Cogent Business and Management</i> | 0.524 | 3 | 0 | 0 | 3 |
| 9 | <i>International Journal of Recent Technology and Engineering*</i> | 0.107 (2019) | 2 | 1 | 0 | 3 |
| 10 | <i>Journal of Advanced Research in Dynamical and Control Systems*</i> | 0.129 (2019) | 2 | 1 | 0 | 3 |

Note: *Coverage discontinued in Scopus.

Source: Own editing.

5 RESULTS—STAGE 1: BIBLIOGRAPHIC ANALYZES OF THE SELECTED STUDIES

5.1 Citation of documents – TAM; UTAUT/UTAUT2; DOI

A citation is a tool that allows the reader to determine the impact of a scientific paper, author, or journal on the creation of a body of knowledge [20]. In bibliometric research, researchers may choose different units of analysis depending on their research objectives. The documents were selected as the unit of analysis in the current study to address the first research question. In all three models, the author chose a minimum of two citations per scientific work for this analysis. As a result, 102 out of 130 papers related to the TAM met the threshold criteria and were grouped into 75 clusters (see Figure 3). Furthermore, the clusters below are not interconnected. Once again, it illustrates that research in the mentioned field is conducted randomly. Based on Figure 3, the most cited papers were published between 2010 and 2017.

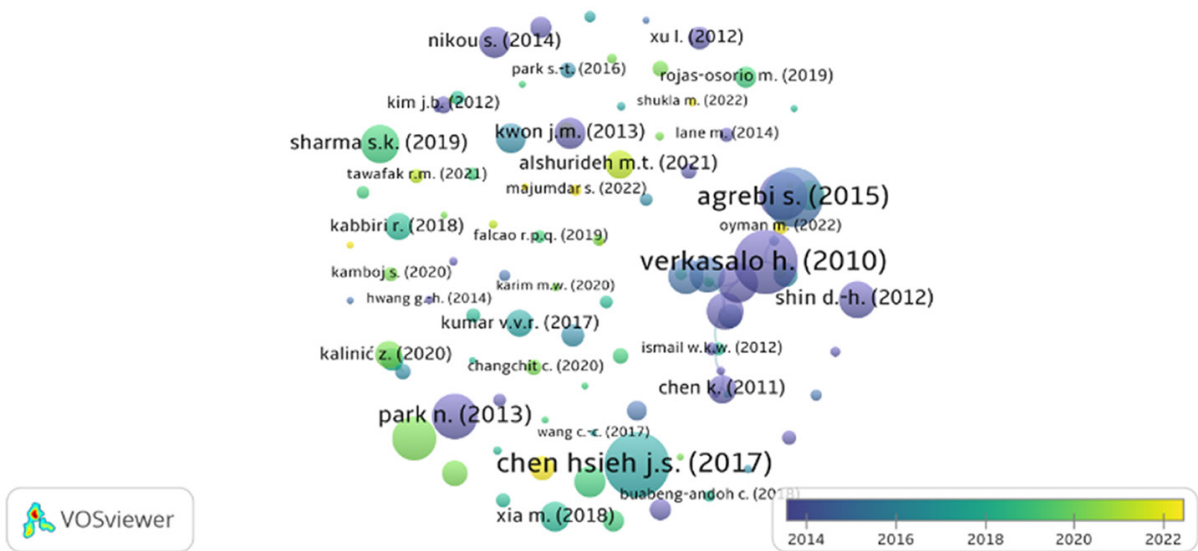


Fig. 3. Citation of TAM-related scientific works: visualization of 102 studies

In the case of UTAUT/UTAUT2, 69 out of 85 papers met the threshold criteria (i.e., number of citations = 2) and were grouped into 50 clusters (see Figure 4). Furthermore, the clusters below are not connected.

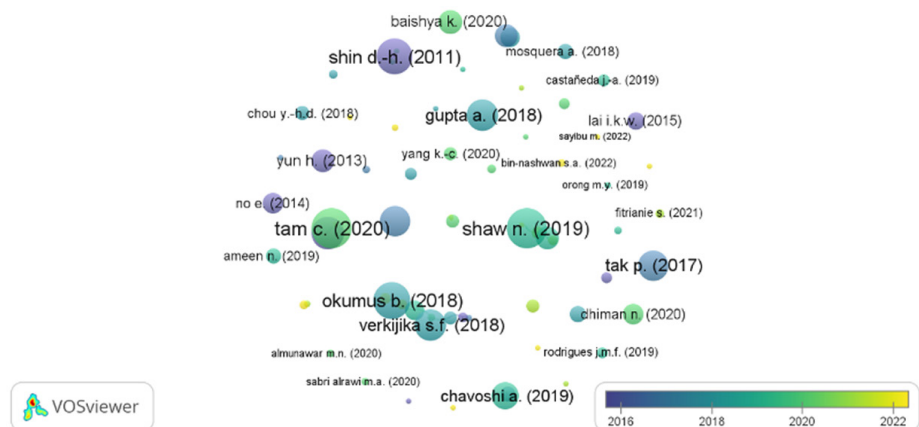


Fig. 4. Citation of UTAUT/UTAUT2-related scientific works: visualization of 69 studies

In the case of IDT, 15 out of 19 papers met the threshold (i.e., number of citations = 2) and were grouped into 14 clusters (see Figure 5). Most of the clusters below are not connected. Nevertheless, the paper by Pham and Ho from 2015 is one of the most cited (i.e., 171 citations) and influential works on NFC payments. The other prominent paper published by Kaur et al. [21] also applied IDT to the topic of mobile payments and wallets, with 70 citations.

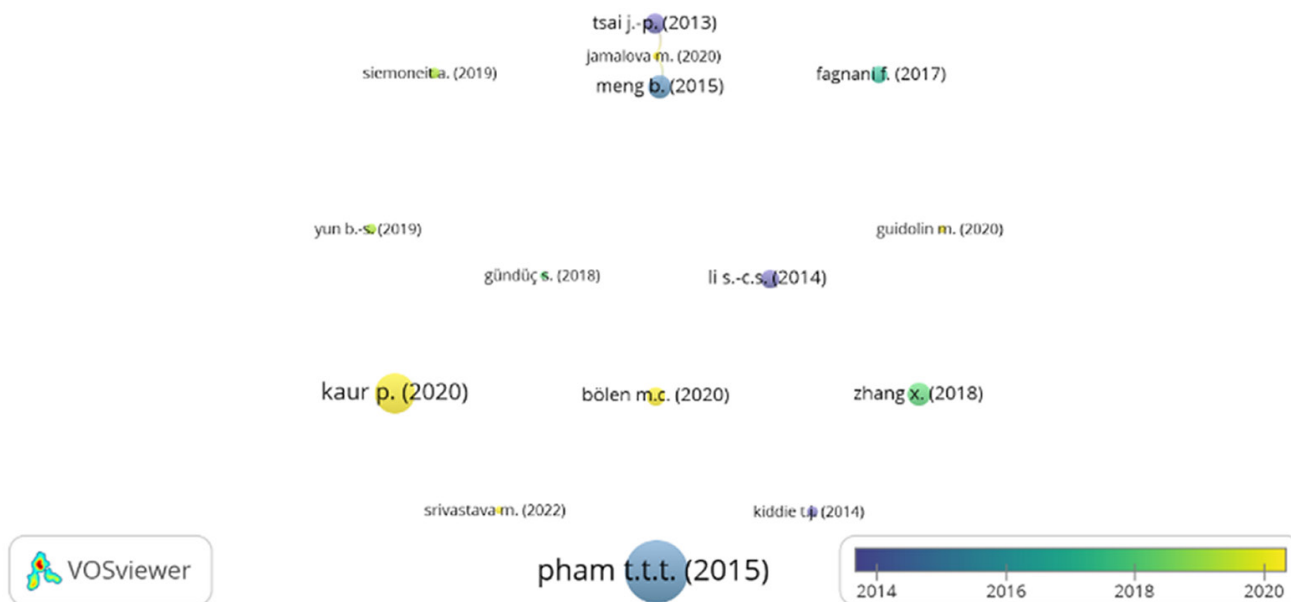


Fig. 5. Citation of IDT-related scientific works: visualization of 15 studies

5.2 Citation linkage of documents – TAM; UTAUT/UTAUT2; DOI

The citation linkage of documents determines how scientific papers are interconnected with each other. This section aims to address the second research question. In the case of TAM, the largest set of documents consists of 23 scientific works that can be grouped into seven categories, which represents about 22.5% of the overall sample (see Figure 6). The authors of these studies are illustrated in the figure below. Interestingly, this group included only the study by Agrebi and Jallais from 2015, which was published in the *Journal of Retailing and Consumer Services* and cited 244 times. The other four most cited studies in the sample were not related to the mentioned group in any way.

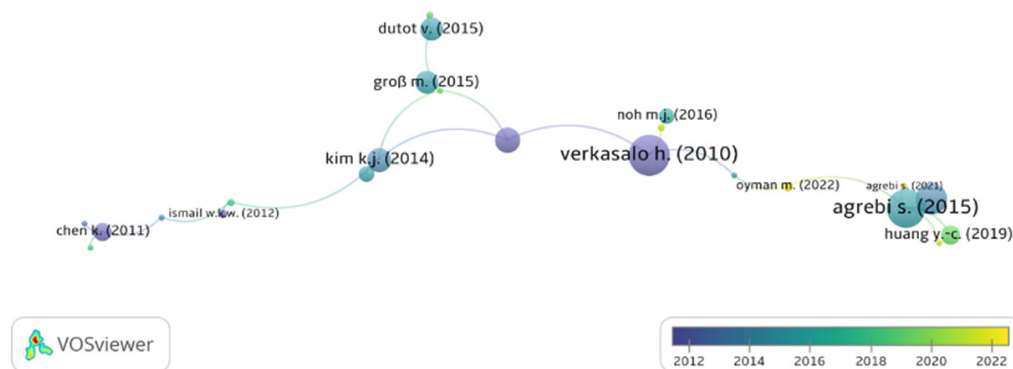


Fig. 6. Citation of TAM-related scientific works: visualization of the biggest group

In the case of UTAUT/UTAUT2, the largest set of documents consists of nine scientific works that can be grouped into four categories, representing about 13% of the overall sample (see Figure 7). The authors of these studies are depicted in the figure below. Interestingly, this group included only the study by Okumus, Ali, Bilgihan, and Ozturk from 2018, which was published in the *International Journal of Hospitality Management* and cited 166 times. The other four most cited studies that applied UTAUT/UTAUT2 were not connected to the mentioned group in any way.

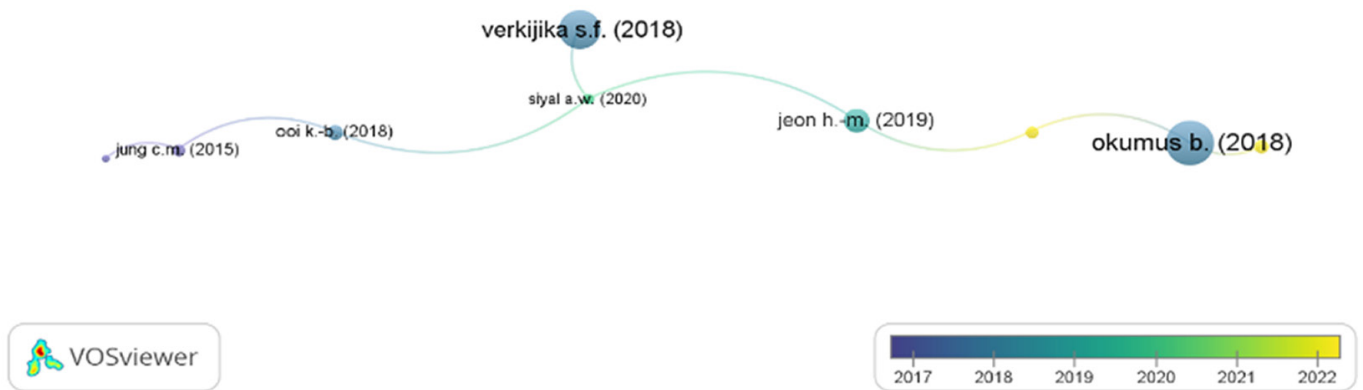


Fig. 7. Citation of UTAUT/UTAUT2-related scientific works: visualization of the biggest group

In the case of IDT, the largest set of documents consists of three scientific works that can be grouped into four categories; this represents about 20% of the overall sample (see Figure 8). The authors of these studies are illustrated in the figure below. Interestingly, this group included two studies from Figure 8 that were conducted by Meng et al. [22] and Tsai and Ho [23] (See Figure 8). The studies were cited 25 and 19 times, respectively. The other three most-cited works were not connected to the mentioned group in any way.



Fig. 8. Citation of IDT-related scientific works: visualization of the biggest group

5.3 Bibliographic coupling – TAM; UTAUT/UTAUT2; DOI

The answer to the third question focuses on applying VOS viewer to analyze the number of shared references in two papers through bibliographic coupling [20]. It is also well known that the mentioned method is one of the best tools for illustrating precise research areas [24]. To identify the most influential journals that could significantly contribute to the advancement of the body of knowledge, the author established a minimum threshold of three documents and two citations.

Seven journals out of 98 were selected. The figure illustrates that some journals began to pay attention to the mentioned field later than others (see Figure 9). For example, the *International Journal of Technology, and Human Interaction*, the *Journal*

of *Theoretical and Applied Information Technology* as well as *Cogent Business and Management* have primarily focused on TAM-related papers after 2019. In contrast, the *International Journal of Interactive Mobile Technologies* has been publishing scientific papers in this field since 2018.

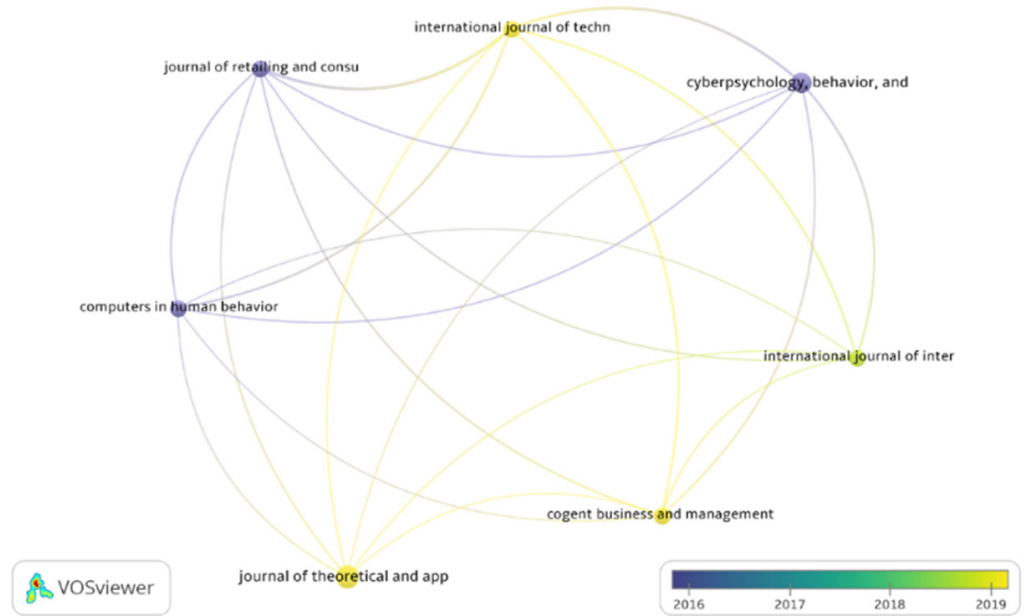


Fig. 9. Bibliographic coupling of TAM-related scientific works: visualization of relationships between seven journals

In the case of UTAUT/UTAUT2-related studies, five out of 65 journals were selected. Figure 10 illustrates that some journals began to pay attention to the mentioned field later than others. For example, the *International Journal of Innovation and Technology Management*, as well as the *Journal of Theoretical and Applied Information Technology*, have primarily focused on UTAUT/UTAUT2-related papers since 2020.

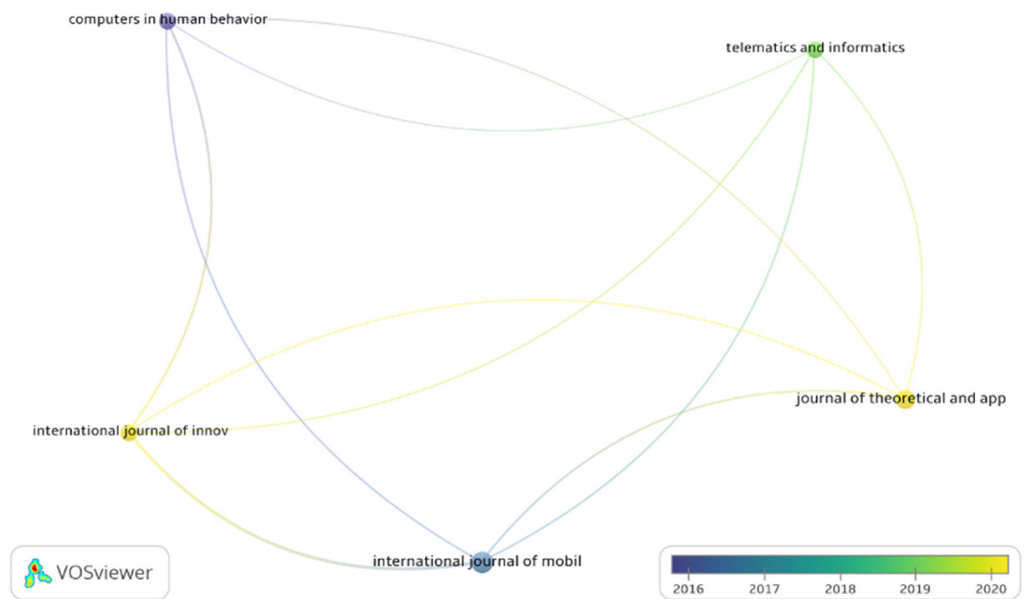


Fig. 10. Bibliographic coupling of UTAUT/UTAUT2-related scientific works: visualization of relationships between five journals

In the case of IDT-related studies, 14 out of 19 journals were selected. Considering that only 19 papers were included in the analysis, the author set the minimum number of documents and the minimum number of citations as one. Figure 11 illustrates that some journals began to pay attention to the mentioned field later than others. For example, the *Computers in Human Behavior*, *Asia Pacific Journal of Tourism*, and *Industrial Management & Data Systems* have primarily focused on IDT-related papers since 2014.



Fig. 11. Bibliographic coupling of IDT-related scientific works: visualization of relationships between 14 journals

5.4 Co-occurrence/co-word analyses – TAM; UTAUT/UTAUT2; DOI

To determine the development direction of the studies and the state of the art in the body of knowledge in general, the author conducted co-occurrence analyses as mentioned in the fourth research question. For this purpose, the unit of analysis was selected as all keywords, and the minimum number of keyword appearances was set at five. As a result, 24 keywords out of 659 were included in the analyses (see Figure 12). Five factors were determined based on the keywords. The most interesting keywords are social influence, social and economic effects, and trust.

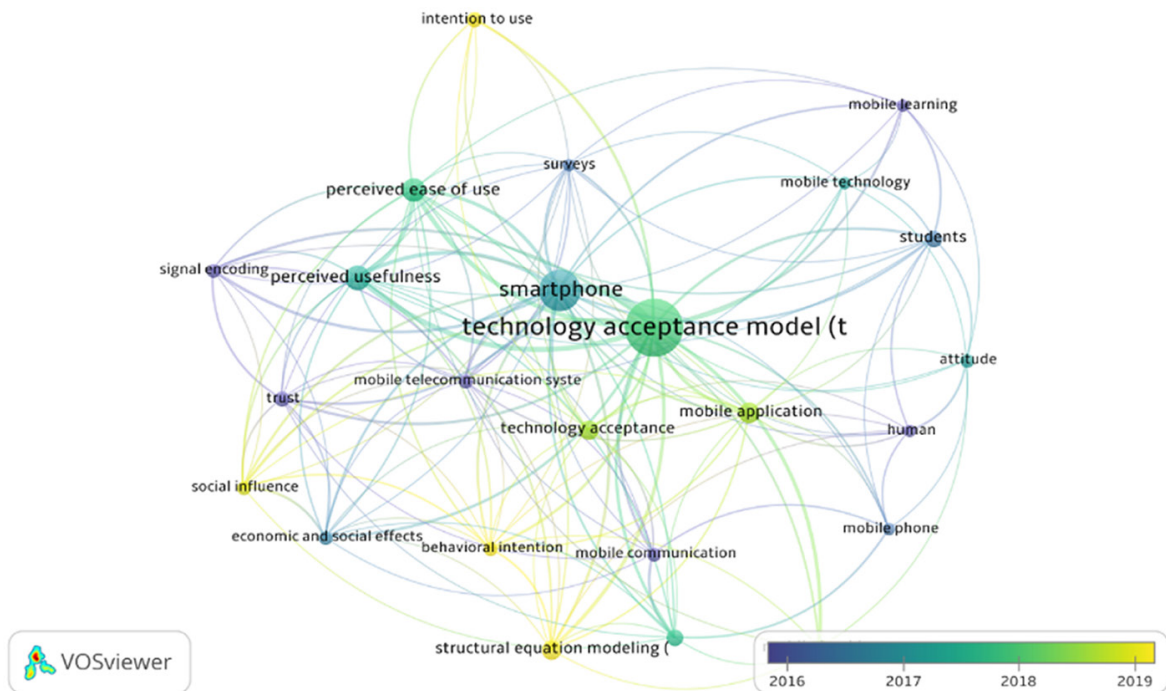


Fig. 12. Co-occurrence/co-word analyses of TAM-related scientific works: visualization of relationships between 24 keywords

The inclusion of the other keywords appears to be quite logical and directly related to TAM as well as the smartphone industry. Figure 11 illustrates that trust has been used in TAM-related models for quite a long time; however, the impact of social influence has captured the attention of scientists since 2019. Since 2019, researchers have mostly tended to use various versions of SEM in calculations related to the technology acceptance model.

In the case of UTAUT/UTAUT2, 16 keywords out of 566 were included in the analyses (see Figure 13). Three factors were determined based on the keywords. The co-occurrence of keywords illustrates that research in developing countries is one of the distinguishing elements in the application of UTAUT/UTAUT2. The involvement of trust in the models, as well as utilizing the model in the case of mobile learning, shows similarities between UTAUT and TAM-affiliated research.

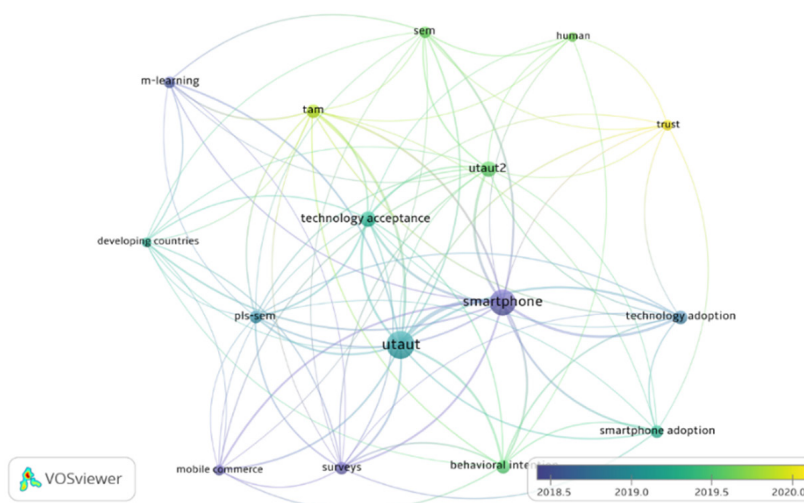


Fig. 13. Co-occurrence and co-word analyses of UTAUT/UTAUT2-related scientific works: visualization of relationships between 16 keywords

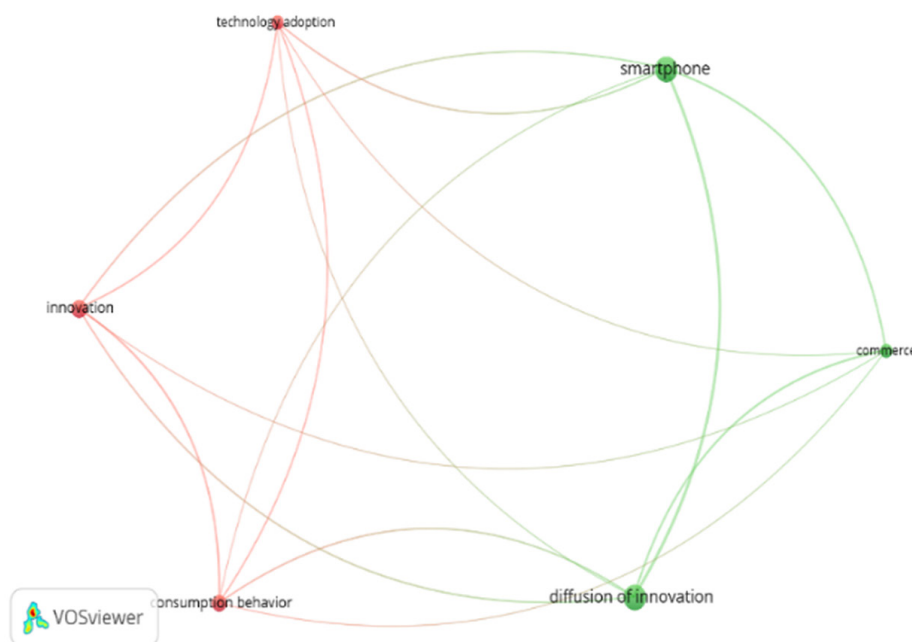


Fig. 14. Co-occurrence and co-word analyses of IDT-related scientific works: visualization of relationships between six keywords

In the case of IDT, 6 keywords out of 207 were included in the analyses (see Figure 14). Considering that only 19 papers were included in the analysis, the minimum number of keyword appearances was decreased to three. Two factors were determined based on the keywords. The co-occurrence of keywords illustrates that research in commerce is one of the distinguishing elements of the application of DOI.

6 DISCUSSION—STAGE TWO: BRIEF REVIEW OF SELECTED STUDIES

6.1 Technology acceptance model for smartphone context

A brief history of TAM's development was explained earlier. In this section, the author would like to draw attention to the adoption of TAM in the context of smartphone adoption and diffusion. The model is a simple yet powerful tool for explaining end users' behavior [25]. However, it was created to measure the behavior of individuals in the workplace [12], [26]. It means that essential elements focusing on the selection of devices (price-value, habit) and external factors (advertisements, social influence) that might have a significant impact on customer decisions were not included in the model. Also, the original model does not consider any moderating effects that have been shown to be important in the case of technology diffusion [27–29].

One of the most influential papers that was frequently cited was published by Hsieh et al. [30] and focused on understanding the learning of English as a foreign language through the LINE smartphone app. The authors applied a mixed-methods research approach; quantitative data analyses were conducted using TAM among Taiwanese and exchange students. All the other papers listed in Table 2 utilized solely quantitative research methods. The studies were published in the *Journal of Computer Assisted Language Learning*, the *Journal of Retailing and Consumer Services*, as well as two of Elsevier's journals, namely *Telematics and Informatics* and *Computers in Human Behavior*. The highest number of citations was 281, while the other papers were cited 278 and 244 times, respectively. The most cited studies using TAM were mainly focused on smartphone applications [30], [31], mobile shopping [32], mobile wallets [33], and smartphone dependency [34]. Mostly, all illustrated papers extended TAM by involving various variables such as technical barriers [31], perceived enjoyment and satisfaction [32], mobile wallet self-efficacy, informal learning, and trust [33], among others. However, co-occurrence analysis illustrates that researchers mainly apply TAM to understand economic and social effects, including social influence, as well as the relationship between TAM variables in mobile learning and technology contexts.

6.2 Unified theory of acceptance and use of technology for smartphone context

In this section, the author would like to draw attention to the adoption of UTAUT/UTAUT2 in the context of smartphone adoption and diffusion. It is clear that the model is a complex and powerful tool for explaining end users' behavior [35]. Even though the original version was created for measuring the behavior of

individuals in the workplace [12], the extension is focused on the customer and end-user electronics context.

Table 2. A brief review of the most influential papers included in the analyses

| Model | Journal | Institution | Cited |
|---|--|--|-------|
| TAM | | | |
| Chen Hsieh J.S., Wu W.-C.V., Marek M.W. – Using the flipped classroom to enhance EFL learning | <i>Computer Assisted Language Learning</i> (2016)/UK | National Central University (Taoyuan City) Taiwan; Providence University, (Taichung City), Taiwan; Wayne State College (NE), US | 281 |
| Verkasalo H., López-Nicolás C., Molina-Castillo F.J., Bouwman H. – Analysis of users and non-users of smartphone applications | <i>Telematics and Informatics</i> *(2010)/UK | Helsinki University of Technology, Finland; University of Murcia, Spain; Delft University of Technology, Netherlands | 278 |
| Agrebi S., Jallais J. – Explain the intention to use smartphones for mobile shopping | <i>Journal of Retailing and Consumer Services</i> (2015)/UK | France Business School (Tours Cedex), France; University of Rennes (Rue Jean Macé), France | 244 |
| Shaw N. – The mediating influence of trust in the adoption of the mobile wallet | <i>Journal of Retailing and Consumer Services</i> (2014)/UK | Ryerson University (Toronto), Canada | 154 |
| Park N., Kim Y.-C., Shon H.Y., Shim H. – Factors influencing smartphone use and dependency in South Korea | <i>Computers in Human Behavior</i> (2013)/UK | Yonsei University (Seoul), South Korea (SK); Cheil Worldwide, Seoul, South Korea; Korea Information Society Development Institute, | 140 |
| UTAUT/UTAUT2 | | | |
| Tam C., Santos D., Oliveira T. – Exploring the influential factors of continuance intention to use mobile Apps: Extending the expectation confirmation model | <i>Information Systems Frontiers</i> (2020)/NL | NOVA Information Management School (Lisbon), Portugal | 202 |
| Shaw N., Sergueeva K. – The non-monetary benefits of mobile commerce: Extending UTAUT2 with perceived value | <i>Int. Journal of Information Management</i> (2019)/UK | Ryerson University (Toronto), Canada | 201 |
| Okumus B., Ali F., Bilgihan A., Ozturk A.B. – Psychological factors influencing customers' acceptance of smartphone diet apps when ordering food at restaurants | <i>International Journal of Hospitality Management</i> (2018)/UK | University of Central Florida (FL), United States; University of South Florida Sarasota-Manatee (FL), United States; Florida Atlantic University, (FL), United States; | 166 |
| Qasim A., Abu-Shanab E. – Drivers of mobile payment acceptance: The impact of network externalities | <i>Information Systems Frontiers</i> (2015)/NL | Yarmouk University (Irbid), Jordan | 136 |
| Gupta A., Dogra N., George B. – What determines tourist adoption of smartphone apps?: An analysis based on the UTAUT-2 framework | <i>Journal of Hospitality and Tourism Technology</i> (2018)/UK | University of Jammu (Jammu), India; Fort Hays State University (Hays KS), United States | 128 |

(Continued)

Table 2. A brief review of the most influential papers included in the analyses (*Continued*)

| Model | Journal | Institution | Cited |
|--|--|--|-------|
| IDT | | | |
| Pham T.T.T., Ho J.C. – The effects of product-related, personal-related factors and attractiveness of alternatives on consumer adoption of NFC-based mobile payments | <i>Technology in Society</i> (2015)/UK | Yuan Ze University (Chung-Li), Taiwan | 171 |
| Kaur P., Dhir A., Bodhi R., Singh T., Almotairi M. – Why do people use and recommend m-wallets? | <i>Journal of Retailing and Consumer Services</i> (2020)/UK | Aalto University, Finland; North-West University, (Vanderbijlpark), South Africa; Lappeenranta University of Technology (Lappeenranta), Finland; Motilal Nehru National Institute of Technology (Allahabad), India; King Saud University, SA | 70 |
| Meng B., Kim M.-H., Hwang Y.-H. – Users and Non-users of Smartphones for Travel: Differences in Factors Influencing the Adoption Decision | <i>Asia Pacific Journal of Tourism Research</i> (2015)/UK | Shanxi University (Taiyuan City), China; Dong-A University (Busan), South Korea | 25 |
| Zhang X. – Frugal innovation and the digital divide: Developing an extended model of the diffusion of innovations | <i>International Journal of Innovation Studies</i> (2018)/UK | University of North Texas (TX), United States | 24 |
| Tsai J.-P., Ho C.-F. – Does design matter? Affordance perspective on smartphone usage | <i>Industrial Management & Data Systems</i> (2013)/UK | Far East University (Tainan), Taiwan; National Sun Yat-Sen University (Kaohsiung), Taiwan | 19 |

Source: Own editing based on literature review.

It means that essential elements focusing on smartphone selection [36], as well as external factors such as social influence, are included in the model. Additionally, the inclusion of moderators could enhance the exploratory capability of the model [15], [29]. Almost all the studies, except for [37], as listed in Table 2, utilized the extended version of UTAUT and incorporated new variables. These variables include perceived value [38], confirmation and satisfaction [39], personal innovativeness [40], trust and network externality [37], perceived risk, and perceived trust [41]. The authors mentioned aim to expand the current model and enhance the body of knowledge with new findings. Two of the papers mentioned were published in *Information Systems Frontiers* [37], [39]. The papers mainly focus on understanding users' intentions towards mobile apps [39], including diet apps [40] and tourist apps [41], as well as mobile payment [37] and e-commerce [38]. However, co-occurrence analysis has shown that researchers primarily utilize UTAUT/UTAUT2 to comprehend mobile learning and mobile commerce, with a significant emphasis on the context of developing countries.

6.3 Innovation diffusion theory for smartphone context

In this section, the author would like to draw attention to the adoption of IDT in the context of smartphone adoption and diffusion. The model is a complex and powerful

tool for explaining end users' behavior [17]. Moreover, Rogers [42] paid special attention to the field of telecommunication, where four main elements of diffusion (innovation, channels, time, and members) impact the aforementioned model. Also, the theory summarizes the factors influencing the acceptance of innovative products within personal, social, and technological categories [43–44]. However, as mentioned in the models above, IDT is also continuously improved and extended [45]. Based on the results of the literature review (see Table 2), IDT was mainly applied in the context of mobile payments (i.e., m-wallet [21] and NFC payments [46]) as well as smartphone adoption-related topics (travel [1]; smartphone [23], [47]; agriculture [48]). Co-occurrence analysis [49] also illustrates that researchers commonly use IDT to understand payments and commerce.

7 CONCLUSION

The results of the bibliometric analyses and the literature review show that all three models might be applicable to the topic mentioned. However, the unit of analysis might be an essential point in determining which of the models fits the scope of the analysis better. Moreover, the most cited papers related to TAM were published between 2010 and 2017. In the case of UTAUT/UTAUT2, significant scientific works were released from 2016 to 2020. Citation linkage results illustrate that most of the papers related to TAM were interconnected. It might be connected to the fact that TAM is a well-known tool compared to UTAUT/UTAUT2, which is a newer model. The visualization of the data also illustrates that the IDT model is the least utilized.

Co-occurrence and co-word analyses of TAM proved studies have primarily been conducted among students. The model has been expanded by incorporating variables related to social influence, social and economic impacts, and trust. The co-occurrence of keywords in the context of UTAUT/UTAUT2 highlights that research in developing countries is a distinguishing factor. The incorporation of trust in the models and the utilization of the model in the context of mobile learning are similarities between UTAUT and TAM-related research. In the case of IDT, the main issue was the diffusion of innovations.

Co-occurrence analyses have shown that the studies included in the analysis rarely utilized moderating and mediation effects, which is one of the major issues. Defining the moderation effect of age and gender, as well as the mediation effect of other variables, will enrich the literature and reduce the knowledge gap. In the future, it would be better to not only examine individual relationships but also strive to establish a comprehensive model for understanding behavior related to the adoption of smartphones and wearable devices within a broader context.

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