

# Towards a UTAUT-Based Model for Studying the Integrating Physical and Virtual Identity Access Management Systems in E-Government Domain

Sara Jeza Alotaibi

Web and Internet Science, ECS  
University of Southampton  
Southampton, UK

Mike Wald

Web and Internet Science, ECS  
University of Southampton  
Southampton, UK

**Abstract**—The success of any technology is not only dependent on the number of good reviews or great revenues, but also on the factors that can help one comprehend the level of acceptance that can be expected from any technology. This paper discusses the progress of acceptance theories and models, which have led to the development of an effective model that can be used to calculate the level of predicting, explaining, and understanding individuals' acceptance for a new proposed system, called Ubiquitous Identity Access Management System (UbIAMS), that provides interoperability between the physical and virtual spaces, alongside to three perspectives: Security, which includes identity; User Experience, comprising Usability; and Acceptability, containing Accessibility. Existing research in this area tend to focus on one of these research perspectives. However, there is little evidence that researchers have approached the issue of an overlap and conflict between these three research perspectives with the intent of building a cohesive understanding of integrating physical and virtual Identity Access Management Systems (IAMSs) in e-government domain and the relationships that exist between the different dimensions and components. Consequently, this paper has developed a conceptual Unified Theory of Acceptance and Use of Technology (UTAUT)-based model for integrating physical and virtual IAMSs.

**Keywords-** IAMS; UbIAMS; UTAUT; Security; User Experience; Acceptability.

## I. INTRODUCTION

The widespread adoption and delivery of services on the internet has created the issue of maintaining multiple identities; a user previously compelled to maintain numerous physical identities has been further burdened in remembering virtual identities. The virtual identities may be based on specific login credentials, such as username, password, and PIN(s). The ordeal of remembering various different login credentials proves tedious for users since the lack of user needs amongst them may pose a major security threat [24]. However, multiple physical identities also prove to be difficult to maintain since different sources require the presence of different smart cards, mobile devices or other proofs of identity. The increasing number of proof of identity makes it stressful for users to perform operations physically, as well as virtually [24]; thus, there is the pressing need to integrate virtual and physical services on a single platform so as to ensure greater

convenience for users who have the right to have multiple IDs or a single ID within physical and virtual services [2].

However, the integration of physical and virtual services proves to be a daunting task. One of the challenges in terms of the integration of such services is gaining the level of trust of users, and making them confident regarding the level of security to be provided in the proposed usage of technology. Arora states that achieving interoperability is one of the most crucial challenges to be faced by Belgian Personal Identity Card "BELPIC" [3]. Markedly, difficulties have been faced in achieving interoperability between administrative organisations in the country, including federal, municipal, and regional units. Another challenge that becomes apparent is devising a system that focuses on the limitations of the existing systems. The Italian government faced a number of other interoperability issues regarding the development of a platform where all the services would be able to collaborate and become linked with each other. The centralised platform was known to be supported by only a single type of middleware—i.e. Microsoft's Internet Explorer—whereas all other platforms could not be configured to support different units within the country [3]. Undoubtedly, this was a crucial interoperability issue since the users of other browsing software were not able to utilise the integrated virtual and physical services. Therefore, the success of any IAMS is not only dependent on the number of good theories, but also on further experiments in order to ascertain users' behaviours and outcomes with the use of one of the existing acceptance models for understanding users' behaviours towards integrated physical and virtual IAMSs especially in E-Government.

This paper is organised in the following manner: firstly, a background of the relevant acceptance theories and models are clarified in *Section 2*; *Section 3* shows some applications of acceptance models in the E-Government; *Section 4* proposes the conceptual UTAUT-based model for integrating physical and virtual IAMSs; finally, *Section 5* ends the paper with a summary and suggestions for future work.

## II. ACCEPTANCE THEORIES AND MODELS

The concept of evaluating acceptance of any technology was considered to be an innovative model since it brought forward aspects that had never been previously addressed and focuses on the individual acceptance of technology [8]. The

following describes the important acceptance theories and models that have evolved over the years, and examined individual acceptance:

#### A. Theory of Reasoned Action (TRA)

The first framework utilised with the aim of explaining technology acceptance was that devised in the social psychology arena, which is a work that was carried out during 1918–1970, at which time scientists were making attempts to explain individuals' behaviours through attitude impact [4]. Their efforts resulted in contrasting explanations in terms of attitude and behaviour, with the former found to have either an indirect or direct impact on behaviour, and also being unidimensional or multidimensional in nature. In this regard, the work of Fishbein and Ajzen was also conducted following a study programme initiated during the late 1950s [4], with the scholars' effort aiming towards predicting behaviours in the context of applied and laboratory environments. Markedly, their approach acted as an amalgamation of numerous theories and study topics relating to attitudes, such as balance theory, expectancy-value theories, learning theories, theories of attribution, and theory of cognitive dissonance. Markedly, in 1975, Ajzen and Fishbein introduced the TRA framework, which had the objective to develop a theory able to estimate, describe and impact human behaviours [4]. The theory can be explained by the model in Fig. 1.

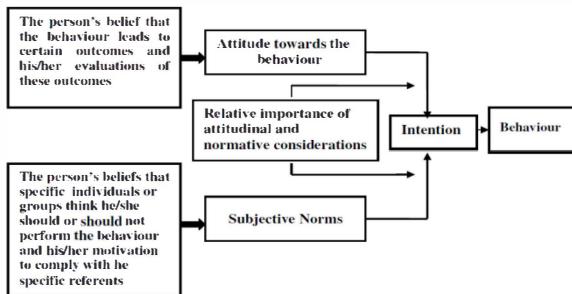


Figure 1. Factors determining a person's behaviour [4]

It has been acknowledged by Ajzen that the most apparent of the theory restrictions stems from the assumption that behaviours are completely conscious. Accordingly, for this task, there are two conditions: there must be the examination of intentions and perceptions of control in relation to certain behaviours and contexts; and perceptions of control and intentions must be recognised as stable during the period between behaviour observation and assessment [5]. In other words, only those behaviours consciously considered prior to being performed can be explained through the use of this theory.

#### B. Theory of Planned Behaviour (TPB)

Owing to the various TRA-related limitations, the TPB framework was introduced by Ajzen, with 'perceived behaviour control' (PBC) included as a new construct [5]. Importantly, PBC is made up of those perceptions held by an individual that a certain behaviour can be carried out. With this in mind, it may be stated that there are keen similarities between this model and the TRA, with the PBC recognised as the third antecedent of the BI. When considering the TPB

model, as shown in Fig. 2, actual human behaviour variance may be rationalised and estimated when considering two factors in unison, namely our perceptions of our own behavioural control, and our intentions.

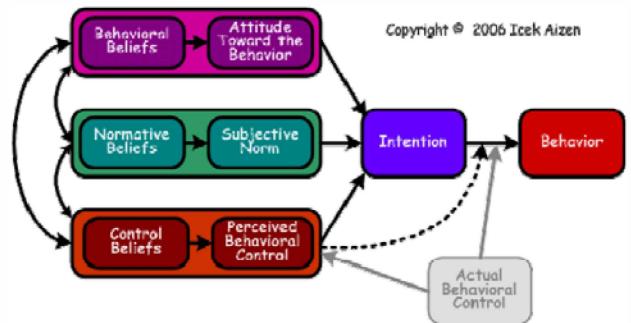


Figure 2.Theory of Planned Behaviour [5]

The TPB and TRA models have been criticised by Taylor and Todd, who emphasise that both frameworks require individuals to be motivated to conduct certain actions [6]. However, it remains that such a postulation may be challenging when considering consumer adoption behaviours, as well as the assumption of an identical belief structure amongst individuals carrying out a behaviour [6]. Moreover, TPB introduces PBC in an attempt to provide some response to the subconscious aspect of behaviours, with the belief behind the PBC combined with the aim of creating a measure for such. Such amalgamation has been criticised for failing to establish specific factors that may be able to estimate behaviours and any biases created as a result. With this in mind, the decomposed TPB was introduced by Taylor and Todd with the aim of delivering an improved understanding of behavior [6].

#### C. Decomposed Theory of Planned Behaviour (DTPB)

As a follow-up to the TPB framework—which is known to be an enhancement of the TRA model—Taylor and Todd devised a framework whereby the TPB constructs were broken down into individual elements [6]. The subsequent model, the decomposed TPB (DTPB) is an expansion of the TPB. The constructs contained within the TPB and their decomposition can be seen in Fig. 3 which carried out previously that identified a consistent link between the three innovation characteristics, i.e. compatibility, complexity, and relative advantage, and the implementation of decisions generally and IT-use in particular [6].

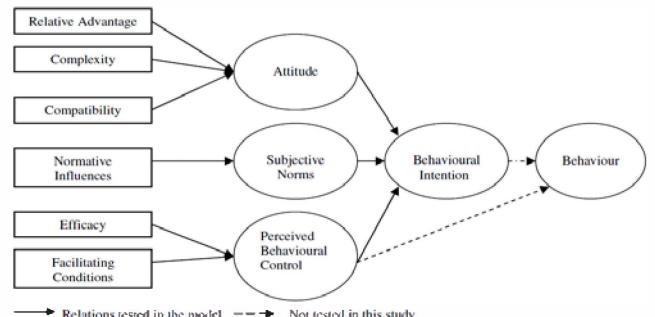


Figure 3. Theory of Planned Behaviour with beliefs decomposed [6]

Even though DTPB is a far more complicated model than TPB, DTPB has been recommended as a measure able to

predict certain behavioural aspects, which may prove useful to managers seeking to implement system design- and/or marketing strategy-related changes [6].

#### D. Technology Acceptance Model (TAM)

In a further extension of TRA, Venkatesh stated that TAM was initially devised from the TRA [7], and was proposed by Davis [9]. The TAM was based on the need to explain the behaviour of computer users [7]. TAM is the most commonly applied model for evaluating the level of acceptance and usage by a user. TAM is mainly based on two aspects that are directed towards evaluating the intention of a user to use a certain system or technology: perceived ease of use and perceived usefulness. Venkatesh further explained the TAM model, stating that there exists a simple relation between these two factors [7]: perceived usefulness will be influenced by perceived ease of usage since an easier technology will prove to be more useful for the user as shown in Fig. 4.

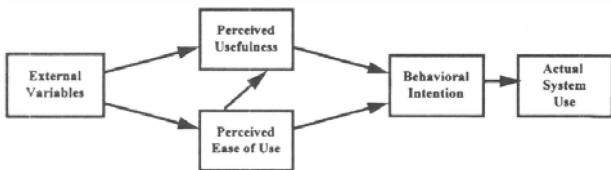


Figure 4. TAM Model [11]

However, Porter and Donthu state that this model was devoid of reflecting the demographic differences amongst users, and sought to measure the level of acceptance whilst assuming constant profiles related to gender, age, etc. Besides, the TAM failed to address some of the perceptions of barriers of usage in the context of computer technology [11].

#### E. Diffusion of Innovations Theory (DIT)

DIT is a framework that seeks to explain the process via which technological innovations are implemented by users. With this in mind, the term ‘innovation’ is described by Rogers as, ‘an idea, practice, or object perceived as new by an individual or other unit of adoption’ [12]. Moreover, it is highlighted that the concept of ‘diffusion’ may be described as the approach through which innovation is communicated via various channels over time and amongst a number of individuals within society. Accordingly, it can then be stated that Innovation Diffusion Theory places emphasis on describing the way in which new concepts and ideas achieve large-scale implementation. Furthermore, IDT takes into account a number of attributes link with technological innovations and which may impact their rate of implementation such as Relative advantage, Compatibility, Complexity, Trialability and Observability [12]. However, IDT fails to deliver detailed interaction-based explanations in terms of innovation and the way in which it is adapted and reinvented.

#### F. The Social Cognitive Theory (SCT)

The SCT is mainly linked with Bandura, and is founded on the all-encompassing idea that cognitive, environmental and personal factors, in addition to behaviour, are determined mutually [13]. This aspect of Bandura’s behavioural framework implies that the behaviour of an individual is

shaped by not only personal factors, but also environmental factors.

Researches utilising SCT with the aim of justifying IT-use-related behaviours have placed emphasis on the way in which cognitive factors behaviour in regard to individual behaviour [13]. With this in mind, two different sets of expectations are focused on by Compeau et al. as being the main cognitive factors impacting behaviour: expected outcomes, which suggest that individuals demonstrate a greater tendency to carry out behaviours with perceived beneficial outcomes; and self-efficacy, which considers the beliefs held by an individual in regard to their capacity to carry out certain behaviours. Importantly, SCT provides contribution in terms of the verification that computer-related self-efficacy and outcome expectations are essential aspects in the utilisation of IT [13].

#### G. The Motivational Model (MM)

The MM is believed to be useful in explaining behaviours in a number of different circumstances and environments, positing that individual behaviours are essentially based on two pivotal constructs: extrinsic and intrinsic motivation [10]. Extrinsic motivation was measured in regard to perceived usefulness, whilst intrinsic motivation was measured in regard to the degree of user enjoyment derived from IT use. With this in mind, the MM of technology acceptance was tested by Davis et al., who found both intrinsic and extrinsic motivation to be key factors in the intention to carry out a behaviour in the context of technology utilisation. Such results emphasised that the intention of individuals to utilise computers within a professional environment is influenced mainly by the way in which they view the usefulness of computers and how they can improve their overall job performance, as well as what enjoyment they derive from such use. Moreover, it was also found that usefulness has a significant impact on behavioural intention, with the subsequent impact of enjoyment on behavioural intention found to be profound; nevertheless, it was much weaker than the overall usefulness effect. In other words, enhancing the overall enjoyability of a system is recognised as similarly improving the overall acceptance of useful systems, although there is less of an effect concerning the acceptance of useless systems [10].

#### H. The Model of PC Utilisation (MPCU)

Motivated by a dearth of agreement amongst various fields in terms of defining the link between attitude, values, and other behavioural inclinations to behave or act, a model was introduced by Triandis with the aim of describing the way in which behaviours are seen, as well as what variables encourage human behaviours [14]. The model comprises a number of both general and abstract variables, ensuring relevance regardless of culture. Moreover, the concept of behaviour is described by the scholar as having objective consequences that are interpreted within individuals, subsequently inducing in them feelings of reinforcement. In addition, Triandis argues that the perceived consequences associated with behaviours are reinforced in two main ways, namely: through changing the behaviour’s associated perceived probabilities; and changing the value associated with behaviour’s perceived probabilities.

## I. Unified Theory of Acceptance and Use of Technology (UTAUT)

Based on the reviewing and testing of the previous eight models related to IT acceptance, as shown in Table I, Venkatesh developed UTAUT, which was developed by comparing the effectiveness of these eight theoretical models in four different industries' IT systems [8].

TABLE I. DETERMINANTS OF BEHAVIOUR IN ACCEPTANCE MODELS

Model	Determinants of Behaviour
TRA	Attitudes towards the behaviour+ social influences [4-5].
TPB	Attitude towards behaviour+ subject norms + PBC [5-6].
DTPB	Attitude towards behaviour (compatibility, complexity, and relative advantage)+ subject norms + PBC (Effecicy, and facilitating conditions) [6].
TAM	Perceived Usefulness +Perceived Ease Of Use [7], [11].
DOI	Innovation attributes + innovators' characteristics [12].
SCT	Self-Efficacy + outcome expectations + affect [13].
MM	Intrinsic motivation (enjoyment, and fun) +extrinsic motivation (perceived usefulness) [10].
MPCU	Beliefs + affect+ social norms+ perceived consequences+ habit+ facilitating conditions [14].
UTAUT	Effort expectancy + performance expectancy+ social influence+ facilitating conditions [8].

This comprises an extensive range of factors that are proposed to be taken into consideration in the process of evaluating the level of acceptance for a technology [8]. In this regard, there are four significant constructs for determinants of user acceptance and user behaviour [8]:

- Performance expectancy: 'The degree to which an individual believes that the use of the system will help him or her to attain gains in job performance'.
- Effort expectancy: 'Degree of ease associated with the use of the system'.
- Social influence: 'The degree to which an individual perceives that others believe he or she should use the new system'.
- Facilitating conditions: 'The degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system'.

As can be seen in Fig. 5, there is a causal link between performance expectancy, effort expectancy and social influence, which are the determinants of behavioural intention. Furthermore, it is recognised that behavioural intentions and facilitating conditions are determinants of utilisation-associated behaviours. Importantly, a number of other variables moderate, which include voluntariness, experience, gender, and age [8].

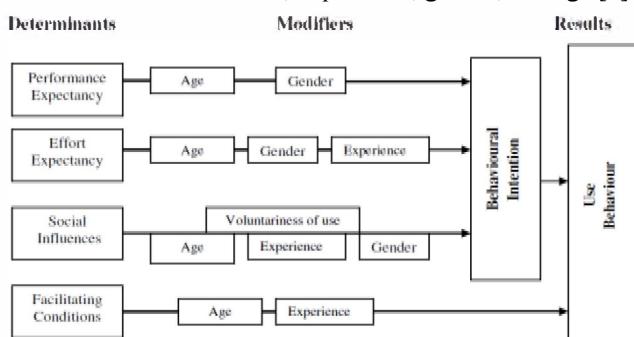


Figure 5. UTAUT attributes [8]

## III. USING ACCEPTANCE MODELS IN E-GOVERNMENT

The wide acceptance of acceptance models and theories have made their mark in different domains in the world of computing. These models and theories have even made its way in e-government solutions and services. For example, Mauritian e-government services were able to evaluate the level of adoption of e-government services by using the TAM and UTAUT variables [15]. However, in Romanian e-government portal, they used TAM more than UTAUT since the authors found the TAM variables (Perceived ease of use and perceived usefulness) to be directly correlated to the actual usage of the technology [16]; however, UTAUT was not used to an extensive level by the respective government agency since the model is most suitable in the introduction of new technology in an organization.

Another research proposed a new approach for evaluation of E-government services of health and education [17]. The sectors that were considered for this study included public, as well as private ones. This research also revealed that private sector tends to make use of TAM more than the public offices [17]. Besides, the e-government services in Tehran were evaluated on the basis of TAM's variables and approximately 350 responses were received that were tested against the hypothesis developed upon the variables in the TAM [26].

Al-adawi proposed a model to assist e-government to understand the level of acceptance that can be expected from their users [18]. It aims to identify the drivers and consequences of the adoption of e-government processes by the users. The author divided this model in two main categories; getting information from e-government sources and conducting transactions through them. It is communicated by the authors that the user is not required to give any personal information or details if he requests the acquisition of information from government agencies, but the user should be able to prove his identity if he wishes to access some e-government service.

## IV. PROPOSED MODEL AND HYPOTHESIS DEVELOPMENT

Among the different types of technology acceptance models, UTAUT is considered to be the most appropriate one for the respective research study because this theory reviews and synthesises the major theories in the user acceptance of information technology. Venkatesh et al. developed this theory with the objective to address the need for a unifying perspective: for example, the authors cite diverse theories from information systems, psychology, and sociology that can explain over 40% of variance in individual intention to use technology, although no unifying theory has yet been established [8]. Besides, the UTAUT has been developed by testing and integrating eight different models in regard to information and communication technology use. Such models are: TRA, TPB, DTPB, TAM, DOI, SCT, MM, and MPCU [8].

While many studies have utilized the technology acceptance models in investigating various systems' adoption in different contexts, very few have utilized the UTAUT model. This research utilizes the UTAUT model and proposes an extension to the model that integrates a construct, which complements the IAMS framework that includes the themes for chosen attributes that have been categorised with respect to

Security, Acceptability, and User experience perspectives [1], [25]. This study adopts the IAMS framework's perspectives as external variables to serve as direct determinants of intention and user behaviour in the original UTAUT model, as shown in Fig. 6.

The components of security and identity in the IAMS framework are to be included in the model as direct variables since they are not present in the original UTAUT model. The presence of items relating to security and identity will increase the level of trust and privacy for users [20]. Nevertheless, the variables of performance expectancy and effort expectancy are dual in nature since they possess qualities of both the domains of user experience, and acceptability. Therefore, the components of user experience, and acceptability in the IAMS framework are to be included in the model as indirect variables

#### A. Selected hypotheses for the current research study

Extensive research on the chosen domain has revealed that the degree of system usage has been considered the benchmark of success in many studies, which is a conclusion similarly found by DeLone and McLean [21]. However, DeLone and McLean clarified this misconception, and stated that an isolated inclination to use a system does not suffice for the actual adoption of the technology in one's life, whereas usage behaviour tends to refer to the success of a system in a better manner [21]. Moreover, Wang and Liao stated their concern regarding the lack of measures in terms of assessing the success of e-government systems since much attention has been assigned to similar measures for information systems [22]. They also stated that system usage is used as a dependent variable in many research studies. Furthermore, they also highlighted the importance of variables 'system usage' and 'intention to use' in regard to measuring the rate of success of those applications voluntarily used by users. Alongside the arguments for the inclusion of 'system usage' and 'intention to use' in the measuring of any system by the above-mentioned researchers, most technology acceptance models support these two variables, and further consider them relevant in terms of evaluating the success rate of any system.

Adell discussed a system that is known as the driver support system; this implementation of the UTAUT model, for such a model, is evaluated in this paper [23]. Amongst the four variables of performance expectancy, effort expectancy, social influence, and facilitating conditions, the last variable is not considered relevant for the system under discussion, and so it is omitted from the formulation of the UTAUT model. In addition to the exclusion of facilitating conditions, user behaviour is also omitted since facilitating conditions directly influence user behaviour. Furthermore, Sedana and Wijaya also used UTAUT with the objective to evaluate the level of acceptance for their technology, Exelsa, which is a learning management system at Sanata Dharma University [19]. The authors of the paper explained their choice of UTAUT by stating that UTAUT tends to better facilitate understanding the level of user acceptance and the use of the technology. In an attempt to simplify the UTAUT model for their research study, the authors made behavioural intention the base of the model, thereby being influenced by performance expectancy, effort expectancy, and social influence. However, all of these models have the

common base of behaviour, which signifies the use of the new technology or system.

In the light of the above findings, it can be stated that the intention to use UbiIAMS may be influenced by performance expectancy, effort expectancy, social influence, and security and identity. Moreover, it may also be further stated that a strong intention to use any system is eventually translated into actual usage of the system. Likewise, further work should be conducted if there are differences recognised amongst users concerning education, languages, culture, occupation, and income, all of which may affect the adoption of UbiIAMS System [1], [25]. Fig. 6 shows the hypotheses to be used to test the system. The grey shaded boxes are not included in the current research study.

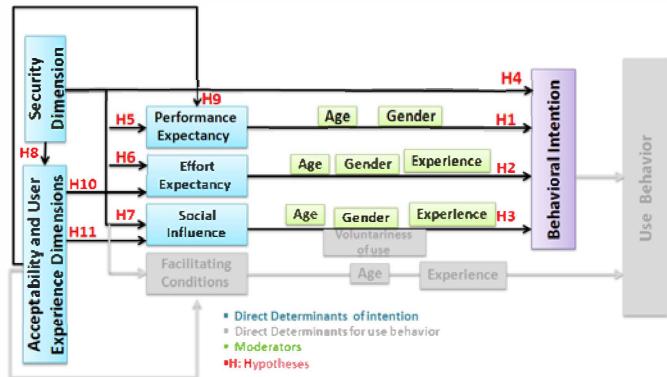


Figure 6. UTAUT-Based Model for Studying the Integrating Physical and Virtual Identity Access Management Systems

The list of hypotheses that have been selected for the research study under discussion:

- **H1:** There would be a significant positive relationship between performance expectancy and behavioural intentions to use UbiIAMS, and this relationship would be moderated by gender and age.
- **H2:** There would be a significant positive relationship between effort expectancy and behavioural intentions to use UbiIAMS, and this relationship would be moderated by gender, age and Internet experience.
- **H3:** There would be a significant positive relationship between social influence and behavioural intentions to use UbiIAMS, and this relationship would be moderated by gender, age and Internet experience.
- **H4:** There would be a significant positive relationship between security and identity's components and behavioural intentions to use UbiIAMS.
- **H5:** Security and identity's components will have an indirect effect on behavioural intentions to use UbiIAMS through performance expectancy.
- **H6:** Security and identity's components will have an indirect effect on behavioural intentions to use UbiIAMS through effort expectancy.
- **H7:** Security and identity's components will have an indirect effect on behavioural intentions to use UbiIAMS through social influence.
- **H8:** Security and identity's components will have an indirect effect on behavioural intentions to use UbiIAMS through acceptability and user experience's items.
- **H9:** Acceptability and user experience's components will have an indirect effect on behavioural intentions to use UbiIAMS through performance expectancy.
- **H10:** Acceptability and user experience's components will have an indirect effect on behavioural intentions to use UbiIAMS through effort expectancy.
- **H11:** Acceptability and user experience's components will have an indirect effect on behavioural intentions to use UbiIAMS through social influence.

The validation of this proposed UTAUT will lead to an answer the research question: *How can the selected attributes—in the proposed conceptual model for integration of physical and virtual identity access management systems—be tested so that the best relationship will result in predicting user intention to utilise these systems?*

## V. CONCLUSION AND FUTURE WORK

There are limited systems in the domain being discussed since the concept of IAMSSs has only recently emerged in the world of computing; rather, the known publications and research studies tend to focus on the interoperability of the physical and virtual services, and ultimately neglect the other necessary aspects of usage and operations of systems. Some of those important aspects are usability, accessibility, and identity. The presence of such aspects makes the services accessible and usable by all types of users as opposed to constraining the usage to a certain set of users. It is due to this reason that this paper focused on designing an acceptance model for integrating physical and virtual IAMSSs. Amongst the eight types of technology acceptance models, UTAUT is considered to be the most suitable one for the respective research study because the range of variables in UTAUT are even more compatible with the vision of the proposed system since it provides a stronger platform for catering to the unique needs of different types of user. Furthermore, it has been developed after a series of improvements on the previous eight models, and aims to predict the level of usage and acceptance that can be expected from users regarding a certain technology or system. Thus, the research proposes an extension to the UTAUT model that accounts for the utilisation of the unified model within the components of the IAMS framework.

The research findings and proposed UTAUT model shall be used to develop a prototype system (UbIAMS) that shall cater to the needs of all kinds of users in the presence of their unique traits and experiences [1], [25]. The prototype shall be tested and evaluated on the basis of the selected hypotheses. More details about evaluating the proposed UTAUT will be presented in the conference.

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