Evolution of Technology Adoption Theories and Models: A Review of Literature

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Abstracts

This paper aims to review the evolution of prominent technology adoption theories and models and identify the limitations in each studied theory and model. For this, a literature review method was used. The literature review demonstrates that an amalgamation of consumer behaviour theory and technological framework has consistently developed from its inception to the present day to frame the adoption and use of new technology. The review further indicates that each technology acceptance theory and model has distinct advantages and limitations. UTAUT and its extension are widely regarded as the most complete consumer technology adoption and use model. The UTAUT model is essential to technology acceptance research because it provides a strong foundation for understanding the variables affecting consumers' willingness or inability to accept new technologies. The UTAUT framework has been applied widely in numerous research initiatives, demonstrating its increased effectiveness in promoting technology adoption in various contexts. Furthermore, the technology acceptance model (TAM) is essential for understanding consumer behavior and technology adoption. The review results indicate that many theories and models have distinctive components that may impact consumers' willingness to accept new technology for particular applications. Because of this, it is essential to carry out distinct, in-depth evaluations of different theories and models, focusing on identifying the traits and attributes each uses.

Keywords: Prominent, Technology Adoption, Evolution, Theory, Model, Literature Review

1. Introduction

The incorporation of technology has become an essential component of contemporary society, exerting a significant impact on several facets of human existence. Many models and ideas have been developed over time to understand better and clarify the process of adopting new technology and using it afterward. The Technology Acceptance Model is one of the most well-known and essential models. The Technology Acceptance Model (TAM) was first introduced by Davis in 1986, and since then, several industries have used it, including fintech, information systems, innovation management, and healthcare. The main emphasis of the Technology Acceptance Model is the defining factors that impact the adoption and application of new technology. Perceived utility (PU) and perceived ease of use (PEU), according to the Technology Acceptance Model (TAM), are two essential characteristics that affect a person's desire to utilize a technology. These two elements directly affect how the user plans to accept and use the technology and how they will behave.

Although the Technology Acceptance Model has gained widespread acceptance and application in research, additional models and theories have also surfaced to enhance and broaden our comprehension of technology adoption and utilization (Rahman et al., 2016). For instance, Venkatesh et al. expanded on the Technology Acceptance Model in 2003 with the creation of the Unified Theory of Acceptance and Use of Technology (UTAUT). A more thorough understanding of technology adoption is provided by this model, which also includes other components, including performance expectancy, effort expectancy, social influence, and facilitating factors.

The Theory of Planned Behaviour and Reasoned Action are commonly used models to explain technology adoption. These models propose that attitudes, subjective norms, and perceived behavioural control influence individuals' behavioural intentions towards technology. In addition to these individual-level models, the Innovation Diffusion Theory has been widely used to understand the adoption and diffusion of technology at a broader societal level. According to this idea, a number of elements, such as the innovation's features, communication channels, societal norms, and the adopter's traits, have an impact on the adoption of new technology. Scholars have also expanded and modified previous models to capture the complexity of adopting and using technology accurately. In 1990, Tornatzky and Fleischer, for example, developed the Technology-Organization-Environment Framework to provide a thorough understanding of technology adoption. This approach considers organizational and environmental elements in addition to human traits.

The main objective of this review paper is to discuss the evolution of technology adoption theories and models and highlight the key constructs, extensions, advantages, and drawbacks of previous literature. This paper also aims to review and compare the adoption theories and models used in relation to consumer behaviour studies. Thus, this critical review focused on the prominent models and theories used to explain human behaviour toward adopting various technologies at the individual level. It provides a broad summary of the advantages and disadvantages of well-known adoption theories and models, providing insightful information for future research on the acceptance and application of technology.

2. Prominent Technology Adoption Theories and Models

Various models and theories have been used to understand and predict technology adoption and usage behaviours. Each model has strengths and limitations, and researchers should carefully choose the most suitable model for their empirical studies. Based on a thorough literature analysis, this study focuses on the following well-known theories and models often used to comprehend the motivations behind people's adoption or opposition to technology.

Theory of Diffusion of Innovations (DOI)

The sociological theory known as the Theory of Diffusion of Innovations (DOI) was formulated by Everett Rogers in 1962. This theory aims to elucidate the mechanisms, causes, and velocity at which new concepts, commodities, or technological advancements disseminate within a given societal framework (Dibra, 2015). The idea has special significance within the domain of technology adoption; however, its applicability extends to the adoption of many innovations, including new goods, services, and activities. DOI become a popular adoption model in Information technology research (Koenig-Lewis et al., 2010). The four crucial elements of the Diffusion of Innovations theory include Innovation, Social systems (Adopters), communication channels, and Time(Atkin et al., 2015).

Innovation is the concept, idea, product, or technology that is being introduced to a social system. Innovations can be new inventions, practices, or even existing ideas applied in new ways. Social Systems (Adopters) are the people or organizations in a society who decide to adopt and make use of the invention. Generally, adopters are categorized as innovators, early adopters, early majority, late majority, or laggards, depending on when they adopt. Every group has unique traits and preferences when it comes to the timing of innovation adoption. The third key element in the concept of diffusion is communication Channels. The channels of communication are how knowledge about the invention is spread. Word-of-mouth, social media, mainstream media, and other techniques are examples of communication routes. The final component is time. The diffusion process occurs over a period of time, and the rate at which various factors influence an innovation spread(Atkin et al., 2015).

Roger (2003) also identified five factors that affect the rate of adoption and the diffusion process: "Relative advantage," "Compatibility," "Complexity," "Trialability," and "Observability." *"Relative advantage"* is the "degree to which an innovation is perceived as better than the idea it supersedes." The adoption rate of an invention is positively correlated with its relative advantage. *"Compatibility"* is the "degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters." *"Complexity"* is the "degree to which an innovation is perceived as difficult to understand and use." "Trialability" is the "degree to which an innovation may be experimented with on a limited basis*." "Observability"* is the "degree to which the results of an innovation are visible to others." There exists a favourable correlation between observability and the rate of innovation adoption. Complexity has a negative relationship with adoption rate, although relative advantage, compatibility, trialability, and observability have favourable relationships with adoption rate.

The DOI theory also introduced the concept of the "S-curve," which represents the diffusion process as a sigmoidal curve(Dhakal et al., 2019). Innovations tend to follow this curve, starting slowly, accelerating as they gain acceptance, and eventually slowing down as they approach saturation. The hallmark of this theory is gathering quantitative information on a particular innovation from adopters at a certain moment after extensive dissemination(Abbas & Michael, 2022). Over the years, DOI has been practically implemented in various fields, such as marketing, product development and public policy) and applied to new technologies and societal challenges. Diffusion researchers began using naturalistic diffusion knowledge in process intervention studies to spread innovations by the 1950s. This purposeful goal has led to a science of distribution in which empirical procedures are intended a priori to promote internal validity, external validity, and diffusion (Dearing, 2009). DOI has also been used in research, such as on the uptake of information communication systems, cloud computing, and other mobile apps, including mobile banking. For instance, Predicting (2010) revealed that risk, perceived usefulness, and compatibility influence mobile banking services acceptance. According to research by Carreiro & Oliveira (2019), adopting a

significant IS breakthrough like mobile cloud computing is closely correlated with leaders' vision and ability to consider others' sentiments and understand their requirements.

Limitations of DOI

The practical ramifications and usefulness of DOI theory are what make it strong; they can be used to a broad range of situations. The model's diffusion process embodies the necessary actions for an idea to proliferate from its origins to a larger populace, irrespective of cultural context, societal hierarchy, or demographic characteristics (Atkin et al., 2015). DOI theory is also not free from criticism. The primary critique leveled with the DOI theory was that, because of its agricultural orientation, it would not be conducive to developments in more technology fields(Weil, 2018). The following are some of the DOI Theory's main limitations.

The DOI theory is a simplistic model that does not encompass the intricate nature of diffusion processes in real-world contexts(Lyytinen & Damsgaard, 2001). The assumption in this context is that the acceptance of innovation follows a linear trajectory, disregarding the many causes and complexity inherent in the spread of innovations. The DOI also fails to consider and address individual differences adequately. The primary emphasis of DOI is on examining the attributes of innovations and the adopter types. However, it fails to adequately consider the individual variances in attitudes, motives, and behaviours that have the potential to impact the adoption process (MacVaugh & Schiavone, 2010).

The DOI paradigm fails to include socioeconomic factors. The paradigm fails to adequately consider the significant impact of socioeconomic circumstances, cultural variations, and disparities in adoption rates (Ardis & Marcolin, 2017). The assumption is that all individuals possess equitable opportunities and levels of incentive to embrace innovative practices. It also fails to sufficiently account for the influence of cultural, ethical, and moral considerations on the acceptance of specific inventions, particularly in situations involving cross-cultural or global dynamics.

The DOI is predicated upon the assumption of rational decision-making(Dhakal et al., 2019). The DOI framework operates on the premise that the process of adopting an innovation is driven by rational decision-making and entails a thorough review of the innovation's qualities. Emotional factors, impulsive tendencies, or societal pressures may drive adoption choices. The model fails to include the influence of network effects and the interconnectedness among adopters (Weil, 2018). In some instances, individuals tend to embrace innovations due to the influence of their social networks or the prevalence of prior adopters rather than relying on the invention's inherent features.

The theory of DOI is limited in considering the temporal dimension. It presents a static perspective on the acceptance of innovation, failing to account for the dynamic character of the adoption process(Weil, 2018). The dynamic nature of an innovation's comparative advantage over time is not adequately taken into account in the analysis.. The predictive capacity of the DOI is constrained. Although the DOI framework provides a theoretical foundation for comprehending the process of diffusion, its ability to accurately forecast the precise outcomes of an invention in terms of success or failure is limited. The provided information offers a comprehensive comprehension of the diffusion process, although it lacks specific recommendations for implementing techniques to facilitate acceptance.

The DOI model does not adequately address the phenomenon of resistance to change(Benhayoun, I., & Zejjari, 2022). The primary emphasis of DOI is in the examination of the adoption of innovations, with less exploration of the underlying causes contributing to resistance towards change or the difficulties involved with terminating established methods. Moreover, the DOI is a paradigm that focuses on technology's role in the adoption and spread process (Kapoor et al., 2014). The applicability and relevance of DOI may be limited when it comes to transmitting non-technical breakthroughs or social innovations since it was primarily established within the context of technology advancement choices (Lyytinen & Damsgaard, 2001).

Notwithstanding these limitations, the DOI theory continues to be a powerful conceptual model for comprehending the fundamental principles governing the dissemination of inventions among populations. However, it is crucial to include it with other theories and models in order to get a more full comprehension of the diffusion process.

Theory of Reasoned Action (TRA)

The field of social psychology known as TRA is credited with creating the initial model that explains how individuals adopt new technologies. TRA is the cornerstone of the Technology Acceptance Model, introduced in 1975. TRA has been used in a

vast majority of empirical research, and it has been shown to be an effective estimator of actual use behaviour in a variety of environment. TRA explains different kinds of actions or behaviours manifested by individuals in different settings or environments (Albarq & Alsughayir, 2013). According to the Theory of Reasoned Action (TRA), people make logical decisions based on their intentions. Their attitudes and arbitrary norms consequently influence their goals or intentions. The Theory of Reasoned Action encompasses many fundamental elements: the main elements are; attitude, subjective norm, behavioural intention and actual behaviour.

"Attitude" is a person's comprehensive assessment or appraisal of a particular conduct (Fishbein & Ajzen, 1975). Perception of a certain activity may be characterized as an individual's subjective evaluation, which may be either positive or negative. Attitudes are comprised of individuals' views on the consequences or characteristics associated with a particular activity and their subjective assessments of these consequences. Attitudes have the capacity to exhibit either positive or negative orientations, exerting a substantial influence on the formation of behavioural intentions.

The term "subject norm" describes how an individual interprets the social pressure or influence surrounding a certain activity (Fishbein & Ajzen, 1975). The individual's adherence to societal norms and expectations is influenced by their own convictions and the level of incentive to conform to the perceived desires of significant individuals in their social circle, such as family, friends, and classmates. When an individual feels that others have certain expectations about their engagement in a specific action, and they attach importance to the views of these others, it enhances the probability of the individual's intention to practice this conduct.

The term "behavioural intention" describes a person's propensity or willingness to engage in a particular activity. (Fishbein & Ajzen, 1975). It is often regarded as the direct antecedent to subsequent actions. According to the TRA, people's intentions regarding their behaviour are shaped by their perceptions of subjective norms and attitudes towards a specific activity. The degree of a person's behavioral intention to carry out a particular action is positively correlated with the degree of their positive attitude and subjective norm.

The last phase in the process is the actual behaviour. The concept refers to the behaviour shown by a person, which is influenced by their underlying objectives (Fishbein & Ajzen, 1975). Although the TRA does not directly predict actual conduct, it posits that intentions serve as the most reliable indicators of behaviour. In other words, a positive correlation exists between an individual's intention to participate in an action and their likelihood of actually doing that conduct.

The TRA has been extensively used across many disciplines, such as health psychology, marketing, and social psychology, to effectively forecast and comprehend human behaviour. The idea has undergone further development and refinement in succeeding theories, such as the Theory of Planned Behavior (TPB), whereby perceived behavioural control has been included as an additional factor influencing behaviour. This comprehensive perspective encompasses scenarios whereby people may possess restricted agency over their behaviours. In essence, the TRA offers a framework for comprehending the impact of attitudes and social norms on an individual's intentions and subsequent conduct. The underlying assumption is that individuals engage in rational decision-making processes, considering these elements and that behavioural intentions serve as robust indicators of subsequent conduct.

Limitations of TRA

While TRA has been influential and useful in understanding various behaviours, it has some limitations. The first limitation is the generic characteristics of TRA. It is a generic model that isn't exclusive to one behaviour or technology. Nevertheless, its generality has drawn criticism since TRA was not intended for specific information technology or behaviour. Due to its broad nature, the TRA is limited in its ability to discern the fundamental ideas that serve as the foundation for a particular behaviour. Before using TRA, researchers must ascertain the respondents' salient beliefs about the behaviour they are studying(Al-Mamary et al., 2016).

TRA is still constrained in that it ignores other factors that could have an impact on an individual's intentions or actions; for instance, it fails to adequately consider the influence of cultural and environmental factors on human behaviour(Alkhwaldi & Kamala, 2017). The other fundamental limitation of the TRA, as identified by Taherdoost (2018), is the absence of consideration for factors such as habit, cognitive deliberation, misunderstanding via survey responses (including attitudes toward the intention, subjective standards, and purpose of the participants), and moral concerns.

However, in situations where attitudes and social norms play a substantial role in shaping conduct, the TRA continues to be a useful framework for comprehending and forecasting certain forms of behaviour. Researchers often use it with other theories to provide a more thorough understanding of behaviour.

The Theory of Planned Behavior (TPB)

Icek Ajzen presented the TPB, a theory of social psychology, in the latter part of the 1980s. It broadens the scope of Ajzen and Fishbein's 1980 Theory of Reasoned Action (TRA). The TPB is a highly regarded and prominent theoretical framework within the realms of psychology and social science. It serves as a valuable mechanism for comprehending and forecasting human behaviour (Ajzen et al., 2021).

TPB is well recognized as a prominent social psychology framework used for understanding and predicting human behavior in contemporary society. In short, according to the TPB, a certain behaviour's "intention" to carry it out is its immediate antecedent. Three types of factors or beliefs are thought to influence human behaviour. These are attitude towards behaviour, subjective norm and behavioural control. Attitude towards behaviour pertains to an individual's evaluative stance on a certain behaviour, either favourable or negative. This concept incorporates an individual's ideas on the potential results of a particular behaviour and their overall assessment of the significance of those results(Ajzen, 2015). Subjective norm refers to the individual's perception of social pressure or influence exerted by important individuals, such as friends, family, or coworkers, on their decision-making process about behaviour engagement. A person's subjective assessment of the degree to which essential people would support or disagree with their activity is referred to as their "subjective norm." The term "perceived behavioural control" describes how someone feels about their capacity to carry out a particular task. The assessment takes into account the individual's subjective evaluation of their own capabilities, the resources at their disposal, and the many contextual factors that might either facilitate or hinder the activity.

Over the course of its existence, the TPB has undergone many transformations. One notable advancement in the TPB was the incorporation of "perceived behavioural control." Initially, the TRA just focused on the factors of "attitude" and "subjective norm". However, Ajzen acknowledged the paramount of "perceived behavioural control" in exerting influence on behaviour. The incorporation of this modification resulted in an enhancement of the model's prediction efficacy and included scenarios in which people may possess restricted agency over their behaviours.

The researchers have expanded the Theory of Planned conduct (TPB) by including supplementary components that have the potential to impact behaviour. These extra factors encompass moral standards, self-identity, and historical behaviour. Adding these additional variables advances our understanding of the factors influencing people's engagement in particular behaviors in a more comprehensive way. The TPB has been subject to variations and applications across many cultural and contextual situations. Scholars have acknowledged that social norms and cultural influences substantially impact the formation of attitudes, subjective norms, and perceived behavioural control. Consequently, the model has been modified to accommodate these variances.

The Theory of Planned Behavior (TPB) has been effectively merged with several other theoretical models in order to augment its explanatory capacity. For instance, researchers have integrated it with the Health Belief Model to enhance comprehension of health-related activities and the Extended Parallel Process Model to investigate risk perception and communication (Gerend & Shepherd, 2012). Notable progress has been made in measurement and methodology, especially with regard to the assessment of constructs under the TPB. These developments have led to improved measurement accuracy for attitudes, subjective norms, and perceived behavioural control. The development of TPB has greatly aided the theory's advancement and strengthening.

In brief, the TPB has been refined since its conception, including integrating perceived behavioural control and accommodating many contextual and cultural factors. The paradigm remains a significant tool for comprehending and forecasting human behaviour and has found use in many domains, such as health psychology, environmental psychology, and consumer behaviour.

Limitations of TPB

The theory of planned behaviour (TPB) is generally recognized as a very effective and extensively used conceptual framework for predicting human behaviour (TPB; Ajzen, 1991, in press) (Ajzen, 1985 & Ajzen, 2011). Despite its widespread appeal, the TPB has been the subject of much criticism. Some scientists consider it an inadequate explanation for human social behaviour. "Even when all TPB constructs are rigorously analyzed, they contain random measurement error." (Ajzen, 2011) questioned

the predictive efficacy of TPB. The reliability of attitude measures pertaining to the TPB constructs is often below 0.75 or 0.80, even when they are well-designed. As a result, even with reasonable measures, we may only expect coefficients of roughly 0.60 in terms of correlations across the theory's conceptions."

Notwithstanding these limitations, the TPB continues to be a powerful conceptual framework for comprehending and forecasting certain behaviours, especially in cases where attitudes, subjective standards, and perceived behavioural control have substantial impact on such conduct. Researchers often use this theory in conjunction with other theoretical frameworks and methodologies in order to get a more thorough comprehension of human behaviour.

Social Cognitive Theory (SCT)

Psychologist Albert Bandura introduced the SCT. This theory has seen notable advancements during its development and has substantially influenced the domains of psychology, education, and communication (Compeau et al., 1999). The SCT has a prominent position as one of the most significant theories in the arena of behaviour change. It has served as the foundational framework for several health behaviour interventions, including those aimed at smoking cessation, weight management, and other health-related behaviours. The primary purpose of developing models or theories such as the SCT and other behaviour theories was to provide explanations for variations seen across individuals. However, there is a growing need for explanatory theories that focus on understanding within-person behavioural variability. This need arises from advancements in technology that enable the collection of intense longitudinal data and the development of interventions based on these findings(Riley et al., 2016).

The social learning hypothesis was first developed by Albert Bandura during the 1960s. This theory places significant emphasis on the value of observational learning, which refers to the cognitive process of acquiring knowledge and skills through seeing and copying the behaviours of others. Bandura performed a series of investigations, one of which was the renowned Bobo doll experiment, in order to illustrate the phenomenon of observational learning, specifically in relation to aggressive behavior.

During the 1970s, Bandura augmented his theoretical framework by integrating the notions of self-regulation and self-control. The proposition suggests that humans are not only passive recipients of knowledge but actively engage in their own personal growth and development. As a result of this extension, the theory underwent a rebranding process, becoming known as the Social Cognitive Theory. This revised framework recognized the significance of cognitive processes, including attention, memory, and motivation, in the process of learning.

Bandura (1980s) established the notion of "self-efficacy," defined as an individual's conviction in their ability to successfully execute a certain job. "Self-efficacy" plays a vital role within the framework of SCT, exerting influence on an individual's motivation, behavior, and level of accomplishment. Bandura's research on self-efficacy has significantly influenced several fields, including education and health psychology. This work has been essential in comprehending and improving individuals' capabilities and drive to attain their objectives.

The integration of Self-Compassion Training (SCT) has been seen across several areas, including education, health, business, and media. This research has made Important discoveries regarding how individuals learn new information and alter their behavior. In contemporary times, the aforementioned theory has found practical application in several domains, including online education, social networking platforms, and digital modes of communication. The investigation of observational learning and self-efficacy in influencing human behavior has garnered considerable attention within these contexts.

Limitation of SCT

According to Thojampa and Sarnkhaowkhom (2019), one of the drawbacks of SCT is that it has found widespread application in the medical and nursing fields. According to Munro et al. (2007), the SCT has been critiqued for having a pretty comprehensive formulation, making it difficult to operationalize and evaluate the theory. In addition, some researchers who have utilized SCT as a theoretical foundation have been criticized for explaining behavioral data using only one or two concepts from the theory (Baranowski et al., 2002). These researchers have used SCT as a theoretical foundation.

Technology Acceptance Model (TAM)

One of the important information systems theories used to gauge consumers' adoption and usage of new technology is Davis's (1989) Technology Adoption Model (TAM). TAM is an expansion of Davis's TRA. Davis developed this technology acceptance

framework to forecast or assess future users' acceptance of information systems, i.e., predicting IS/IT adoption and diagnosing design flaws before implementing the plans. TAM claims that when users are introduced to modern technology, they choose when and how to use it based on various factors (Esmat Abdulmajid Wahdain & Mohamad Nazir Ahmad, 2015). TAM is an extension of TRA. Accordingly, this model aimed to offer an explanation for the factors that drive the adoption of computers among a diverse group of end-users in the field of IT/IS. This explanation is achieved by maintaining a balance between simplicity and theoretical reason.

The TAM effectively compares and contrasts the TRA and the TPB, offering valuable insights into these different frameworks. Multiple empirical investigations have repeatedly shown that the TAM reliably accounts for a considerable proportion of the variability, often around 40%, in individuals' intentions to use and actual use behaviour. Perceived utility (PU) and perceived ease of use (PEU) are two factors that the Technology Acceptance Model (TAM) suggests impact a person's behavioral intention to utilize a new technology or system. *"Perceived ease of use"* is the "degree to which a person believes using the system will require little effort." In contrast, *"perceived usefulness"* is the "degree to which a person believes that using innovation will improve their performance, make tasks more manageable, or provide other practical benefits." Users are more inclined to embrace new technology if they perceive it is designed with their needs in mind.

The effects of external factors (such as system characteristics, training, and the development process) on an individual's *"intention to use"* are mediated by PU and PEU. PEU influences perceived usefulness; a system that is easy to use can be more valuable. The construct of perceived usefulness has consistently shown a robust predictive relationship with use intentions in various empirical examinations of the TAM. The standardized regression coefficients associated with this relationship often converge around 0.6. It is crucial to understand the components that determine the construct of PU and how their relative relevance changes with increasing system experience, considering PU's fundamental role in forming use intentions. Perceived ease of use, the single factor in the TAM determining intention, has varied effects on intention across empirical research (Venkatesh & Davis, 1996).

According to Davis et al.(1989), to learn more about why people adopt or fail to reject computers, people's intentions were significantly impacted by their perceived usefulness. Moreover, intentions were impacted considerably by perceived ease of use, but this effect gradually diminished. This study's finding further concludes that the behavioural intentions toward technology usage were unaffected by subjective norms.

Extended Technology Acceptance Model 2 (TAM2)

To create a more comprehensive model for describing technology acceptance and usage, TAM2 expands on the foundation of TAM by adding new factors and concepts (Venkatesh and Davis, 2000). Its primary objective is to comprehend and forecast the manner in which users embrace and integrate novel technology or information systems (Venkatesh and Davis, 2000). The development of TAM2 aimed to enhance the comprehensiveness and robustness of the framework used to explain technology adoption and utilization. TAM2 proposes that perceived usefulness and behavioural intention are influenced by two more social influences, namely voluntariness and image, in addition to subjective norm (Ducey & Coovert, 2016).

TAM2 is a more comprehensive and sophisticated model than TAM as it considers several more variables. The extra components included in the model are categorized into two groups: "social influence processes" and "cognitive instrumental processes." The "social influence process" component includes "subjective norms," "voluntariness," and "image." In contrast, the "cognitive instrumental process" addresses variables such as "job relevance," "output quality," "result demonstrability," and "perceived ease of use." Numerous research studies have shown that the components of the "cognitive instrumental processes" and the "social influence processes" significantly impact users' acceptance of technology (Venkatesh and Davis, 2000; Zaineldeen et al., 2020).

The first added construct, "*subjective norm*," is a "person's perception that most people who are important to him think he should or should not perform the behaviour in question". This construct, via image and PU, was believed to directly and indirectly influence Intention (Venkatesh & Davis, 2000). Evidence for the direct influence of subjective norms on intention can be found in the idea that people may be persuaded to engage in particular behaviors based on the opinions of influential others, even if they do not personally agree with the behaviors or their results (Venkatesh & Davis, 2000). Mixed findings have been found in user acceptance study that looks at the linear impact of "subjective norm" on "intention." For instance, while Mathieson (1991) discovered no substantial impact of subjective norms on intention, Taylor, S., & Todd (1995) did discover that there was a momentous effect.

The second exogenous variable included in TAM2 was *"image"*. Image is Defined as "the degree to which use of an innovation is perceived to enhance one's status in one's social system" (Abbas & Michael, 2022). Based on the TAM2 findings, a significant positive correlation has been observed between image and subjective norm. Furthermore, TAM2 postulates a positive correlation between PU and image(Abbas & Michael, 2022). Thus, according to TAM2, the possibility of a good view of technological productivity may be raised by having a positive reputation among peers in the social group (Venkatesh & Davis, 2000). According to Venkatesh and Davis (2000), Job relevance is the third antecedent of perceived usefulness and has an interactive and direct impact on PU. "An individual's perception regarding the degree to which the target system is applicable to his or her job" is the definition of "job relevance."

Furthermore, several theories and models explaining technological uptake support the direct influence of employment relevance(Abbas & Michael, 2022). The fourth component included by the Technology Acceptance Model 2 (TAM2) is *"Output quality,"* which refers to the perceived quality of the technology's performance in completing a given job. Previous studies (Davis, Bagozzi & Warshaw, 1992 cited in Abbas & Michael, 2022) have established a direct and specific connection between output quality and perceived usefulness. Nonetheless, per the Technology Acceptance Model 2 (TAM2), output quality can augment the assessment of a technology's appropriateness for a certain activity, consequently culminating in a positive technological perception (Venkatesh & Davis, 2000).

"Result demonstrability" is the fifth independent variable proposed in TAM2. It is the "tangibility of the results of using the innovation" (Moore & Benbasat, 1991), cited in Abbas & Michael (2022). This component was included in the model in response to the claim that it may not be adopted if a user does not see the advantages of using modern technology (Venkatesh & Davis, 2000). According to the impact of outcome demonstrability, people's increased performance due to using technology should be visible, observable, and shareable. The Job Characteristic Model asserts that individuals are more motivated when they are aware of their work's outcomes.

To sum up, TAM2 expands upon the foundational TAM framework by including further factors and ideas, enhancing the depth and breadth of comprehension about adopting technology. The analysis considers not only the user's subjective impressions but also considers the influence of external and societal elements that may impact the individual's adoption and use of technology. TAM2 is a beneficial tool for academics and companies trying to study and enhance technology uptake and implementation.

Technology Acceptance Model 3 (TAM3)

Previous research has provided significant insight into the decision-making processes involved in adopting and utilizing information technology (IT) in the workplace. However, from an organizational perspective, the more crucial matter is how managers decide which actions to pursue in order to increase IT adoption and effectiveness (Venkatesh & Bala, 2008). Little study has been done on interventions that may be used to accelerate the adoption of new technologies (Abbas & Michael, 2022). Venkatesh & Bala (2008) reviewed a large body of past literature on TAM to fill the gap in the TAM and promote greater adoption and efficient use of IT and management decision-making, which resulted in the introduction of TAM3 (Raeisi, S., & Meng, 2016).

TAM3 states that *"perceived usefulness"* will be less affected by *"perceived ease of use"* and that "perceived usefulness" will not be considerably impacted by the factors that determine "perceived ease of use." Comparing TAM and TAM2 to TAM3, Venkatesh and Bala (2008) state that TAM3 is a larger nomological network. Moreover, Jaradat (2014) notes that the model is all-inclusive, taking into account the variables that impact both PU and PEU. The expanded theoretical framework of TAM3 suggests that behavioural intention predicts actual activity and that perceived utility and perceived ease of use, each with their own set of antecedents, form the basis of behavioural intention. The constructs incorporated in TAM3 are:

1. *"Computer Self-Efficacy*:" "An individual's assessment of his or her ability to perform desirable behaviours in specific situations". (Venkatesh & Bala, 2008)
2. *"Perception of External Control*:" "The extent to which a person thinks that technological and organizational resources are available to enable the system's control usage." (Venkatesh et al., 2003).
3. *"Computer Anxiety*:" "The extent to which a person hesitates or even becomes afraid when confronted with the prospect of employing technology." (Jaradat, 2014)
4. *"Computer Playfulness*:" "The degree of cognitive spontaneity in microcomputer interactions" (Venkatesh &Bala, 2008)

5. **"Perceived Enjoyment:"** The degree to which "the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use" (Raeisi, S., & Meng, 2016).
6. **"Objective Usability**:" A "comparison of systems based on the actual level (rather than perceptions) of effort required to complete specific tasks" (Venkatesh, 2000, pp. 350–351) as cited in Raeisi, S., & Meng (2016).

Limitations of TAM and its extension

Over time, TAM and its expansions have been subject to many discussions over restrictions. Previous research has criticized the simplicity of TAM and ignores factors that precede technology adoption, such as PU and PEU (Abbas & Michael, 2022). The first limitation reported on TAM is that the model obscured the emphasis on how technology use affects performance and highlighted the variables that lead individuals to use technology. TAM research subtly implies that performance improves with more technology use. However, this is not the case (Goodhue, 2007). The second blind spot is when people overlook the factors contributing to a system's effectiveness, namely its design and fit for the task (Goodhue, 2007).

Additionally, extended technology adoption models have drawbacks. For instance, TAM2 received flak for being created especially for the organizational setting (Venkatesh, Thong & Xu, 2012). Methodological difficulties in the TAM2 framework imposed additional limits. Several components of TAM extensions, such as "job relevance" and "output quality," were assessed using just two items. Furthermore, it is important to acknowledge that the self-reported measure of use intention behaviour and the possibility for common method bias are constraints often encountered by TAM-based models. The TAM 2 model has been subject to criticism due to its perceived incompleteness in terms of its failure to identify the components that influence perceived ease of use, as noted by Zaineldeen et al. (2020). Moreover, TAM2's weaknesses include the inadequate attention given to exogenous variables, which include experience, enabling situations, or reported satisfaction, as well as the low variation in exploratory investigations.

PC Utilisation Model (PCUM)

Thompson, Higgins, and Howell (1991) developed the PC Utilization Model (PCUM) to establish PC utilization (A. Rahman et al., 2021). Triandis' (1971) model of individual behaviours served as the basis for this model. According to the Individual Behaviors Model, attitudes, social norms, behaviours, and expected outcomes all play a significant role in a person's behaviour. Attitudes encompass cognitive, affective, and behavioural components(Jen et al., 2009). Contrary to the TRA and TPB, Triandis (1980) distinguishes between attitudes' emotive and cognitive aspects. A belief is a part of the cognitive aspect of an attitude. "A person's behaviour is influenced by their attitudes, habits, and beliefs about social norms and what they should do, as well as by the expected outcomes of their actions"(Thompson et al., 1991).

Later, Thompson et al. (1991) used Triandis's model to estimate PC consumption by refining and adapting it for information systems contexts [(Venkatesh et al., 2003)]. Because of its features, the model can forecast an individual's acceptance and use of a wide range of information technologies. They noted that individuals' attitudes toward PC use, social norms, expected consequences, behaviours, and facilitating conditions can influence PC usage. They proposed that social factors, perceived consequences, effects, and facilitating conditions directly influence behaviour. The present model does not include the element of intentionality since it focuses only on the observed use patterns of personal computers (PCs) rather than considering the intended usage. The model incorporates the complexity and occupational appropriateness as explanatory factors for the perception of consequences. This paradigm posits the assumption that individuals possess the requisite expertise in using personal computers, namely professionals or administrators who willingly utilize PCs for their work-related tasks. In 1994, the authors furthered their investigation on the importance of expertise in personal computer use. According to Momani & Jamous (2017), it was postulated that experience has the potential to have direct, indirect, and moderating influences on behaviour. The following are the primary constructs in the improved model:

1. **"Job-fit"** is "the extent to which an individual believes that using {a technology} can enhance the performance of his or her job."
2. **"Complexity"** is "the degree to which an innovation is perceived as relatively difficult to understand and use."
3. **"Long-term Consequences"** is "the outcomes that have a pay-off in the future."
4. **"Affect towards Use"** is "the feelings of joy, elation, pleasure, depression, disgust, displeasure, or hate associated by an individual with a particular act."
5. **"Social Factors"** is "an individual's internalization of the reference group subjective culture and specific interpersonal agreements that the individual has made with others, in specific social institutions."

6. ***"Facilitating Conditions"*** is "the provision of support for users of PCs may be one type of facilitating condition that can influence system utilization."

Limitations PC Utilisation Model (MPCU)

The PC Utilization Model (MPCU) is a conceptual framework used for comprehending and examining the utilization patterns of personal computers within organizational settings. Similar to other models, it has a limitation. It's limited in scope and methodology, focuses on hardware, and has limited predictive power. The MPCU has been criticized for its lack of interaction with other competitor models, its limited industry cross-application, and these issues. The theory successfully explains the behaviour of computer users, but it does not explain the situation's complexities or the indirect influence on the apparent short-term results(Momani & Jamous, 2017).

To overcome these constraints, researchers may need to supplement MPCU with additional models, frameworks, and procedures tailored to their unique requirements. Furthermore, researchers should consider qualitative research methodologies, including surveys, interviews, and observations, to comprehend better user behaviours, attitudes, and motives about using personal computers within their particular settings.

Combined Technology Acceptance Model (TAM) and Theory of Planned Behaviour (TPB) (C-TAM-TPB)

The Combined Technology Acceptance Model and Theory of Planned Behaviour (C-TAM-TPB) is a theoretical framework that combines elements from two well-established models in psychology. It was initially proposed by Taylor and Todd (1995) as a combination of TAM and TPB. This integration aims to offer a more thorough comprehension of user attitudes and behaviours around the adoption and utilization of technology. The TPB variables of "attitude," "subjective norm," and "perceived control" are contrasted with the TAM constructs of perceived usefulness and ease of use.

The C-TAM-TPB model asserts the favourable impacts of perceived ease of use on perceived benefit. Both perceived ease of use and perceived benefit favourably impact attitude. Therefore, perceptions of behaviour control, attitudes, and subjective standards all favourably impact use habits(Momani & Jamous, 2017). Integrating the C-TAM-TPB model resulted in a more all-encompassing framework that enhances our comprehension of technology adoption and use. The acknowledgment is made that individuals' attitudes and intentions towards technology are influenced not just by the perceived utility and convenience of use, as outlined in the TAM, but also by their wider attitudes, subjective norms, and perceived behavioral control, as outlined in the TPB.

The use of C-TAM-TPB in practical settings enables the evaluation and anticipation of user behavior pertaining to the adoption and utilization of technology. By conducting evaluations, researchers and practitioners may assess the many elements that impact users' intents, enabling them to make well-informed judgments on the promotion and facilitation of technology adoption. This comprehensive paradigm facilitates comprehension of the technical dimensions and the social and psychological determinants that impact the acceptance and use of technology.

Limitations of the C-TAM-TPB model

The benefits of TAM and TPB are included in the combined model; however, the individual behaviour planning aspect is omitted. While helpful, gathering the "subjective norm" from TPB and the usability from TAM is not a perfect solution (Momani & Jamous, 2017). It still doesn't get attention due to usage-related worry or danger. Jen et al. (2009) found that more intricate models, like C-TAM-TPB, don't always better explain the adoption of new technology. Conversely, the Technology Acceptance Model simultaneously benefits from parsimony and richness. Furthermore, planned behaviours have more explanatory power than C-TAM-TPB and the technology acceptance model (Chih Chung, 2013).

It is recommended that researchers and organizations use the C-TAM-TPB model in conjunction with other models or qualitative research approaches to circumvent the limitations outlined. This approach will provide a more thorough comprehension of technology adoption and behaviour. Furthermore, it is essential for researchers to possess a comprehensive understanding of the assumptions and limits inherent in the model and to use discretion when using it within a suitable context.

The Motivational Model (MM)

Davis et al. (1992) examined the adoption and usage of information technology and proposed the motivating theory. The two most crucial MM model elements are thought to be intrinsic and extrinsic motivation. According to the Motivation Model, both intrinsic and external factors influence people's behaviour. Davis et al. (1992) defined "extrinsic motivation" as "the perception that users will want to perform an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, promotions or pay." "Intrinsic motivation" is defined as "the perception that users will want to perform an activity for no apparent reinforcement other than the process of performing the activity" (Venkatesh et al., 2003).

Igbaria et al. (1995) research revealed that extrinsic incentives more influence people's behaviour and that use is impacted by perceived ease of use, usefulness, and pleasure. In addition, it was demonstrated that they fully mediated the connection between the usage of computers and a person's perception of how easy it is to use. The effect of perceived utility and entertainment on computer usage intentions and actual use in the workplace was examined by Davis et al. (1992). According to this research, use intentions were significantly influenced by both pleasure and perceived usefulness. The study also emphasizes how pleasure and usefulness might be positively combined. The results imply that both usefulness and pleasure influence intentions and behaviour related to computer use.

In their study, Igbaria et al. (1996) conducted a survey among professionals and managers employed in North American organizations with the aim of comprehending the determinants that drive the use of microcomputers. The research put forward a motivational framework that included perceived utility, perceived fun/enjoyment, and social pressure as determinants impacting the use of microcomputers. The findings indicate that professionals and managers are primarily motivated to enhance their utilization of microcomputers due to their perceived utility. The function of perceived complexity is crucial in establishing a connection between abilities, organizational support, and organizational utilization with motivating factors.

Limitations of the Motivation Model (MM)

MM, a theoretical framework, mainly applies to the domains of motivation, learning, and healthcare. However, its effectiveness diminishes when used in the context of technological usage and adoption. In research by Igbaria et al. (1996), the MM only described 28% of the data while being proven to be helpful in explaining new technology adoption and usage. Furthermore, 62% of the change in behaviour intention was discovered by Davis et al. (1992). These results suggested that further investigation was necessary to find other elements that would enhance the explanation of the variation in behaviour intention.

Unified Theory of Acceptance and Use of Technology (UTAUT)

The UTAUT is a widely recognized model researchers use to understand consumers' adoption intentions and usage behavior toward new information communication technology (Najib & Karima, 2022). The model was first put forth by Venkatesh et al. with the intention of offering a thorough framework for analyzing the variables affecting people's adoption and usage of technology. To provide a comprehensive explanation of how users embrace new technologies, the UTAUT model incorporates several preexisting theories and models. These include the TRA, the TAM, and the DOI. To explain individuals' intentions to utilize technology, the UTAUT model takes into account several aspects, including "performance expectancy," "effort expectancy," "social influence," and "facilitating conditions" (Borondo et al., 2020).

According to the UTAUT theoretical paradigm, a person's behavioural intention determines whether or not they use technology. The direct impact of four important factors—performance expectations, effort expectations, social influence, and enabling circumstances—determines the perceived likelihood of technology adoption. Age, gender, experience, and voluntariness of usage all moderate the impact of the predictors (Venkatesh et al., 2003; Abbas & Michael, 2022). The moderating effects of "age," "gender," "experience," and "voluntariness" of usage define the strength of predictors on "intention." "Age" modifies the influence of all four elements. "Gender" affects relationships between social influence, performance expectancy, and effort expectation. "Experience" modifies the strength of the relationships between social influence, favourable circumstances, and effort expectations. Venkatesh et al. (2003) state that voluntary usage only changes how social impact and behavioural intention are related.

Venkatesh et al. reviewed users' acceptance literature to assess eight prominent models of technology adoption and use, namely the "TRA)," the "TAM)," the "MM," the "TPB," "C-TAM-TPB," "MPCU," "DOI," and "SCT." This review's primary goals

are to evaluate the status of the field's understanding of how individuals embrace technology and to pinpoint the parallels and divergences among the eight publications under consideration.

An empirical comparison of the eight models and their extensions was also carried out to develop a unified model that incorporates components from all eight models and empirically validate it. Eight different models accounted for between 17 and 53 per cent of the variation in users' intent to utilize information technology, based on data collected over six months with three points of assessment from four different firms. After that, a comprehensive model was developed, known as the UTAUT, which included up to four moderators of essential interactions in addition to the four main constructs that determine intention and use. The same data was then used to evaluate UTAUT, and the results showed that it performed better than the eight separate models (adjusted R2 of 69%). Then, using data from two more companies, UTAUT was validated with comparable outcomes (adjusted R2 of 70%). Thus, UTAUT offers managers a helpful tool for evaluating the chances of new technology introductions succeeding and aids in their comprehension of the factors that influence acceptance.

This validation allows managers to proactively design interventions (such as marketing campaigns) aimed at users who might be less likely to embrace and utilize new technologies. Additionally, the article offers several suggestions for further research, such as strengthening the comprehension of the dynamic impacts examined here, improving the assessment of the fundamental constructs used in UTAUT, and comprehending the consequences of new technology usage on organizations (Venkatesh et al., 2003).

Unified Theory of Acceptance and Use of Technology Two (UTAUT2)

A well-known theoretical framework in the realm of technology adoption and acceptance is the UTAUT. UTAUT held in high regard and is quite well known. Venkatesh et al. (2003) and Abbas & Michael (2022) describe how the original UTAUT paradigm was developed to forecast and explain technology adoption in an organizational environment, even if it was later evaluated in non-organizational contexts. There was insufficient evidence in the literature to support a user behavioural model that would account for consumers' rather than workers' technology usage. In order to examine technology adoption and utilization in a substantially transformed context, Venkatesh et al. expanded the UTAUT in 2012. The new extended model is known as the unified theory of acceptance and application of technology two (UTAUT2). Four primary approaches served as the foundation for the model's adaptations: a) adapting the model to new situations, b) changing the endogenous variables, c) adding attitudinal antecedents, and d) looking at different moderating factors (Abbas & Michael, 2022).

In UTAUT 2, three new exogenous factors that affect people's use of technology—hedonic motivation, cost/perceived value, and habit—as well as three mediating variables—gender, experience, and age—were presented. "Hedonic motivation" is defined "as the fun or pleasure derived from using technology, and it has been shown to play an important role in determining technology acceptance and use"(Venkatesh et al., 2012). Previous research in the fields of marketing and information systems (IS) has shown that consumer technology usage is strongly predicted by the perceived hedonic nature of the outcome, such as perceived pleasure. These findings have provided a basis for including hedonic construct in the study framework (Abbas & Michael, 2022).

The factor's relative relevance when considering consumer product use instead of technology utilization in an organizational setting justified the inclusion of cost in the new model. Consumers often face the financial expense of such usage, but workers do not, which is a significant distinction between a consumer use setting and the organizational use context where UTAUT was established. The cost and pricing structure may substantially impact customers' usage of new technology (Venkatesh et al., 2012). "Price value" is defined as "consumers' trade-off between the perceived benefits of the applications and the monetary cost for using them" (Venkatesh et al., 2012).

The third exogenous construct that is included in UTAUT2 is known as "habit**,**" and it is described as "the extent to which people tend to perform behaviours automatically" (Venkatesh, Thong, and Xu, 2012; Abbas & Michael, 2022)). It was proposed that behaviour intention, via habit, directly and indirectly impacted actual usage. However, the impact of either route depends on how much people embrace and use technology via routine behaviour (Venkatesh, Thong, & Xu, 2012). Individual factors such as age, gender, and experience may impact how these dimensions influence behavioural intention and technology use. The added variables described in UTAUT2 resulted in a substantial increase in the variance elucidated in behavioural Intention (from 56% to 74%) and technology use (from 56% to 74%) (40%to 52%) when compared to UTAUT (Venkatesh et al., 2012).

Limitations of UTAUT and Its Extension

A comprehensive method for assessing technology acceptance and usage is the UTAUT (Venkatesh et al., 2003; Venkatesh et al., 2007). Even yet, there are theoretical and methodological issues with UTAUT that have not been resolved in subsequent research despite the model's rigour (Venkatesh et al., 2003; Venkatesh et al., 2007). UTAUT faced criticism for its inability to characterize the intention of behaviour in various situations accurately. More study was conducted to broaden the model's scope to incorporate additional behavioral drivers such as perceived risk, innovativeness, trust, computer self-efficacy, and perceived threats due to the model's poor external validity (Martins et al., 2014). In addition, additional moderating factors like income, geographical location, culture, and technological preparedness were included in the model (Borrero et al., 2014). However, certain crucial elements like computer self-efficacy remain under study (Abbas & Michael, 2022).

Dwivedi et al.(Dwivedi et al., 2019) expressed worry about the widespread use of UTAUT, noting that most research in the IS context mentions the original UTAUT publication without using the model. These unexpected results lead to the hypothesis that, given overrated citations relative to the theory's true implications, UTAUT may not be as robust as it was previously thought to be (Dwivedi et al., 2019; Abbas & Michael, 2022). Employing a mix of meta-analysis and structural equation modeling (MASEM) methodologies, Dwivedi et al. examined the UTAUT model. They showed that attitude significantly influenced behavioural intents and use behaviors. Additionally, it had a direct impact on usage patterns and served as a partial mediator of the impacts of external variables on behavioural intentions (Dwivedi et al., 2019).

Creating the scales used to test the fundamental components is the primary methodological constraint of UTAUT. The research used each scale's highest loading elements for the final measurement development. Although the research (Hevner et al., 2004) supported this strategy, there was discussion as to whether it would be beneficial to verify the measures or even create new ones in order to rule out any possible problems with content validity (Venkatesh et al., 2003). Furthermore, the intention to use and use behaviour scales was taken from earlier research (e.g., Davis, 1989); however, future studies should design and test other measures (Venkatesh et al., 2003).

3. Conclusion

The adoption of technology has undergone substantial evolution throughout history, marked by the emergence and increasing acceptance of theories such as the Diffusion of Innovations (DOI), Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), and TAM2. The field of Innovation and Diffusion of Technology (DOI) primarily examines the outcomes and determinants of innovative processes, although it does not sufficiently address the influence of attitudes on the acceptance or rejection of technologies. However, the TRA lacks a specific design for behaviors or associated technology, which therefore leads to constraints in accurately forecasting certain behaviors and effectively addressing elements such as action, target, context, and prediction time.

The Technology Acceptance Model (TAM) and its subsequent version, TAM2, primarily emphasize the fundamental elements involved in technology adoption. However, these models do not include supplementary components that are crucial in encouraging adoption, such as integration, flexibility, information completeness, and information currency. Notwithstanding these constraints, these theories have shown their practicality in many settings, showcasing their efficacy in facilitating technology adoption in different settings or environments.

The MM model, TPB, TAM, and MPCU theories provide valuable perspectives on user behaviour; nonetheless, they exhibit limitations in comprehending individual processes and their influence on behavioural intention and motivation. The efficacy of the MM model is constrained when it comes to the use and adoption of technology, and the amalgamation of TAM and TPB fails to include planning aspects.

The UTAUT framework and its extension UTAUT2 have several limitations despite its significant value in facilitating the understanding of technology adoption. To comprehensively elucidate the challenges associated with adopting technology in various settings, academics and practitioners using or extending the model need to acknowledge these constraints and consider contextual factors.

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