Towards a Dynamic Technology Acceptance Model (DTAM) in ICT Diffusion

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ABSTRACT

For over two decades now, the Technology Acceptance Model (TAM) has been dominant in Information Systems (IS) research. However, in recent years, TAM has been criticized by IS researchers due to a number of shortcomings. Therefore, this paper points to the overemphasis of parsimony in TAM that severely limits its completeness and dynamism, and hence this paper presents a more complete and dynamic technology acceptance model (DTAM) for the purpose of providing a foundation for a paradigm shift. Unlike preceding TAM, TAM 2, and TAM 3 models that are based on the organizational-individual- technological variable construction, DTAM is based on four categories of variables, namely; environmental-organizational-individual- technological. Drawing on prior work in information systems, and using a triangulation method on the key theorization and findings of ten closely related theoretical paradigms, this study used a descriptive research design and a cross-section survey methodology. It developed a Dynamic Technology Acceptance Model (DTAM), which is more complete, coherent and unified. Out of a population of 91,542 university students, a representative sample of 1092 student's respondents from higher education institutions (HEI) were used to empirically test DTAM in the context of the ICT artefacts - internet, electronic mail, and learning management systems (LMS) acceptance. DTAM explained 72.7 percent of the students' intention to accept ICTs, with good model fit (Normed x2=5, RMSEA=0.06, GFI=0.94, and AGFI=0.91).

CATEGORIES AND SUBJECT DESCRIPTORS

H.4.0 [**Information Systems**]: Information Systems Applications – *General;*
K.3.1 [**Computing Milieux**]: Computers and Education - *Computer Uses in Education;*
K.6.2 [**Computing Milieux**]: Management of Computing and Information Systems - *Installation Management.*

KEY WORDS
TAM, DTAM, Completeness. Parsimony, Dynamism.

1. INTRODUCTION

The ongoing search to ensure user-acceptance of information systems and technology (IS/IT) is a continuous management challenge [15] [38] and one that has engaged the Information Systems (IS) researchers to the extent that IS/IT adoption, diffusion and infusion research is now considered to be among the more mature areas of exploration within the Information Systems discipline [21] [48]. Indeed, the problem of technology rejection is persistent in all sectors of the economy and the higher education institutions have their share of this problem. Consequently, the leading international bodies namely; the Association For Information Systems (AIS) [1], and International Federation For Information Processing (IFIP). 2010. Technical Committee on Information Systems, Technical Committee number eight (TC8)- Working Group on Transfer and Diffusion of Information Technology (WG 8.6) [25] have recognized the subject of this study which is Adoption and Diffusion of Information Technology on Information Systems research as a major sub domain of research [3] [15] [25]. Consequently, the results of this study have brought forth the urgent and much needed insights into the determinants of ICT diffusion and infusion in institutions of higher education that will enable the institutions to in-turn develop interventions to overcome ICT diffusion and infusion barriers [1].

Adoption is generally defined as the set of practices and factors associated with organizations or individuals in selecting, deploying, and sustaining the use of a technology, while rejection is a decision not to adopt it [37]. On the other hand, the term diffusion is commonly defined as "the process by which an innovation is communicated through certain channels over time among the members of a social system" [37], where the 'innovation' can be anything that is seen as new, from the perspective of the adopters. Additionally, information and communication technology infusion is the degree to which different ICT tools are integrated into individual or organizational context activities [24]. For purposes of this paper, ICT tools will refer to the threesome namely: internet, electronic mail, and learning management systems.

2. LITERATURE REVIEW

2.1 Critiques of TAM

Studies on TAM have been plentiful but wanting [13] [31] [42] [47] [49]. In comparison with other models, TAM is well accepted since it shares comparable validity and predictability with its predecessors and yet it is the most parsimonious of all. Although parsimony is TAM's strength, it is also its drawback. Like the TRA, TAM has three limitations. First, the incompleteness of the theoretical model that has made it omit other contingency factors influencing technology acceptance. These omitted variables need to be studied in order to raise its explanatory power. Second, most empirical results using TAM came from North America and thus the applicability of the model in other cultures has been questioned by recent studies [47]. Third, it has weak implication for managerial intervention across cultures because of its solitary theoretical origin from social psychology without relating cultural factors and the model. Consequently, these innate restrictions of the TAM model in part explains the emergence of several variants of TAM in IS literature tailored to address these limitations on specific areas. Therefore, it is rational to expect more TAM research to go beyond social psychology consideration. The present study assesses the

influence of the environment and organizational variables, which are not considered in most TAM researches.

2.2 Theoretical Extensions of TAM

One main criticism of the TAM model is that its parsimony gives unclear guidance on organizational intervention to improve user technology acceptance. Recent studies have found it essential to explore TAM antecedents in an effort to find better nomological validity and improve its practical significance. This will help augment user perceptions of technology, ease of use and usefulness [47]. The simplicity of TAM has resulted in many variants or supplements of the model, and research has been done in search of potential antecedents of PEOU and PU. Extensions of TAM include inclusion of other factors that affect BIU directly in addition to PEOU and PU; other factors that affect actual usage directly in addition to intention; antecedents of PU and antecedents of PEOU; and new measures of user acceptance. Recent studies have also included the search for moderating variables [49].

Due to the vagueness in the final TAM, many variables have been proposed. The list of possible variables goes to over one hundred, making it impractical for one research to investigate the whole set of variables. The robust approach that has been adopted by recent studies is to categorize the variables to three or so groups, and then select the most relevant ones in the particular research context. From the literature survey, this study has categorized the variables into four categories, namely; environmental; technological; individual, and organizational. This creates a very dynamic model that is not vague but is able to dynamically adapt to any study set of variables and research context, and at the same time compare findings with previous studies using TAM. The involvement of environmental, technological, organizational and individual factors in the theorized Dynamic Technology Acceptance Model (DTAM) as shown in Figure 1 allows any researcher to select a sizeable and suitable set of external variables from each of the four categories of factors and plug them into the Dynamic TAM for investigation on the particular context and ICT system.

Figure 1 is the overview of the research model adopted for this study. In the model, the TAM part is indicated with a dashed box, while the arrows in the figure indicate the directions of the key hypotheses. First, the research model proposes that four sets of external variables, namely; environmental, technological, organizational, and individual factors will influence both Perceived Usefulness and Perceived Ease of Use. Second, in the TAM, the relationships between the constructs of Perceived Usefulness, Perceived Ease of Use and Behavioural Intention are indicated. *Behavioural Intention is* defined as "a person's subjective probability that he/she will perform some behaviour" [16].

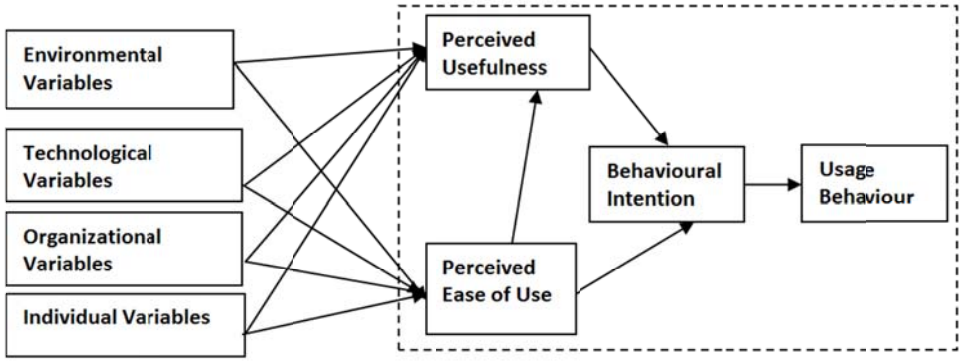
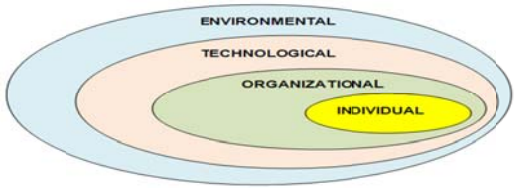


Figure 1: Theoretical Research Model (Dynamic Technology Acceptance Model) (DTAM)

Considering the higher education sector in developing countries, the omission of external variables such as Access to ICTs, and Availability of ICT in preceding studies such as that of [11] makes their frameworks inadequate for developing countries context where ICT access and availability are major issues of concern. It is our opinion that in such contexts, the inclusion of environmental factors in the external factors is more appropriate as proposed in the Dynamic TAM. Figure 2 is a schematic diagram showing relationship of the four categories of variables that generally influence the individual in the process of ICT adoption, diffusion and infusion. The focus of contemporary ICT adoption and diffusion research appears to be centred on understanding the dynamics of adoption and diffusion at four specific levels: national, industry, organization and individual [7]. In this study, national and industry factors are termed as environmental factors. These variables are beyond the control of both the individual and the organization, yet may influence the adoption and diffusion behaviours of the individual student. This is illustrated in Figure 2.



(Source: [28])

Figure 1: Factors that Influence Individual ICT Adoption and Diffusion

2.3 Theories on Technology Acceptance

Researchers in the area of Information Systems and Information and Communication Technology are concerned with researching the theories and models that will have power in predicting and explaining behaviour

across different fields. The main objectives of these studies are to find ways of promoting use, and to examine what thwarts intention to use the technology. Each important technology acceptance theory or model, which has not been outdated by recent research , has different premises and benefits. It is, therefore, imperative to examine them individually, since it is expected that theoretical concepts from these theories will help provide a sound basis for the theoretical framework used in creating a research model that could properly demonstrate the acceptance of technology for this research.

Consequently, this section will review and discuss the literature in relation to ten prominent technology acceptance theories/models. These theories include:

(1). Theory of Reasoned Action (TRA),
(2). Innovation Diffusion Theory (IDT),
(3). Theory of Planned Behaviour(TPB),
(4). Social Cognitive Theory,
(5). Decomposed Theory of Planned Behaviour (DTPB),
(6). Technology Acceptance Model (TAM),
(7). Technology Acceptance Model 2(TAM2),
(8). Combined TAM and TPB(C-TAM-TPB),
(9). The Unified Theory of Acceptance and Use of Technology (UTAUT), and
(10). Technology Acceptance Model (TAM 3).

From the literature relating to these theories, it was established that the UTAUT has the highest power in explaining behaviour intention and usage (an adjusted R^2 was 69%). It explains usage behaviour more completely than other theories, and contributes to better understanding of drivers of behaviour. With this justification, this study is based heavily on these ten theories as the foundation of theoretical framework (see Figure 3).

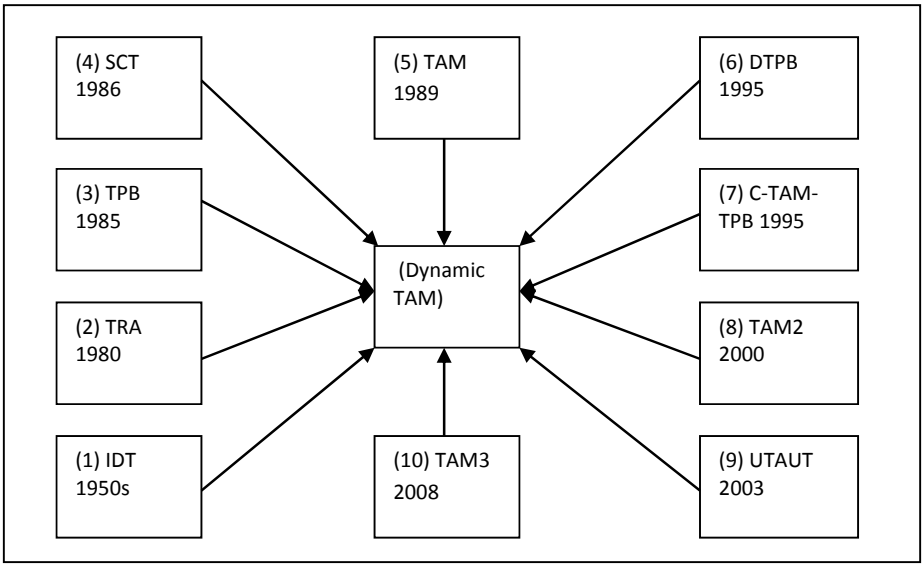


Figure 3: Development of the Research Model -Dynamic TAM

A modified version of TAM is adopted for this research. Figure 4 presents the overall picture of the formation of the research model (Dynamic Technology Acceptance Model – "DTAM"). The development of the research model is based on the significant aspects of these ten theories/models as previously discussed. The approach details on how the research model was formulated are discussed in chapter 5.

From the literature on the theories on technology acceptance, an important fact was established. To understand comprehensively individual acceptance of technology we need to interpret user behaviour within at least four contexts: technology (system) context, individual context, organizational (implementation) context and the environmental (cultural (national) and socio-economic) context, where a context refers to the interrelated conditions in which something exists or occurs.

2.4 Contextualization

The study has developed a complete nomological network of the factors that influence ICT diffusion and infusion—DTAM. DTAM has three major strengths, namely: *dynamism, comprehensiveness* that can be adapted for any context. While preceding studies like TAM presented a *parsimonious* model, and others like TAM3 aimed at completeness, their major weaknesses are the lack of contextualization that limited their applicability to both developed and developing worlds. Due to this and other limitations, a growing number of researchers have advocated for extension of the TAM theoretical framework or a complete paradigm shift [5]. To address this gap, this study has presented an extension to TAM that adds richness and insights to our understanding of user reactions to new ICT in general and the higher education context in particular. Factors that mattered in 2010, in developed world may not be important in certain regions of the planet for some technologies.

Dynamism caters for inclusion and interaction of variables taking into account the three aspects of modelling, time, place, and system factors. Further, dynamism, comprehensiveness and parsimony have their own intrinsic worth in theory development. This study defines the dynamism of a model as the capability of the model to take on any number of variables that matter today or those that will matter in the future, and in any region/organization of the earth and for any technological innovation. With the categorization of determinants of ICT diffusion into environmental, technological, organizational, and individual variables, future researchers using DTAM can select their variables that are relevant to a phenomenon, from hundreds of possible variables and plug the selected factors into DTAM variable categories for empirical testing. On the other hand, "comprehensiveness ensures whether all relevant factors are included in a theory", and "parsimony dictates whether some factors should be deleted because they add little value to our understanding of a phenomenon" [47]. DTAM is therefore a major contribution of achieving all the three dimensions. This theoretical framework is likely to be valid now and in the future and in any part of the globe, and for any ICT artefact.

2.5 **Moderating Factors**

Several previous studies five variables namely: gender, age, experience, years in studies, and voluntariness, have commonly be treated as moderating the effect of self-efficacy, Computer Anxiety, Perceived Enjoyment, Subjective Norm and Perceived Ease of Use on ICT adoption and diffusion. This paper has therefore considered these variables as moderating factors in its investigation.

Gender

Several studies have given a good case for why men and women would respond in different ways to ICT. These studies help us to build via literature review the influence of gender on the adoption and diffusion of ICT in circumstances analogous to those involved in ICT perception and usage [12] [20]. The study by Hofstede (1980) cited in [12] provides extensive work on cultural dimensions that provides insight into how sex differences in behaviour and thinking arise. This suggests why there may be fundamental ICT gender differences. Although there have been some studies on the role of gender in ICT adoption and diffusion including the studies in the UK [36] and USA [46] in Sub-Saharan Africa, there has been modest methodical capture of national data about women in the ICT, and none in the higher education sector. Despite findings like that of a recent study that has shown that context and place affect the gendered realities of women in the ICT industry [12], the unresolved agreement between the theoretical and essentialist approaches warrant further research. In contrast to [47], this study has found gender a pertinent variable for investigation. Consequently, this paper has included gender as a moderating factor in its research model.

Age

According to [37] Diffusion of Innovation Theory, earlier adopters are usually younger in comparison to later adopters and laggards. Several studies such as [33] [52] have documented the role of age in the adoption and diffusion of ICT. The use of age as an independent variable to explain social process, a particular social grouping, or piece of individual or collective behaviour in ICT adoption and diffusion has been supported by [37] and [51]. Among the studies that have provided evidence for the significant, direct, and moderating effect of age on Behavioural Intention, adoption, diffusion and usage behaviour are [33] and [47]. The findings by [51] clearly suggest, "that there is an unequal or heterogeneous adoption (or a digital divide) in various demographic dimensions including age". This line of thought is supported by several researchers, including [49. Lastly, earlier studies argue that routines become more difficult to change, as one grows older because the habits can become stronger [52]. Taken as a whole, the paths through habits and behavioural control imply that age always influences usage [9] [52].

In this study in contrast to [47] we have included age as a pertinent factor that influences ICT adoption and diffusion and hence requires further investigation. Additionally, it is suggested that age can influence usage in addition to its effect on PU, PEOU via its effect on technological, organizational and environmental factors.

Education Level/Years of Study

In a review of the literature, Rogers (1983, in [19] reports that 73 per cent of past research supports a positive relationship between education and innovativeness. For example, [19] formulated that education is a very powerful variable for explaining internet use and access. They posited that education level explains 37 per cent of variance in internet usage, 62 per cent of variance in narrow band adoption and 33 per cent of variance in broadband adoption, across countries [19]. The education level is expected to enhance the effect of cultural dimensions that are positively related to Internet use and access and mitigate the effect of negative cultural effects. In addition [32] have established that education also plays a moderating function in the association between the three basic determinants and ICT users' attitude toward online shopping. On the other hand, prior research has shown that higher educated ICT users are more pleased using non-store channels, like the Internet to shop [8]. These studies build our basis for inclusion of level of education variable in our study. We propose that education level can affect usage in addition to its effects on PEOU and PU via its effects on Subjective Norms. The effect of education level variable via Subjective Norm however, may be negative, or positive depending on the context. Unlike [9] who stated a non-directional proposition, this study theorizes a positive influence because more years spent in a university environment increase both experience in ICT and education level.

Experience

Several studies have shown the relevance of the individual experience in an ICT artefact effect on its adoption, diffusion and infusion [18] [27] [35] [40 [47]. Researchers using TAM to investigate determinants of ICT adoption and diffusion have argued that a person's experience with a specific ICT artefact affects

perceptions of ease of use and of usefulness of that information system [40]. Scholars such as [49] have suggested that it is vital to understand the role of users experience in ICT adoption, diffusion and use contexts. This line of thought is supported by a recent study by [47] which found that with rising experience, while the influence of Perceived Ease Of Use on Perceived Usefulness will increase, the effect of Perceived Ease Of Use on Behavioural Intention will decrease [47]. The effect of experience has been unclear with several studies reporting conflicting findings. For example with respect to Perceived Usefulness (PU), we can find numerous studies where some researchers argue that there are no significant differences in the behaviour of probable and actual users [45]. Others support the assertion that PU acquires more significance as the individual's knowledge grows and he/she becomes an experienced ICT artefact such as online shopping user [18] [26]. Another set of studies posits that the last perception is greater for non-experienced ICT users [43] [44]. In the present study, we consider that the fact that a student use the Internet, e-mail, and LMS to accomplish a task means that the initial perception of usefulness has been strengthened by his/her own experience [35]. Since PU is an extrinsic motivation, it will become significant in the study of ICT. Thus conflicts and ideas form existing literature form the basis for this paper to consider experience as one of the moderating variables in its research model.

Voluntariness

Voluntariness is the "extent to which potential adopters perceive the adoption decision to be non- mandatory" [14]. Previous studies have identified voluntariness as one of the four major moderating variables in addition to gender, experience, age and education [14] [49]. In the recent times, there has been a determined attention in the IS literature to investigate the function of the voluntariness variable in the adoption and diffusion of ICT. A recent study by [47] posits that voluntariness is an important variable in technology acceptance since it affects ICT diffusion. It was, therefore, imperative that this variable was included in the current research.

3. THEORETICAL FRAMEWORK AND HYPPOTHESES

3.1 Basic Concepts of the Theoretical Framework

The fundamental concept underlying the dynamic ICT user acceptance model of this study adapted from preceding research suggests that environmental, technological, institutional, and individual reactions to diffuse and infuse ICT may influence behavioural intention and consequently, actual usage of the ICT (see Figure 4). It is likely that the study model, based on this research model could have power in explaining usage behaviour and could predict future usage based on users' intention [47] [49]. The model could go through a number of tests and modifications to make it more suitable for use in higher education sector and in developing countries like Kenya.

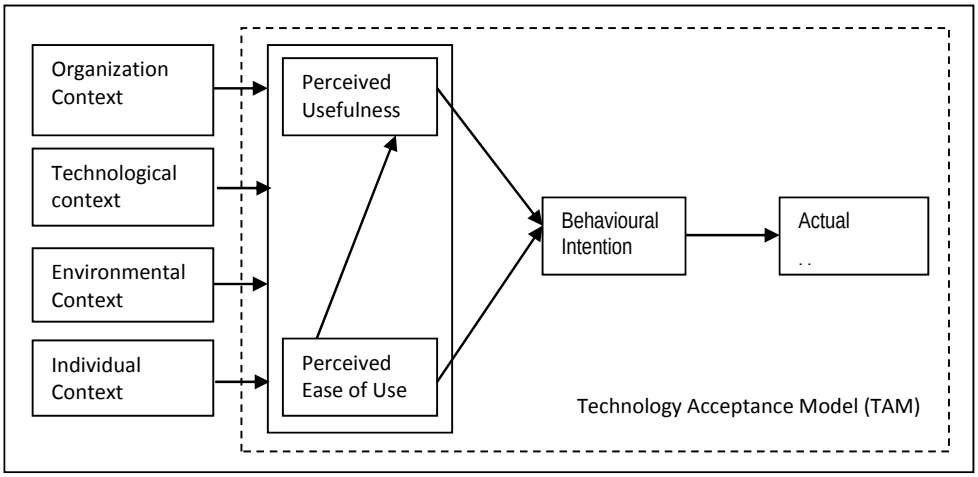


Figure 4: Theoretical Framework. (Dynamic TAM)

The research model proposed in this study comprised three important types of variables (see Figure 4 and 5). The first category of variables consists of four core constructs (independent variables), namely; **Technological** variables (TC), **Environmental** variables (EC), **Organizational** variables (OC), and **Individual** variables (IC). These core constructs were expected to influence Perceived Usefulness (PU), and Perceived Ease Of Use (PEOU), and hence behaviour intention to use ICT (BIU), and actual usage of ICT (AU). Behavioural intention is defined as the degree to which individuals intend to use the ICT artefacts –Internet, Email and learning management systems in the future. The second category of factors is composed of two dependent variables namely, Behavioural Intention to use ICT (BIU) and actual Usage (AU). Behaviour intentions are expected to influence usage behaviour in ICT, while PU and PEOU are expected to influence (BIU). Finally, the third category consisted of a set of variables from the individual categories that will also double as moderating factors. These consisted of gender, age, experience, and education/years in the institution. The moderators normally affect the influence of main constructs on PU, PEOU, and Behavioural Intention toward usage behaviour. Derived from the proposed study model, a number of research hypotheses were investigated. In the next section is a discussion about the determinants that form the core of this study model.

3.2 Research Hypotheses

This study examined the relationships among perceptions of usefulness, ease of use, intention to use ICTs, and external variables, namely; environmental, individual, technological, and organizational factors and their effect on Behavioural Intention to use ICT. To achieve this goal, the following hypotheses were formulated to investigate ICT diffusion and infusion in institutions of higher learning:

H1. Environmental factors significantly influence the diffusion and infusion of ICT in higher education.

H2. Technological factors significantly influence the diffusion and infusion of ICT in higher education.

H3. Organizational factors significantly influence the diffusion and infusion of ICT in higher education.

H4. Individual factors significantly influence the diffusion and infusion of ICT in higher education.

H5. DTAM can adequately be used as a model in explaining the diffusion and infusion of ICT in higher educational institutions.

3.3 The Dynamic ICT-TAM Model

Several determinants pertaining to technology acceptance have been identified from previous research. However, a number of inconsistencies in using major constructs (determinants) in the theories/models in previous research have been found. In this research, the focus was on the major constructs (determinants) based on literature of the prominent theories/models identified and reviewed in Section 2 in combination with the findings from previous studies. Generally, covariance-based SEM is usually used for analysis with an objective of research model validation and needs a large sample. On the other hand, component-based Structural Equation Modelling (SEM) is mainly used for score computation and can be carried out when samples are very small. Since in this research, the sample size of 1092 can be considered large, covariant based SEM using AMOS statistical package was most deemed appropriate.

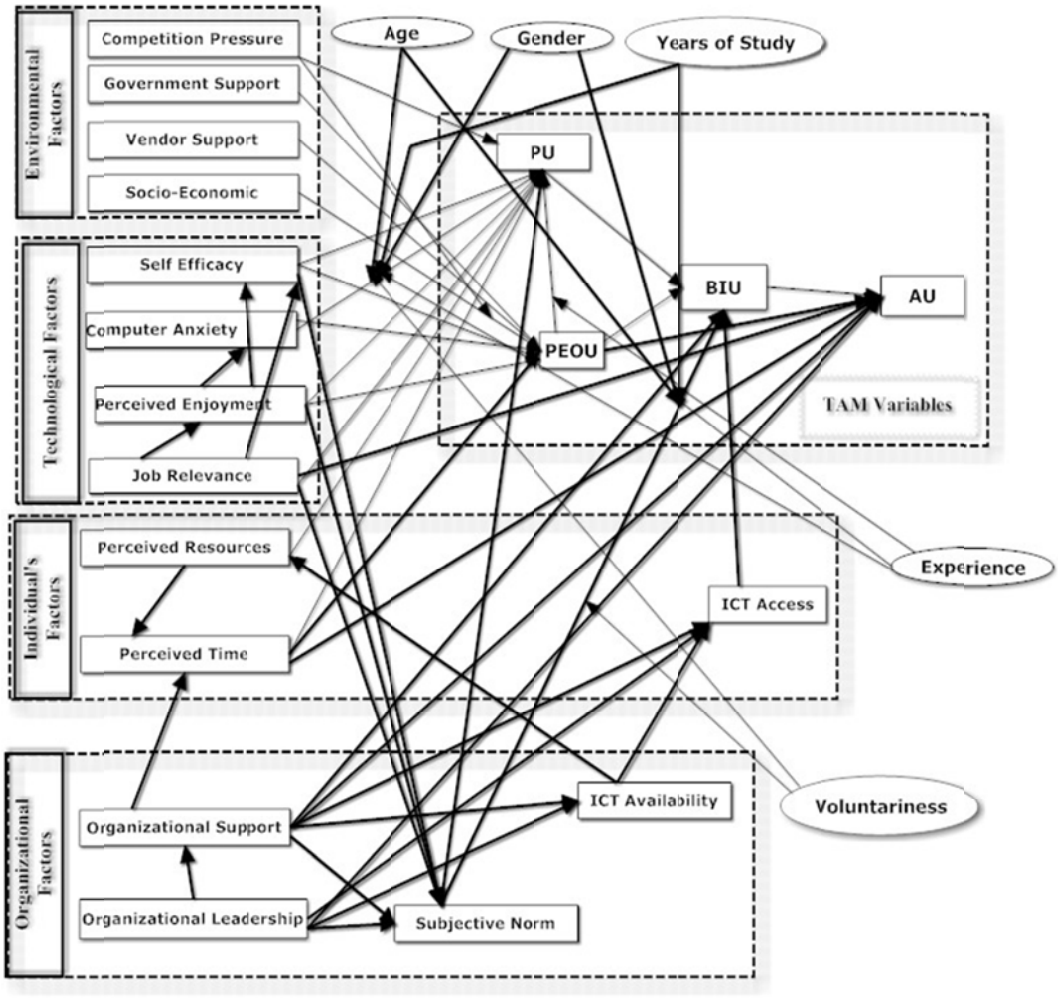


Figure 5 Expanded DTAM

The darker arrows in Figure 5 are really the result of the path analysis statistical procedure performed on the sample data. Those that do not link directly to PU and PEOU were not in the initial model. The variables Age, Gender, Years of service and Experience are sometimes grouped as personal attributes while Voluntariness is usually seen as an organisational factor. To be able to compare their outcome with preceding research, in this study, they have all been treated as in the case of [47] as personal attributes.

The major determinants of Behavioural Intention in the proposed research model in this study were Perceived Usefulness (PU), Perceived Ease Of Use (PEOU), in addition to **Organizational Factors**- Subjective Norm (SN), Availability of ICT , organizational ICT support, Organizational Readiness, CEO characteristics, and Top Management Support. Additionally, **Environmental Characteristics**- (competition intensity, government ICT Support, ICT sector support, and socio-economic barriers); **Technology Factors**- (self-efficacy, Computer Anxiety, Perceived Enjoyment, job relevance); **Individual Factors**- (Access to ICT , perceived resources, Perceived Time); and **Moderating factors** (Gender, Age, Years of study, ICT experience, voluntariness) are also variables in the model. Next is a justification and an explanation of why these determinants were integrated into the research model in this study that is shown in Figure 4 and elaborated in Figure 5.

4. RESEARCH METHODOLOGY

This study employed a descriptive research design, which was deemed appropriate because it agreed with the purpose of this study, which was to investigate the influence of environmental, technological, organizational, and individual determinants of adoption, diffusion, and infusion of ICTs, by students in higher educational institutions in Kenya. This design used a cross-sectional approach taking on a survey method that used a self-administered questionnaire for data collection. Further, in this study, a triangulation methodology was adapted in the study of ICT adoption, diffusion, and infusion. Triangulation was used in the following aspects: *approach triangulation*, where both quantitative and qualitative techniques were employed. Using a qualitative approach, a review of existing literature on the subject matter - adoption, diffusion, infusion and technology acceptance determinants and assessment models was done. The most suitable models in the framework of this research were then adapted to formulate a dynamic TAM that may be suitable in the assessment and prediction of user acceptance of ICT in higher educational institutions. In addition, discussion on the instrument constructs was done with a panel of experts to improve its validity and reliability; and *triangulation of theories*, where ten theories were taken from various disciplines and used to explain the ICT diffusion and infusion phenomenon in higher education [29]).

The constructs in this study were adapted from prior studies including that of [47]. Each construct was operationalized using multiple items to measure it. The constructs were modelled in a formative mode. According to previous studies, formative constructs occur when the items describe and define the construct rather than vice versa. In this study the items measuring the construct described the construct (Straub, Boudreau, & Gefen, 2004). For purposes of this study, a 7-point Likert Scale was used coded as follows: (1) Very Strongly Disagrees, (2) Strongly Disagree, (3) Disagree, (4) Neutral, (5) Agree, (6) Strongly Agree, and (7) Very Strongly Agree.

The target population consisted of universities in Kenya from which the actual sample of 1800 respondents of students was selected from a sample of 16 public and private universities selected from 30 accredited universities by Commission of Higher Education (CHE) in 2007. The units of analysis were the individual students from the departments in the selected sampled universities. Students who were officially enrolled in the respective schools were chosen. Because a key objective of this research was to understand the ICT diffusion factors and process, it was necessary to focus on university departments with a sustained ICT deployment history. Therefore, rather than use a random sampling approach, a purposive sampling technique was applied to select the participating schools/departments within a university in the sample that use ICT in the running of their academic programs.

Out of the one thousand eighth hundred (1800) total distributed questionnaires, four hundred and eighty six (486) of them were not returned, while one thousand three hundred and fourteen (1314) were returned giving a response rate of 73%. Out 1314 returned questionnaires, two hundred and twenty-two (222) were excluded from the data analysis process due to large incomplete answers, which resulted in a total of 1092 usable questionnaires. Other researchers have suggested a minimum sample size ranging from 100 to 200 for reliable LISREL or AMOS analysis [10]. The sample size was significant to create the representativeness of the sample for result generalisability [39].

4.1 Assessing Non Response Bias

In this study, the non-response bias was evaluated by comparing surveys questionnaires returned after a cut-off date of 30th March 2009 against the rest of the sample. Respondents whose questionnaires were not ready for collection by the cut-off date were said to belong to non-respondents (Chau, 1996). However, the sampling procedure employed in this study made it impossible to assess non-response bias. The survey questionnaires were distributed over 4 months from December 2008; to March, 2009 period and were collected over the same period. The distribution date and return date stamping on the questionnaire were not considered necessary since the subjects received the questionnaires on different dates, and consequently the number of days given to different subjects to respond varied from a few hours, to more than three months. Thus, some questionnaires were distributed and picked within a few days, weeks or months, while others were issued a few days or weeks before the cut-off date of the 30th of March, 2009. Consequently, the number of days given to each respondent to return the completed questionnaire was not equal to enable a reliable and uniform determination of non-response rate. Thus, even though the subjects are representative of the higher education students in the public and private universities in terms of sex, age and ICT usage experience, it is not appropriate to rule out non-response bias.

4.2 Normality of the Data

In this study, the path analysis using AMOS 7 used for Hypothesis testing procedures and confidence intervals deployed maximum likelihood or generalized least-squares estimation. This estimation depends on two assumptions. First, that the observations were independent, and second, that the observed variables met normal distribution. Since there is not a direct test for

multivariate normality, we generally tested each variable in the model. Since multivariate normality of all observed variables is a standard distribution assumption in many structural equation modelling and factor analysis applications, the same assumption was made in this study.

5. RESULTS

5.1 Data Collection

Table 1 shows the distribution of the data collected among the two gender classes and various age groups.

5.2 Reliability and Validity

We used SPSS 15.0 and AMOS 7.0 for data analysis. We adopted Cronbach's alpha in order to assess the internal consistency reliability. The Cronbach's alpha coefficients of the 8 constructs were above 0.8, which directed that there is a reasonable level of internal consistency among the items making up each factor. We conducted a confirmatory factor analysis to test convergent validity of each construct and the results are shown in Tables 2 to 5.

Table 1: Distribution of Respondents

Measure	Item	Frequency	Percent	Cumulative Frequency
Gender	**Male**	564	51.65%	51.65%
	Female	499	45.70%	97.35%
	Missin	29	2.66%	100.00%
Age	<20	173	15.84%	15.84%
	21-25	600	54.95%	70.79%
	26-30	138	12.64%	83.42%
	31-35	70	6.41%	89.84%
	36-40	41	3.75%	93.59%
	41-45	27	2.47%	96.06%
	46-50	12	1.10%	97.16%
	>51	7	0.64%	97.80%
	Missing	24	2.20%	100.00%
	N	1092	100.00%	

Table 2: Squared Multiple Correlations (SMC) and Cronbach's Alpha Results for Environmental Factors

Construct	Component measurements					
	Item	Loadings	SMC	Comment	Cronbach's Alpha	Comment
Competition Pressure	CP01	.572	0.33	Acceptable	0.630	Good
	CP02	.656	0.43	Acceptable		
	CP03	.705	0.50	Good		
	CP04	.620	0.38	Acceptable		
	CP05	.518	0.27	Acceptable		
Government Support	GS06	.697	0.49	Acceptable	0.641	Good
	GS07	.804	0.65	Good		
	GS08	.690	0.48	Acceptable		
Vendor/ISPs ICT Support	VS09	.805	0.65	Good	0.600	Good
	VS11	.810	0.66	Good		
Perceived Socio Economic	SE12	.568	0.32	Acceptable	0.443	Acceptable
	SE14	.674	0.45	Acceptable		
	SE15	.742	0.55	Good		

- Extraction Method: Principal Component Analysis.
- Rotation Method: Varimax with Kaiser Normalization.
- [a]Rotation converged in 5 iterations.

Table 3: Squared Multiple Correlations (SMC) and Conbach's Alpha for Technological Factors

Construct	Item	Factor Loading	SMC	Comment	Cronbach's Alpha	Comment
1. Computer Self-Efficacy (CSE)	SE01	**0.628**	0.39	Acceptable	0.742	Very Good
	SE02	**0.83**	0.69	Good		
	SE03	**0.776**	0.60	Good		
	SE04	**0.728**	0.53	Good		
2. Computer Anxiety (CA)	CA02	**0.812**	0.66	Good	0.874	Very Good
	CA03	**0.895**	0.80	Very Good		
	CA04	**0.877**	0.77	Very Good		
3. Perceived Enjoyment (PE)	PE01	**0.798**	0.64	Good	0.856	Very Good
	PE02	**0.883**	0.78	Very Good		
	PE03	**0.832**	0.69	Good		
4. **Relevance to Studies (REL)**	REL03	**0.676**	0.46	Acceptable	0.882	Very Good
	REL04	**0.891**	0.79	Very Good		
	REL05	**0.924**	0.85	Very Good		
	REL06	**0.862**	0.74	Very Good		

Table 4: Squared Multiple Correlations and Cronbach's Alpha for Organizational Factors

Construct	Items	Loadings	SMC	Comment	Cronbach's Alpha	Comment
Subjective Norm (SN)	SN01	0.752	0.57	Good	0.919	Very Good
	SN02	0.8	0.64	Good		
	SN03	0.812	0.66	Good		
	SN04	0.743	0.55	Good		
	SNEMA05	0.829	0.69	Good		
	SNEMA06	0.829	0.69	Good		
	SNEMA07	0.8	0.64	Good		
	SNEMA08	0.708	0.50	Good		
Availability of ICT (AVAIL)	AVAIL01	0.75	0.56	Good	0.911	Very Good
	AVAIL02	0.811	0.66	Good		
	AVAIL03	0.791	0.63	Good		
	AVAIL04	0.769	0.59	Good		
Organizational Support (OS)	OS01	0.663	0.44	Acceptable	0.927	Very good
	OS02	0.661	0.44	Acceptable		
	OS03	0.785	0.62	Good		
	OS04	0.79	0.62	Good		
	OSEMA05	0.791	0.63	Good		
	OSEMA06	0.744	0.55	Good		
	OSEMA07	0.826	0.68	Good		
	OSEMA08	0.805	0.65	Good		
Organizational Leadership (OL)	CEO01	0.772	0.60	Good	0.927	Very Good
	CEO02	0.775	0.60	Good		
	CEO03	0.73	0.53	Good		
	OR04	0.569	0.32	Acceptable		
	OR05	0.626	0.39	Acceptable		
	OR06	0.676	0.46	Acceptable		
	TMGT07	0.803	0.64	Good		
	TMGT08	0.835	0.70	Very Good		
	TMGT09	0.834	0.70	Very Good		
	TMGT10	0.805	0.65	Good		

Table 5 Results of Individual Factors Loadings: Rotated Component Matrix

Construct	Items	Loadings	SMC	Comment	Conbach's Alpha	Comment
Access to ICT (AICT)	AET01	0.77	0.59	Good	864	Very Good
	AET04	0.873	0.76	Very Good		
	AET05	0.907	0.82	Very Good		
	AET06	0.742	0.55	Good		
Perceived Resources (PR)	PRHS01	0.789	0.62	Good	0.917	Very Good
	PRHS02	0.867	0.75	Very Good		
	PRHS03	0.877	0.77	Very Good		
	DOC04	0.824	0.68	Very Good		
	DOC05	0.796	0.63	Good		
	DOC06	0.714	0.51	Good		
Time (PT)	TIME07	0.843	0.71	Very Good	0.885	Very Good
	TIME08	0.883	0.78	Very Good		
	TIME09	0.806	0.65	Good		

5.3 Measuring Sampling Adequacy for Factor Analysis

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was used. (KMO) measure of sampling adequacy is an index used to examine the appropriateness of factor analysis. High values (between 0.5 and 1.0) indicate factor analysis is appropriate. Values below 0.5 imply that factor analysis may not be appropriate. The KMO value was established to be 0.907 (see Table 6), which allowed factor analysis statistical procedures to be performed. *Bartlett's Test of Sphericity* tests the null hypothesis that the correlation matrix was an identity matrix in which all of the diagonal elements were 1 and all off diagonal elements were 0. From the same table, we can see that the Bartlett's test of sphericity was significant at 0.000. That is, its associated probability is less than 0.05. This meant that the correlation matrix was not an identity matrix. Taken together, these tests provided a minimum standard pass for the factor analysis (or a principal components analysis) that was conducted.

Table 6: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.907
Bartlett's Test of Sphericity	Approx. Chi-Square	50782.121
	df	2628
	Sig.	.000

5.4 Multicollinearity Test for Normality of Data

Researchers have advocated undertaking analysis to establish the multicollinearity among variables. The results of multicollinearity analysis shown on Table 7 reflected that Tolerance levels met the threshold of being **greater or equal to 0.01**, since all were above 0.5. Additionally from the same table, Variation Inflation Index (VIF) values were within desired range since each was below the threshold 10. In addition, Durbin Watson for all variables was 1.96, which fell within acceptable limits of between 1.5 and 2.5). The results reflect that no multicollinearity exist between variables.

Table 7: Collinearity Statistics

Coefficients[a]			
		Collinearity Statistics	
Model		Tolerance	VIF
1	CP	.855	1.170
	GS	.844	1.185
	VS	.920	1.087
	SE	.872	1.147
	PU	.689	1.452
	PEOU	.730	1.371
	CSE	.832	1.202
	CA	.794	1.260
	PE	.691	1.447
	REL	.776	1.289
	AICT	.584	1.711
	AU	.563	1.775
	PR	.639	1.565
	PT	.707	1.414
	SN	.719	1.391
	AVAIL	.549	1.822
	OS	.562	1.780
	OL	.589	1.699
a. Dependent Variable: BIU			

5.5 Harman's Single Factor Test For Common Method Bias (CMB)

In addition, we carried out Harman's single factor test. If common method bias existed in the data, a single factor or one general factor would have accounted for most of the variance and would have emerged from the factor analysis ran on the full set of items considered for defining the dependent and independent variables. Our un-rotated factor analysis criteria revealed nineteen factors shown on Table 8. The first of these explained around 20% of the variance in the data, indicating that the findings could not be attributed to common method bias.

Table 8: Total Variance Explained

	Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %
1	14.906	20.419	20.419
2	6.576	9.008	29.427
3	4.242	5.811	35.238
4	2.958	4.053	39.291
5	2.761	3.783	43.073
6	2.284	3.129	46.202
7	2.173	2.977	49.179
8	1.905	2.610	51.789
9	1.870	2.562	54.351
10	1.790	2.452	56.803
11	1.655	2.268	59.071
12	1.527	2.091	61.162
13	1.422	1.947	63.110
14	1.350	1.849	64.959
15	1.227	1.681	66.640
16	1.217	1.667	68.307
17	1.124	1.539	69.846
18	1.047	1.434	71.281
19	1.002	1.373	72.653
Extraction Method: Principal Component Analysis.			

5.6 Convergent Validity

Convergent validity is achieved when items that are supposed to measure a construct converge. The convergence manifests itself when the items show significant, high correlations with one another, particularly when compared to the convergence of items relevant to other constructs irrespective of method [41]. The comparison with other constructs is one element that distinguishes item convergent validity from item reliability. Practically, the measurement for convergent validity can be evaluated by average variance extracted (AVE) [10] [41]. The average extracted variances recommended threshold is 0.50, which meant that more than one-half of the variances observed in the items were accounted for by their hypothesized factors. [10] [41]. For brevity, this study used the average variance extracted (AVE) value, which measures the amount of variance shared by in-group items. This is captured by the underlying construct in relation to the amount of variance due to measurement error and was calculated as follows: *(sum of squared factor loadings)/ {(sum of squared factor loadings) + (sum of error variances)}* [10]. The value of AVE should be higher than 0.50 to conclude convergent validity. The AVE results will be presented in Table 9, shows that where the measures of convergence validity will be indicated by observing that

the measurement constructs values in those tables meet the required AVE threshold value of 0.50.

Table 9: Average Variance Extracted (AVE)

Construct	No of Items	Sum of Loading^2	Sum of Error Variance	variance extracted (AVE)
Competition Pressure (CP)	3	1.43	0.17	0.89
Government Support (GS)	3	1.55	0.18	0.90
Vendor/ISPs ICT Support	2	1.32	0.12	0.92
Perceived Socio Economic (PS)	2	1.10	0.14	0.89
Perceived Usefulness (PU)	4	2.70	0.20	0.93
Perceived Ease of Use (PEOU)	4	2.34	0.20	0.92
Computer Self-Efficacy (CSE)	2	1.33	0.10	0.93
Computer Anxiety (CA)	3	2.17	0.20	0.91
Perceived Enjoyment (PE)	3	1.94	0.15	0.93
Relevance to Studies (REL)	3	2.25	0.16	0.94
Access to ICT (AET)	3	1.66	0.20	0.89
Actual Usage	7	3.60	0.45	0.89
Perceived Resources (PR)	3	2.04	0.18	0.92
Perceived Time (PT)	3	2.06	0.16	0.93
Behavioral Intention	5	3.00	0.25	0.92
Subjective Norm (SN)	6	3.54	0.29	0.92
Availability of ICT(AVAIL)	3	1.68	0.17	0.91
Organizational Support (OS)	6	3.55	0.34	0.91
Organizational Leadership (OL)	8	4.74	0.41	0.92

5.7 Discriminant Validity

In this study, discriminant validity was also employed on the measuring constructs. Discriminant validity is another way of testing construct validity. A measure satisfies discriminant validity criterion when it shows a low correlation with measures of dissimilar concepts [41]. In this research, apart from using AVE for convergent validity, we also used it in examining discriminant validity of the measuring constructs. To do this, we compared the square root of the AVE with the inter-factor correlations of each construct. When none of the latter exceeded the former, we established the existence of a high level of discriminant validity of the construct (see Appendix 1).

5.8 Findings of Mediating Factors

To test mediation effects, the present study followed the approach suggested by [47]. The mediation of experience, age, gender, study year, and voluntariness were considered on the influence of computer self-efficacy and Computer Anxiety on Perceived Ease Of Use. The result shown in Appendix 2, show that out of the five moderating variables, the three moderators namely experience, age and gender moderate the influence of computer self -efficacy and Computer Anxiety on PEOU. These findings agree with the study by [47] Further, the ICT experience moderation of the Subjective Norm influence on PU, and PEOU influence on PU was investigated. The result of this investigation agrees with [47] that experience moderates the influence of Subjective Norm on Perceived Usefulness. However, the moderation on the influence of PEOU on PU was not significant

The results of voluntariness, (β=-0.054, p=0.065) shown in Table 5.36 indicate that voluntariness negatively influence Perceived Usefulness. This finding has one important revelation, that voluntariness has a direct influence on PU on the TAM model contrary to several studies like [47] [49] who have treated voluntariness of an ICT system as a moderating variable for Subjective Norm. In, addition the assumption that determinants variables of Perceived Ease Of Use will not influence Perceived Usefulness is validated in our results since voluntariness has influence only on PU. It was expected that voluntariness will have positive influence on the Perceived Usefulness of an ICT artefact because the mandatory nature of a system is likely to develop thoughts of improved performance to the students and increased scores. However, our results did not support a positive relationship. The positive relationship between voluntariness and PU assumes that the students enjoy the learning and interaction with the ICT artefact. In situations where the ICT usage is involuntary and not enjoyable, the students are likely to resent on the usefulness of the ICT. Hence, it is not surprising that voluntariness has negative influence on Perceived Usefulness, because individuals may develop the feeling that they are being forced to spend time on an ICT artefact that they are not interested. This could be for example a case where students are being required to check for the originality of their term papers using an originality reporting software like TurnITin, which adds more work on their part. This system will take extra time yet students consider themselves to have completed their essential activities for their respective tasks, yet they could earn whole mark by submitting their work without the TurnItIn report. Consequently, our results support the argument that "for a voluntary system" interventions that will influence the determinants of Perceived Usefulness will be important to implement (e.g. design characteristics, user participation, incentive alignment, training, organizational and peer support)" [47]. Like the finding in our study, individual diffusion of ICT might also be affected by whether the use was voluntary or mandatory [14]. Our findings further agree with the proposition that Behavioural Intentions vary between mandatory and voluntary usage but through Perceived Usefulness [17].

Although *Access to ICT* and *Availability to ICT* variables may conceptually be viewed as very close, they are quite distinct. This is particular so in an environment where ICT tools area available, but would be users do not have adequate access. The inadequate access could be due to the tools having been restricted or devoted to different

assignments like the case where an institution of higher learning has more computers for its administrative operations than those devoted to student learning. The other factor could be due to the users themselves rejecting the technology despite being made available to them or the inability to afford associated costs for example for broadband internet connection required when they are out of campus. Consequently this study was motivated to treat the two variables separately [34].

5.9 Model Evaluation Using Goodness-of-Fit Indices.
Structural Equation Model (SEM) using AMOS 7.0 was conducted in order to test causal model because the model consists of multi-phase. As shown in Table 10, the fitness measures including GFI, AGFI, RMESA, NFI, and CFI, implied that the research model was acceptably appropriate to explain ICT Diffusion. Several researchers have pointed out that while fit indices are a useful guide for structural model evaluation, its examination should also be with respect to substantive theory. When model fit is allowed to drive the research process, there is danger of moving away from the original purpose of theory testing of structural equation modelling. The other weakness with fit indices is the fact they may indicate to a well-fitting model, yet in the real sense, elements of the model may fit poorly [22]. The Fit indices of the DTAM research model are summarised in Table 10. Looking at the results of Normed x^2, RMSEA, GFI, and AGFI in Table 10, we can see that the DTAM model is sufficiently stable. However, a limitation of this model was the value of 4.973 of Normed X^2 is very close to the threshold of 5.0 of the over fit model

Consequently, the subject of fit indices 'rules of thumb' is extremely topical now with some researchers in the subject proposing for a complete rejection of fit indices altogether [6]. On the other hand others are less hesitant to denounce the usefulness of fit indices but do agree that strictly adhering to suggested cut off values may result to the likelihood of Type I error where the incorrect rejection of an acceptable model occurs [30]. However, the debate on fit indices is ongoing, it is improbable that fit indices will become defunct any time soon and for this reason, we have used them from an informed position, in this study in the evaluation of our research model.

Table 10: Fit Indices of the Dynamic Technology Acceptance Model (DTAM)

Model Fit Measures	Cut Off	Model Values	Fit Measures' Indications	Interpretation
Absolute Fit measures				
Normed x^2 = **X^2/df**	5.0	4.973	<1 1 - 5 >5	Over fit Good fit Over fit
Root Mean Square Error of Approximation **(RMSEA)**	0.8	0.06	0.0 <= about 0.05 <= about 0.08 > 0.1.	exact fit close fit reasonable Over fit
Incremental Fit measures				
Goodness of Fit Index **(GFI)**	>0.90	0.941	0 -1, close to 1 >1	Fit Perfect fit. upper bound 1
Adjusted goodness of Fit Index (**AGFI)**	.>0.90	0.909	<1 1 >1	very good fit Perfect fit. over fit
Parsimony				
Parsimony goodness of Fit Index **(PGFI)**	0.4	0.304	0- 1, close to 1 > 1	Fit Very good fit. over fit

Based on several researchers' guidelines and the above review, in the evaluation of the research model of this study we shall select a few suitable indices [2] [22]. These include Chi-Square statistic, its degrees of freedom and p value, the RMSEA and its associated confidence interval, the RMR, the GFI, AGFI and one parsimony fit index such as the PGFI. These indices have been chosen over other indices study since they have been recommended by other researchers, as they have been found to be the most insensitive to sample size, model misspecification and parameter estimates

5.10 Test of Model
Structural Equation Modeling (SEM) using AMOS 7.0 was used to test and present the results of the research model shown in Figure 5. Table 11 shows the summarized results of hypothesizes tests and shows the regression weights generated from path analysis. Note that majority of the non-significant path results have been omitted for clarity purposes. However, new paths that were not in the initial research model, have emerged from the data and are indicated as with '**New**' in the Hypotheses column of Table 11, while they are shown by thick line in Figure 5.

Table 11: Regression Weights For the Final DTAM Analysis Results

Variables	Hypothesis	Path			Estima	S.E.	C.R.	P	Remar
Environmental Variables Hypotheses	H5a	CP	-->	PU	0.034	0.032	1.058	0.29	NS
	H5b	CP	-->	PEOU	0.03	0.033	0.919	0.358	NS
	H6b	GS	-->	PEOU	0.031	0.028	1.092	0.275	NS
	H7b	VS	-->	PEOU	0.053	0.026	2.064	0.039	Supported
	H8b	SE	-->	PEOU	0.114	0.023	4.835	***	Supported
Technological Variables Hypotheses	H9a	CSE	-->	PU	0.078	0.027	2.848	0.004	Supported
	H9b	CSE	-->	PEOU	0.053	0.028	1.936	0.053	NS
	New	CSE	-->	SN	0.101	0.026	3.86	***	Supported
	H10a	CA	-->	PU	-0.09	0.023	-3.902	***	Supported
	H10b	CA	-->	PEOU	-0.059	0.023	-2.576	0.01	Supported
	H11a	PE	-->	PU	0.133	0.032	4.114	***	Supported
	H11b	PE	-->	PEOU	0.233	0.03	7.712	***	Supported
	New	PE	-->	SN	0.204	0.028	7.237	***	Supported
	New	PE	-->	CSE	0.185	0.033	5.624	***	Supported
	New	PE	-->	CA	-0.39	0.043	-9.156	***	Supported
	H12a	REL	-->	PU	0.135	0.027	4.926	***	Supported
	New	REL	-->	AICT	0.161	0.035	4.527	***	Supported
	New	REL	-->	PE	0.199	0.03	6.594	***	Supported
	New	REL	-->	SN	0.062	0.026	2.377	0.017	Supported
	New	REL	-->	CSE	0.087	0.031	2.831	0.005	Supported
	New	REL	-->	AU	0.138	0.028	4.942	***	Supported
Individual Variables Hypotheses	H19a	AICT	-->	PU	0.05	0.022	2.292	0.022	Supported
	H19b	AICT	-->	PEOU	0.077	0.022	3.58	***	Supported
	New	AICT	-->	BIU	0.072	0.02	3.652	***	Supported
	New	AICT	-->	AU	0.292	0.023	12.675	***	Supported
	New	PR	-->	PT	0.26	0.03	8.774	***	Supported
	New	PR	-->	AU	0.218	0.027	8.114	***	Supported
	H21b	PT	-->	PEOU	0.115	0.029	4.022	***	Supported
	New	PT	-->	AU	0.061	0.03	2.052	0.04	Supported
Organizational Variables Hypotheses	H13a	SN	-->	PU	0.175	0.033	5.352	***	Supported
	H13c	SN	-->	BIU	0.408	0.029	13.824	***	Supported
	New	AVAIL	-->	PR	0.202	0.032	6.214	***	Supported
	New	AVAIL	-->	AICT	0.37	0.038	9.65	***	Supported
	New	OS	-->	AVAI	0.416	0.034	12.424	***	Supported
	New	OS	-->	AICT	0.09	0.044	2.039	0.041	Supported
	New	OS	-->	PT	0.136	0.034	4.042	***	Supported
	New	OS	-->	SN	0.122	0.03	4.142	***	Supported
	New	OS	-->	BIU	-0.064	0.027	-2.351	0.019	Supported
	New	OS	-->	AU	0.1	0.032	3.137	0.002	Supported
	New	OL	-->	OS	0.426	0.034	12.558	***	Supported
	New	OL	-->	AVAI	0.421	0.036	11.748	***	Supported
	New	OL	-->	AICT	0.184	0.046	3.965	***	Supported
	New	OL	-->	SN	0.158	0.032	4.938	***	Supported
	New	OL	-->	AU	-0.124	0.034	-3.608	***	Supported
TAM Variables Hypotheses	H2	PU	-->	BIU	0.145	0.026	5.611	***	Supported
	New	PU	-->	AU	0.085	0.03	2.792	0.005	Supported
	H4	PEOU	-->	PU	0.209	0.031	6.826	***	Supported
	New	PEOU	-->	AU	0.107	0.031	3.476	***	Supported
	H1	BIU	-->	AU	0.136	0.035	3.914	***	Supported

**** p<0.001**

Using the results from path analysis, the corresponding regression weights for the paths that were initially hypothesized plus the new paths that have emerged from the data were shown in Table 11. The structural Model for DTAM had acceptable goodness-of-fit indices as shown in Table 10.

5.11 Indirect, Direct and Total Influence of Factors on BIU

The environmental, technological, organizational, individual factors that influenced ICT diffusion outcomes were summarised in Table 12, which shows the indirect, direct and total effects of variables on behavioural intention. From the results of Table 11, which were obtained by a path analysis technique, we note that six variables with the greatest total influence in order of their dominance include Subjective Norm (SN), Perceived Usefulness (PU), Perceived Enjoyment (PE), Organizational Leadership (OL), Relevance to Studies (REL), and Access to ICT (AICT). On the other hand, four variables namely Subjective Norm (SN), Perceived Usefulness (PU), and Access to ICT (AICT) and organizational support had direct effects on Behavioural Intention (BIU). DTAM explained 72.7 per cent of the students' intention to accept ICT, with good model fit.

Table 12 Total Effects of Factors on Behavioural Intention (BIU)

	Variable	Indirect	Direct	Total
1	Competition Pressure (CP)	0.006		0.006
2	Government Support (GS)	0.001		0.001
3	Vendor/ISPs ICT Support (VS)	0.002		0.002
4	Socio-economic (SE)	0.003		0.003
5	Computer Self-Efficacy (CSE)	0.057		0.057
6	Computer Anxiety (CA)	-0.015		-0.015
7	Perceived Enjoyment (PE)	0.131		0.131
8	Relevance to Studies (REL)	0.091		0.091
9	Subjective Norm (SN)	0.025	0.408	0.433
10	ICT Availability	0.03		0.03
11	Organizational Support (OS)	0.073	-0.064	0.009
12	Organizational Leadership (OL)	0.1		0.1
13	Perceived Resources (PR)	0.001		0.001
14	Perceived Time (PT)	0.003		0.003
15	Access to ICT (AICT)	0.01	0.072	0.082
16	Perceived Ease Of Use (PEOU)	0.03		0.03
17	Perceived Usefulness (PU)		0.145	0.145

Apart from Perceived Usefulness, all other variables had indirect effect on BIU. Using the significant direct effects yielded the estimated linear Equation 1:

Equation 1 BIU Regression Linear Equation

BIU =0.433*SN + 0.145*PU + 0.131*PE + 0.1*OL + 0.091*REL + *0.082*AICT + 0.057*CSE + Error

From the results of Factor analysis, the CEO characteristics, organisation readiness, and Top management support were merged to a single variable called Organizational Leadership (OL). This variable was then used along others for the analysis.

6. DISCUSSIONS

The purpose of this study was to investigate the nature and extent of influence of environmental, technological, institutional, and individual factors on ICT adoption, diffusion and infusion in institutions of higher education in a developing country, Kenya. Environmental, organizational, technological, and individual characteristics have been validated to be dominant factors, as we expected. Further, this study has extended TAM by building in it the contextualization variables like access to ICT and Availability of ICTs, that gives the model more predictive power ICT diffusion and user behaviour.

The findings of this study shown in Table 11 highlight some critical issues emerging from omissions of certain ICT diffusion pertinent variables that have been consistently ignored in the modelling and theorization of TAM emanating from developed world. This is revealed in this study by an attempt to investigate new contextual factors such as Availability of ICT in an institution. The results indicate that these variables such as Availability of ICT and Access to ICT are critical to the ICT adoption, diffusion, and infusion in a developing nation like Kenya. Although the hypotheses H15a, and H15b that proposed that availability of ICT in a university will have positive influence on Perceived Usefulness and Perceived Ease Of Use were not supported by the results of this study, an important finding that ICT Availability has a positive influence on both Subjective Norm (β=0.150, $p< 0.001$) and Access to ICT (β=0.270, $p< 0.001$) was established. Due to the fact that many of the previous studies have been done in the first world like US, Canada, Europe, and Australia, where the ICT Availability, and access to ICT by students in universities is not an issue of concern, these variables have been ignored in the theorization of TAM and other ICT diffusion studies. Consequently, it is not surprising that the availability of ICT and access to ICT variables have not been researched on previous studies adequately. Their inclusion is an important contribution to the theory of TAM, to information systems research, and practice of ICT diffusion and infusion, particularly in developing countries. These findings also question the validity of the TAM framework with PU and PEOU as the only endogenous variables that can influence BIU.

7. CONCLUSION, CONTRIBUTIONS AND RECOMMENDATIONS

Looking at the new relationship regression weights column and the significance levels (p column) in Table 11, we see when interactions between the DTAM variables is permitted beyond the initially hypothesized relationships, new postings are revealed. These new relationships particularly those dealing with Access to ICT, and Availability to ICT are critical in developing countries context like Kenya. It is evident from literature that the variables such as *Access to ICT* and *Availability to ICT* have been neglected in the preceding research using TAM in the developed world context. Consequently, this study has made an important contribution in the theorization of technology acceptance constructs by including the two factors. Moreover, the fact that the results show that Access to ICT has a direct influence on Behavioural Intention, confirms the many researchers who have questioned the sufficiency of Perceived Usefulness (PU) and Perceived Ease Of Use (PEOU) as the only two belief constructs that modify external variables influence on Behavioural Intention [48].

The need for institutions to invest in a strategic plan for ICT development is critical to the successful ICT diffusion. Top leadership personnel should therefore champion the ICT deployment process. From the results of this study, it can be concluded that (1) Organizational Leadership characteristics significantly influences organization support, ICT availability, and Access to ICT, (2) Organizational Support has a significant influence on Availability of ICT, (3) Availability of ICT has a significant influence on Access to ICT, and (4) the theorization of TAM with PU and PEOU as the only mediators of external variables is flawed. In general, the study recognized that while individual factors of Access to ICT, and Perceived Time had a positive and significant impact on user ICT adoption, diffusion and infusion, the factor Perceived Resources did not. Further, a number of individual characteristics including age, education, and ICT experience were treated as moderators as has been the norm with previous studies. The two essential factors that have been identified to have influence on Perceived Ease Of Use, in their order of significance are Access to ICT, and Perceived Time. From these results, it can be concluded that Access to ICT for students to engage in ICT usage is the highest individual determinant of intention and usage of ICT. Second, the ICT that is offered for adoption, diffusion and infusion should not only be useful to their daily activities, but also be easy to learn and use. ICT with greater degree of complexity will decrease the uptake of the ICT artefact. Therefore, the findings of this study conclude that (1) Access to ICT has a direct and significant influence on student Behavioural Intention to use ICT , and (2) Perceived Time has significant influence of Behavioural Intention to use ICT through perceived use of use.

7.1 Conclusion

The TAM extension done in this study is justified in the findings of a recent research that highlighted the major differences in ICT diffusion between developing and developed nations [4]. Based on the results of this study, we can conclude like [4] that the effects of some ICT diffusion factors could be similar whereas effects for some other factors could be different for developed and developing nations. Thus, there is need of a dynamic theory in the study of the ICT diffusion phenomenon [5].

From the findings, some practical implications can be derived from the DTAM framework. In the first place, the framework is dynamic in that out of the over hundred and thirty possible factors that can be included in ICT diffusion models, a researcher can select the most relevant variables and plug them into the four sets of external variables for analysis. Prescriptively therefore, the DTAM framework suggests that environmental, technological, organizational, individual, and moderating factors are responsible for driving ICT diffusion and infusion by individual users.

The final model has a number of implications for research and practice. The results confirmed that Perceived Usefulness has a strong direct effect on Behavioural Intention. This suggests that the functionality of an ICT system must be emphasized to potential users. Researchers can help determine ways to do this effectively, and the model indicates that efforts should focus initially on greater internal training, management support, and Vendor Support. Education and training programs should aim to increase awareness of potential applications and emphasize the benefits of using them. In addition, ICT system developers must address usefulness, as well as the ease of use, as an important design objective when developing systems. Ease of use also had a direct effect on use, as well as an indirect effect via Perceived Usefulness. This suggests that efforts to improve Perceived Ease Of Use can have a strong influence on ICT in institutions of higher education. Since internal support, which includes internal training, had influence on ICT diffusion, this highlights the need for institutions of higher learning to provide training for students to encourage them to use different ICT artefacts for their daily study activities. Furthermore, Vendor Support had a much greater effect on usefulness than Government Support. Vendors and consultants are often reluctant to provide training to institutions of higher education ICT users because of the assumption that universities are knowledge towers. Thus, strategies are required to make Vendor Support more available in ICT deployment. A possible strategy can involve vendor-training component in the deployment of any new system. The vendor can provide IS support on a regular, possibly monthly, basis for each institution. In addition, support and training sessions can be made available to institution users through an external information centre that can be utilized and funded by many institutions. Alternatively, a government agency or an educational institution can operate this external information centre. Researchers can examine the effectiveness of such strategies aimed at providing external support to institutions of higher education.

7.2 Recommendations

The results confirmed that Perceived Usefulness has a strong direct effect on Behavioural Intention. This suggests that the functionality of an ICT system must be

emphasized to potential users. Researchers can help determine ways to do this effectively, and the model indicates that efforts should focus initially on greater internal training, management support, and vendor Support. Education and training programs should aim to increase awareness of potential applications and emphasize the benefits of using them.

7.3 Implications for Further Research

With regard to future research, this study raises many questions about current approaches to the development of ICT diffusion models and frameworks that guide both developed and emerging economies toward ICT diffusion. The approach to using a few diffusion variables to build a model is too limited. More comprehensive models that are invariant with time, place and system, and can be used to increase the understanding of the importance of environmental, technological, organizational, individual, and moderating factors in the successful adoption, diffusion and infusion of ICT in both developed and developing economies are needed. An important, non-refutable implication of the Access to ICT and Perceived Time variable is that both are to account for a higher amount of explained variance in the Behavioural Intention construct. Therefore, it is recommended that further empirical research be directed towards these variables since they are new to IS diffusion research. A fruitful extension of the DTAM framework would be the incorporation of the effects of psychological predispositions towards the key DTAM beliefs. For example, the effects of Computer Anxiety and self-efficacy on Perceived Enjoyment, Perceived Usefulness and perceived ease-of-use in both voluntary and involuntary contexts.

Perhaps the most promising area for further research is in the extension of DTAM framework that has postulated several new relationships. including Access to ICT is positively related to Behavioural Intention; ICT Availability will positively influence the Access to ICT ; Organizational Support is positively related to Availability of ICT; Organizational Readiness is positively related to Availability of ICT ; Top Management Support is positively related to Availability of ICT ; Perceived Time to ICT is positively related to Perceived Ease Of Use; Organizational Leadership characteristics is positively related to Organizational Support; Access to ICT, and Availability of ICT.

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7.4 Research Contributions

The study has developed a complete nomological network of the factors that influence ICT diffusion and infusion—DTAM. DTAM has two major strengths, namely: *dynamism, and comprehensiveness.* While preceding studies like TAM presented a *parsimonious* model, and others like TAM3 aimed at completeness, their major weaknesses are the lack of dynamism that limited their applicability to both developed and developing world.

7.5 Research Limitations

The fact that this research has drawn upon more than ten theoretical viewpoints and involved a large size indicative sample of student subjects from 16 universities spread throughout Kenya, makes the findings valuable. However, the study recognized that there were limitations of this study, which could not be avoided. First, the limitation concerns the fact that the sample was drawn from one geographical location – Kenya. To generalize the findings globally a sample drawn from several developing nations especially in Sub-Saharan Africa, and another from developed world for comparison would have been more preferred. Therefore, generalisability must be considered as a concern. To address this issue, as the use of the ICT in learning and teaching in higher education institutions grows in Kenya and Sub-Saharan Africa in general further research could compare the model performance on responses by subjects in different geographical locations.

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Appendix 1: Comparison of SQRT(AVE) and Construct Correlations

	CP	GS	VS	SE	PU	PEOU	CSE	CA	PE	REL	AICT	AU	PR	PT	BIU	SN	AVAIL	OS	OL
AVE	0.89	0.9	0.92	0.89	0.93	0.92	0.93	0.91	0.93	0.94	0.89	0.89	0.92	0.93	0.92	0.92	0.91	0.91	0.92
SQRT(AVE)	0.94	0.95	0.96	0.94	0.96	0.96	0.96	0.95	0.96	0.97	0.94	0.94	0.96	0.96	0.96	0.96	0.95	0.95	0.96
CP	1																		
GS	.289**	1																	
VS	.144**	.133**	1																
SE	.100**	.163**	.019	1															
PU	.169**	.139**	.106**	.088**	1														
PEOU	.159**	.187**	.108**	.199**	.375**	1													
CSE	.157**	.122**	.145**	.060*	.274**	.211**	1												
CA	.000	.013	.014	.165**	.215**	-.118**	.086**	1											
PE	.152**	.132**	.118**	.005	.375**	.348**	.288**	.297**	1										
REL	.176**	.069*	.073*	.052	.325**	.173**	.235**	.142**	.282**	1									
AICT	.041	.126**	-.045	.117**	.196**	.214**	.091**	.069*	.138**	.201**	1								
AU	.055	.114**	.019	.195**	.285**	.289**	.149**	.002	.219**	.306**	.512**	1							
PR	.101**	.154**	-.022	.234**	.110**	.188**	.126**	.180**	.071*	.114**	.269**	.428**	1						
PT	.101**	.163**	.021	.198**	.160**	.239**	.108**	.139**	.082**	.168**	.262**	.356**	.460**	1					
BIU	.168**	.103**	.059*	.052	.373**	.243**	.254**	.195**	.355**	.297**	.236**	.322**	.141**	.253**	1				
SN	.144**	.122**	.046	.031	.359**	.260**	.262**	.183**	.343**	.252**	.176**	.250**	.155**	.174**	.534**	1			
AVAIL	.084**	.142**	.098**	.089**	.143**	.176**	.077*	.048	.130**	.086**	.484**	.291**	.308**	.250**	.198**	.273**	1		
OS	.127**	.178**	-.061*	.157**	.149**	.170**	.118**	.145**	.055	.185**	.395**	.354**	.396**	.358**	.152**	.255**	.534**	1	
OL	.151**	.216**	-.040	.079**	.216**	.218**	.171**	-.002	.165**	.170**	.401**	.240**	.294**	.242**	.246**	.326**	.534**	.496**	1

Appendix 2: Results of Moderating Variables

Path			No Moderators		Moderated by Gender		Moderated by Age		Moderated by Experience	
			Est.	P	Est.	p	Est.	p	Est.	p
PEOU	<---	PE	0.15	***	0.106	0.049	0.065	0.332	**0.363**	***
PEOU	<---	CA	-0.077	***	-0.063	0.014	-0.044	0.113	-0.049	0.024
PEOU	<---	CSE	0.076	0.007	10.631	0.245	0.016	0.959	-0.327	0.18
SN	<---	AVAI	0.15	***	0.17	***	0.21	0.011	0.411	0.004
PU	<---	PEOU	0.202	***	**0.411**	**0.007**	0.029	0.218	-0.009	0.67
PU	<---	PE	0.094	0.082	-0.021	0.717	0.009	0.819	-0.003	0.88
PU	<---	CA	-0.062	0.014	-0.055	0.01	**-0.038**	**0.002**	**-0.024**	***
PU	<---	CSE	0.055	0.09	3.424	0.242	-0.127	0.144	-0.11	0.028
PU	<---	SN	0.13	***	0.012	0.79	0.013	0.605	-0.01	0.568
BIU	<---	PEOU	-0.013	0.678	-0.026	0.262	-0.007	0.573	-0.015	0.087
BIU	<---	SN	0.358	***	**0.223**	***	**0.113**	***	**0.068**	***

Path			No Moderators		Moderated by Years/Study		Moderated by Voluntariness	
			Est.	P	Est.	p	Est.	p
PEOU	<---	PE	0.15	***	0.117	0.057	0.112	0.059
PEOU	<---	CA	-0.077	***	-0.027	0.318	-0.064	0.013
PEOU	<---	CSE	0.076	0.007	-0.495	0.294	-1.039	0.171
SN	<---	AVAI	0.15	***	0.39	***	0.491	***
PU	<---	PEOU	0.202	***	0.026	0.296	0.002	0.929
PU	<---	PE	0.094	0.082	0.004	0.863	0	0.991
PU	<---	CA	-0.062	0.014	**-0.035**	***	**-0.023**	**0.002**
PU	<---	CSE	0.055	0.09	-0.089	0.336	-0.152	0.154
PU	<---	SN	0.13	***	0.026	0.288	0.009	0.635
BIU	<---	PEOU	-0.013	0.678	-0.024	0.032	-0.012	0.167
BIU	<---	SN	0.358	***	**0.099**	***	**0.078**	***