Factors Affecting Emerging Technology Adoption in Higher Education: A Systematic Mapping Study

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Abstract

This paper reviews the most recent literature on studying the factors that affect the adoption of emerging technology in higher education by focusing on the findings and recommended future research. To meet this aim, the authors conduct an in-depth analysis of the current literature by using the systematic review method. This research paper was supplemented by analysis 46 papers from various websites which hosted scientific journals. These papers employed different type of models as a baseline framework on studying the factors that affect the adoption of emerging technology in higher education. The researchers focused on findings in these papers and on the core models used to predict factors that affect the adoption. The results from the previous studies confirmed that the TAM, TOE, DOI, and UTAUT models have demonstrated pioneering research of the adoption of emerging technologies. The applicability of these frameworks within the context of emerging technologies in the information age can continue to remain instrumental in the research of technology adoption. From a researcher's view, we argue that we need to add additional, unique factors (constructs) to be consistent with the standards of application of emerging technology in the context of higher education, and create a conceptual adoption model of emerging technologies and validate the model through the application of this model to various emerging technologies.

Keywords: *emerging technologies; higher education institutions; technology adoption*

1. Introduction

With a steady increase in the use of emergent technologies over the last few years, this has led to the emergence of the Fourth Industrial Revolution (FIR), which includes the use of the Internet of Things (IOT), Robots, Artificial Intelligence (AI), Cloud Computing (CC) and Virtual Reality (VR). All academic institutions must develop their work settings, keep up their sustainability and efficiency with these advances, and determine the emerging patterns to deliver a new education. The effect on the higher education sector is expected to be enormous due to the several factors that affect the adoption of emerging technologies and understanding of technology adoption behaviours.

The main objective of this research paper is to explore the current state of emerging technologies in the higher education sector and determine the factors which relate to adoption. It comprises a systematic in depth review of the current literature in terms of the use of emergent technologies in higher education.

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2. Methodology of The Literature Analysis

The review phases: The in depth analysis of the literature was conducted. The studies were selected using the integrative review process consisting of the following phases [1]:

Phase 1: The study objective was carefully determined, and that is define the factors that affect the adoption of emerging technologies in higher education. Three guiding research questions were then identified as follow,

1. What are the existing factors that affect the adoption of emerging technologies in higher education?
2. What are the main theories and models used in this field?
3. How can convergence and the divergence in prior studies lead to the adoption of emerging technologies in higher education?

Phase 2: The authors search for the relevant literature and select studies and articles using online databases. References at the end of the paper lists the final sources selected. The following inclusion criteria were considered,

1. Quality: Only studies from globally recognised publications were selected;
2. Novelty: All selected studies must be published in 2015 after to ensure newness and originality;
3. Focus: Studies that are specifically within the emerging technologies field and linked to factors that affect the adoption of emerging technologies in higher education.

Phase 3: Data that answered the research questions were isolated from the selected publications. During this step, findings in relation to the emerging technologies specifically used in higher education were located focusing on those found significant by the previous researchers.

Phase4: Data derived from the relevant studies was assessed rigorously. Data was classified into categories and sub-categories for analysis purposes.

Phase 5: Findings of the literature review are discussed and presented below through comparison, and finding directions for future trends. Figure 1 presents the literature search steps and choice of qualifying studies

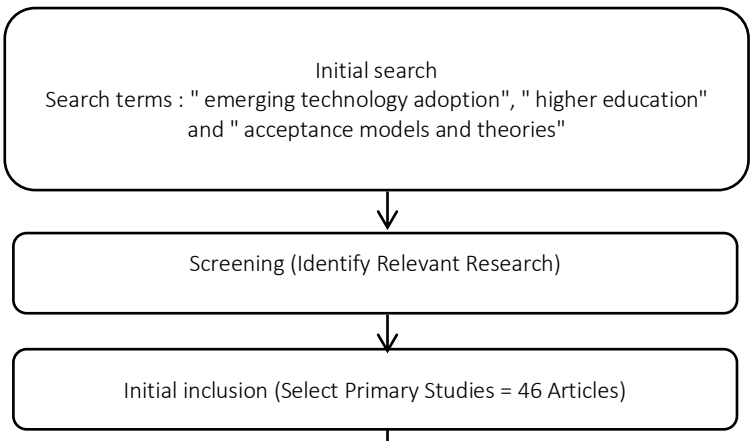


Figure 1 Literature search diagram and choice of qualifying studies.

3. Literature Review

In the era of digital transformation, the higher education sector is under growing pressure to change its organisational and operational structure; to adapt new emerging technology and be relevant to teaching requirements. As a result, universities are constantly seeking insights into emerging technologies, because it is a new phenomenon and there is still a differentiated adoption in higher education institution; including its conceptual relevance, as well as the opportunities and limitations. This allows researchers to broaden the theoretical framework of emerging technology research and poses potential opportunities and limitations associated with accessing the value of emerging technology in higher education institutions. Therefore, studying factors that influence the adoption of these emerging technologies moves towards expanding our theoretical understanding toward the adoption of this technology and involving it in the higher education system.

3.1 The Current State of Emerging Technology In Higher Education

As was discussed in the introduction, emerging technology in higher education deserves more attention and critical analysis, on both sides of the equation theoretical and practical. Studying the current state of emerging technology in higher education on a global scale is crucial to giving a holistic view to experts and to cover several gaps in this area. Moreover, the World Economic Forum (2018) report explained that the skill requirements of the jobs of the future would change by 2020 to involve complex problem solving as one of core skills to deal with the Fourth Industrial Revolution (FIR), and noted that complex problem solving skills represent 36% of a job's core skill.

The literature review identified Artificial Intelligence (AI), the Internet of Things (IOT), Cloud Computing(CC), Virtual Reality (VR) as technologies that can create a huge wave of transformation across higher education industries in the coming years [2]. It emphasises evidence of an accelerating demand for a variety of wholly

new areas such as AI and the IOT in smart campus'with cloud computing and big data affecting the importance of adopting these emerging technologies on campus. To sum, these emerging technologies should be made available as a part of the daily activities in higher education institutions.

The next sections provide definitions of the most important emerging technologies and discuss them in detail, explaining the factors which affect adoption in higher education in terms of a theoretical view based on previous studies.

3.2 Emerging Technologies In Higher Education

Cloud Computing (CC)

Cloud computing (CC) has a great orientation to resolve all issues related to the IOT. Computing is "the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer." Cloud computing has virtually unlimited capabilities in terms of storage and processing power, and it can extend its scope to deal with real world things in a more distributed and dynamic manner, and for delivering new services in a large number of real life scenarios [3].

There are different types of cloud computing for example, computing as a services (i.e. Cloud services), cloud computing platforms and computing as an application. The Cloud and the IOT are two complementary technologies merged together to represents the next generation of the Internet. All institutions need to deal with Cloud platforms which also need to be enhanced to support the rapid creation of applications and developments by providing environments and seamless execution of applications and harnessing the capabilities of multiple dynamic and heterogeneous resources [3].

The Internet of Things (IOT)

MIMOS [4] defined the IOT as "intelligent interactivity between human and things to exchange information and knowledge for new value creation". It encompasses three main technology components, connected with embedded sensors, connectivity and infrastructure, and analytics and applications (see Figure 2).

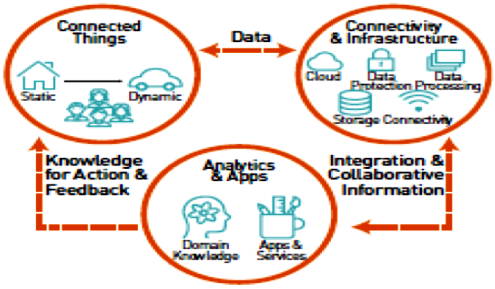


Figure 2. Components of IOT, Source [3]

The IOT stands as a core technology in the emergent technology wave, by building a global network that support new services within the information society [5],[6].

Artificial Intelligence (AI)

Artificial Intelligence is " a combination of both software and hardware components, for example, the robots on a car assembly line and the software that controls them". Machine learning is the most exciting application of AI; it is dependent upon data generation and analysis [7].

Virtual reality (VR)

Virtual reality (VR) is a modern way to transfer education from traditional to digital methods. In the education context, (VR) became more attractive to learners with the introduction of augmented reality (AR) [8]. In addition, virtual reality offers both opportunities and challenges for the educational sector, and one of the challenges in the education sector is the cost [9].

4. Factors Affecting Adoption of Emerging Technology in Higher Education

Based on the criteria defined in the research methodology adopted in this study, the researchers found that the use of keywords, which are the factors that influence the adoption of emerging technologies in higher education, do not give accurate results. Therefore, researchers have changed the mechanism of research, so that the research includes factors affecting the adoption of emerging technologies separately, for example: “factors affecting the adoption of the Internet of things in higher education”. The following writing explains the factors influencing the adoption of emerging technologies separately, together with the most common influential factors which influence adoption.

In the context of higher education, and the adoption of cloud computing, different technology acceptance theories and models have been used to test and validate adoption chances of cloud computing at organisational and individual levels. Jewan and Vibhakar (2019) [10] conducted an experimental study to provide a holistic evaluation of the determinants of cloud computing adoption in the Indian education system using technology-organization-environment (TOE) framework. They found that the pressure, external expertise and attitude presented (considered as environmental factors), relative advantage, compatibility, and complexity (considered an technological factors) and top management support demonstrated (considered an organisational factor), all have a significant impact on cloud computing adoption. In the same context, Yakob and Sugiarto (2018) [11] studied technology acceptance factors for cloud storage, from the perspective of students of higher education institutions who used Google Drive for storage, by applying the technology acceptance model (TAM). The result of this study indicates that social influence has a significant impact upon adoption, with a statistically significant relationship between perceived ease of use (PEOU) and perceived usefulness (PU), but not with attitude. However, they found that attitude and perceived usefulness (PU) influence the behaviour intention. In the same approach, in Saudi Arabia Tashkandi and Ibrahim (2015) [12] worked on methodological exploratory

empirical research based in the technology–organisation–environment (TOE) to study the factors that affect cloud adoption by higher education institutions. The result of this study showed that three factors have a significant in this context and are as follows: Relative advantage, complexity and data concern. In addition, the authors found that there are significant differences between large and small institutions in in the factors of compatibility, complexity, vendor lock-in and peer pressure. In short, in the context of cloud computing and after conducting a systematic review according to guidelines previously mentioned, as well as selecting relevant research papers, we found that the TAM and TOE models are commonly used and the results from most studies demonstrate that security concern, privacy, organisation and environment factors play a significant role in cloud computing adoption. Finally, despite the existence of many studies relating to the adoption of cloud computing in HEIs, the researchers have focused on the organisational and individual perspectives. Thus, additional studies are required to investigate the phenomenon from the perspectives of educational organisations. Table 1 reviews some of selected studies in the context of adoption of cloud computing.

Table 1. Selected studies in the context of adoption of cloud computing.

Factors Affection Emerging Technology Adoption In Higher Education (Cloud Computing)		
Author / year	Factors	Theoretical background
Jewan Singh & Vibhakar Mansotra (2019) [10]	Relative advantage, compatibility, and complexity, top management support, Competitive pressure, external expertise and attitude	TOE
Kamal Kant Hiran1 • Anders Henten (2019) [12]	Use all TOE and DOI variables	TOE + DOI
Yakob and Sugiarto (2018) [11]	Social influence, perceived ease of use and perceived usefulness, attitude, behavior intention	TAM
Herdaya et al., (2018) [13]	Use all TOE variables	TOE
Muhammad Imran et al., (2017) [14]	There are 34 factors were investigated	TOE + DOI
Shamsul et al., (2016) [15]	Relative advantage, complexity, compatibility, top management support, institution size, adoption plan, service provider support, and government support	TOE
AlAlaa N. Tashkandi1 & Ibrahim M. Al-Jabri2 (2015) [16]	Relative advantage, complexity and data concern	TOE

In the context of the Internet of Things (IOT), there are many studies that investigate the factors determining acceptance of IOT technology by consumers and from an organisation perspective. Most of these studies used different types of technology adoption models, for example, TAM, TOE, and Diffusion of innovations (DOI), which consist of technology factors, social context factors and individual user characteristics. In this context, Humaiz et al., (2019) [17] reviewed adoption and acceptance of the IOT in Pakistan's higher education institutions by using the unified theory of acceptance and use of technology (UTAUT2) model as

a theoretical framework. The results of this study showed that all factors included in the UTAUT2 model for the adoption of this technology have a positive impact on the intention of adoption. In another study, conducted by Ogallo (2018) [18], the construct of the UTAUT2 framework was used to explore the adoption of the IOT amongst the participants in higher education. The researcher found that the concerns about the issue of individual privacy, data security and connectivity challenges have a significant impact to the adoption of IOT technology. In addition, most of the current research in the IOT context studied the factors affecting the consumer context more than the organisational context, which is attributed to the IOT having the ability to extend to the higher education ecosystem [19],[20].

In the context of virtual reality (VR) and artificial intelligence (AI), and despite the limited research in this area [21], some researchers have demonstrated attitudes towards this technology by students, and using it to increase learning motivation [22]. However, there is a lack of theoretical reflection, most of the previous studies in Artificial Intelligence (AI) focus on studying the effect of this technology on students by using the TAM and UTAUT instruments [23],[24],[25]. Also, in the same context, Fathali and Okada (2018) [21] used theories of self-determination, while Cheng (2018) [26] used planned behaviour in studying the effect of Artificial Intelligence (AI) in the attitudes towards this technology by students. In summary, we found that the previous studies helped us to expand the TAM and UTAUT models scientific knowledge in adoption of artificial intelligence, augmented reality, and virtual reality (VR) and increase incorporation of emerging technology into the higher education system. The creation of new theoretical models which can be applied to the adoption of these emerging technologie is critical. Table 2 Summarizes the factors affecting IOT, AI, VR adoption.

Table 2 Summarizes the factors affecting IOT, AI, VR adoption

Factors Affection Emerging Technology Adoption In Higher Education (IOT, AI, VR)			
Author / year	Factors	Type of perspective	Theoretical background
Humaiz et al., (2019) [17]	All constructs of UTAUT2 framework	Consumers'	UTAUT2
Ogallo (2018) [18]	All constructs of UTAUT2 framework	Consumers'	UTAUT2
Barroso, 2018 [22]	Student attitudes	Consumers'	TAM
Chang, S., Hwang, G., 2018 [27]	Student attitudes	Consumers'	TPB

5. Main Theories and Models Used In Emerging Technology Adoption

The tendency to study the adoption of new technologies has dramatically increased. Previous studies have been interested in understanding the users' behaviour in adopting and using a new technology at both the organizsational and individual level. Regarding the organisational level, Oliveira and Martins (2011) [36] stated that there are two commonly-used theories applied to IS/IT, namely Innovation Diffusion Theory (IDT) [28] and the Technology Organisation Environment (TOE) framework [29]. On the other hand, at the individual level, many theories: Theory of Planned Behaviour (TPB) [30], Technology Acceptance

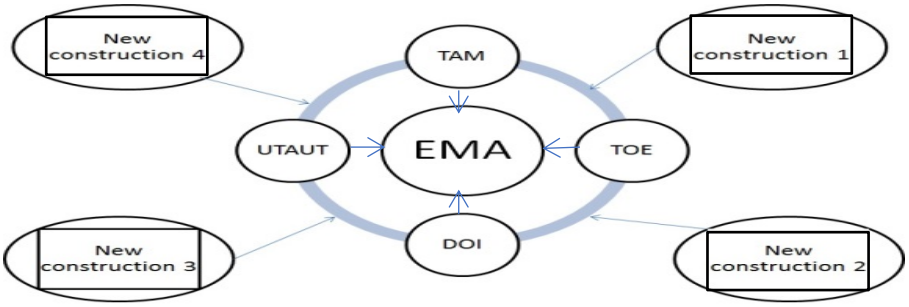
Model (TAM) [31], and Unified Theory of Acceptance and Use of Technology (UTAUT) [32] have examined the technology adoption.

This systematic review seeks to clarify the most common theories and model which have been used in emerging technology adoption by combining our systematic review and previous study's results to answer the second research question of this research paper. For a long time, research has focused on the extent to which technology is adopted in education practice, and the technology acceptance model (TAM) dominated the field. Although there is consensus on the factors that could predict the adoption of emerging technologies in the TAM model, there are a variety of controversies and contradictory results in the current field. Overall, and based on some researchers opinions the TAM can explain technology acceptance well.

The unified theory of acceptance and use of technology (UTAUT), indicated as another theoretical framework, include four key determinants defining the user's intentions and the actual use of technology, namely; performance expectancy (PE) effort expectancy (EE), social influence (SI), and facilitating conditions (FC), with four moderators as follows: (gender, age, experience, and the voluntariness of technology use) [32]. While the UTAUT test is more complicated than the TAM (because of the hypothesised effects of moderation), this model is known to be another effective framework representing the acceptance of technology [33]. Researchers most commonly use TAM and UTAUT to evaluate technology adoption [34]. Marangunić & Granić (2015) [35], confirmed Taherdoost (2018) [34] findings in the aspect of emerging technology adoption, found that the TAM method dominated the research landscape as the most widely used model. Finally, we found that there is still a lack of targeted research on the adoption of emerging technologies in higher education, although the UTAUT theoretical framework may play a major role in accreditation and opening the field for future studies.

6. Convergence and The Divergence in Prior Studies

The previous studies showed that there is a two-way interaction between the individual characteristics, for example (age and gender), and organisational characteristics, for example (privacy and trust) with the emerging technology and performance expectancy (PE) and effort expectancy (EE), social influence (SI), facilitating conditions (FC), relative advantage, compatibility and complexity. The characteristics of emerging technologies are affected by the acceptance of technology by factors such as behavioural intention, real behaviour, perceived ease of use, perceived usefulness. This leads us to think, research and work to develop a new conceptual framework based on the acceptance and adoption of these emerging technologies so as to contain new structures which are compatible with these emerging technologies. The following figure reviews our proposal about a new conceptual framework based on the acceptance and adoption of these emerging technologies (EMA) so as to contain new structures which are compatible with these emerging technologies.



Figur 3. A proposal for a new conceptual framework based on acceptance and adoption of emerging technologies (EMA)

7. Result

Many articles have examined the subject area of emerging technology adoption from an introductory viewpoint, some focusing on real applications, other focusing on the individual or organisational view. In addition, the previous studies showed, that the TAM, TOE, DOI, and UTAUT models was pioneering in research of the adoption of emerging technologies. In our review, we found that previous studies have critically reviewed some of the theoretical frameworks used to examine the impact of emerging technologies for adoption in higher education institutions. In addition, we found that these studies also focus on comparative and behavioral studies to illustrate how the assumed factors of researchers can lead to adoption. The applicability of these frameworks within the context of emerging technologies in the information age can continue to remain instrumental in the research of technology adoption. From a researcher's view, emerging technology (ET) has particular characteristics that differentiate it from the adoption of other technologies, therefore, we argue that researchers must ensure that they understand the underlying assumptions and limitations imposed by the theoretical frameworks taken to interpret results appropriately.

Therefore, and from this systematic mapping study, we argue that the TAM, TOE, DOI, and UTAUT models are not sufficient in investigating the adoption of emerging technologies. This lead us to suggest that we need to add additional, unique factors (constructs) to be consistent with the standards of application of emerging technology in the context of higher education, and create a conceptual adoption model of emerging technologies and validate the model through the application of this model to various emerging technologies.

8. Conclusion

This paper has made a contribution by extending the theoretical knowledge about examined the effects of factors affecting the adoption of emerging technologies and provided a fundamental understanding of technological adoption, which could throught it determine the factors influencing the adoption of emerging technologies. In addition , in this research paper the researchers highlighted the main theories and models used in emerging technology adoption and convergence and the divergence

in prior studies. At the conclusion of the paper, the researcher argue that the TAM, TOE, DOI, and UTAUT models are not sufficient in investigating the adoption of emerging technologies and suggest that we need to add additional, unique factors (constructs) to be consistent with the standards of application of emerging technology in the context of higher education, and create a conceptual adoption model of emerging technologies and validate this model through the application on various emerging technologies.

9. Future work

Researchers in this paper open the way for future studies and research to develop different models for adopting emerging technologies in various fields. Therefore, for the next research paper we will work to develop new model that is applicable with emerging technology by add a special indicators and work to validate this model.

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