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Determinants of Technology Innovation Implementation Effectiveness in Higher Education Institutions

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Abstract: Higher education institutions have continued to acquire technologies with alacrity. However, the transition from adoption to application in teaching and learning has been below expectations. This exploratory study investigated the lack of cadence between adoption and effective implementation of educational technology initiatives. The study was based on PHEA-ETI projects that ran between June 2008 and June 2012. The projects entailed implementation of technology initiatives for example animating science content among others. A questionnaire was sent to all persons involved in the implementation of the projects. Out of the 163 targeted respondents, 105 usable responses were received. Team leaders were interviewed with focus groups held with implementation teams. The study adopted: top management, financial motivation, organizational culture. The new model added the variables: team leadership, monitoring and evaluation and innovation efficacy. When the data was analysed using SPSS version 17, the results confirmed determinants from earlier studies while also showing that team leadership and project efficacy were significant factors to consider in technology innovation implementation.

Keywords: Technology Adoption Theories, Organizational Theory, implementation effectiveness, Higher education, information and communication technologies

1. Introduction

The question on how to scale up success in implementation of instructional technologies in higher education institutions (HEIs) has been a concern to stakeholders. This is because generally the success rate in adoption and implementation of ICTs and generally educational technologies has been less than 30% (Peansupap & Walker 2005, Gichoya, 2005). There is a lot of research done on ICT adoption amidst this high failure. This study undertook to investigate factors causing the success and failure of education technology innovation projects, with emphasis of the PHEA-ETI funded projects between 2008 – 2012. As with other countries, African universities have invested heavily in technology for all sectors of education, but with below par realization of expected benefits of the adopted innovations. The heavily funded projects have resulted in short-lived success or outright failure (Kirschner et al 2011). Traditionally, technical issues were viewed as being the major cause of implementation failure but contemporary research has shown organizational factors impact more (Peansupap et al 2005, Nurdin et al 2011). But the challenge is in knowing what organizational factors will lead to effective implementation of technological innovations. The study adopted an organizational theory stance developed by Sawang and Unsworth (2011) whose work was again based on study by Klein et al (2001). Data was

collected from the twenty-eight projects from the seven institutions through a survey method. This was aimed at ensuring future projects realize more effective implementation. This paper provides (1) an overview of organizational models and structures that can facilitate technology implementation in HEI, and (2) delves deeper into one of the models and discusses how the determinants there in are key (3) proposes team leadership and monitoring and evaluation as additions to the organizational factors.

2. Technology Innovation Implementation

Implementation in the context of this study looks at the stage after organization (top management) has assessed a technological innovation and agreed to adopt and handed it to team that would see its use. Thus it's the stage after primary decision to adopt an innovation has been made. Thus, while top management makes decision to adopt, the middle level, or affected department implements the innovation. Implementation effectiveness results when an innovation has been put to use by users. Weiner et al (2009) work defined implementation as a " course of action to put into use an idea, decision or program "p. 293. Weiner et al (2009) further posited that during implementation, the immediate outcome of interest was initial or early use. In vouching for adoption of an organisational theory, Weiner et al (2009) gave three reasons: that organisations had authority-based innovation decision process, meaning decision on whether to adopt or not was based on the organization. Werlinger (2009) study on implementing IT security supports application of organizational theory in implementation. Further they argued that the organizational structure produced the different levels of implementers and also introduced the organizational dynamics; they noted implementation process was a collective undertaking, not a one-man show. This was by observing that the activities in the implementation, viz: planning, promotion, training, resource allocation, pilot testing " must be coordinated and synchronized for employees working in different functional departments, work shifts and work locations" (p. 294); finally that senior managers expected that the innovation implementation process would lead to collective benefits to the organization.

Adoption of technologies in universities can be regarded as innovation because HEIs use them to as a new approach in delivery. Dede (2000) observed that these innovative new technology-based models when adopted in teaching and learning had the potential dramatically improve educational outcomes. This is an argument that still holds today from the point of contemporary researchers. In the PHEA-ETI case, integration of ICTs in education was the most popular of the innovations. ICT denote technologies computers, Internet, mobile, TV and radio. Due to technological convergence, we mainly see ICT as synonymous with computers and is known as ITCs. But a better wording would be computing devices because in modern society, mobile phones have become more common than computers while the convergence of these technologies have realized interoperability.

2.1 Related Study

2.1.1 Klein, Conn and Sorra (2001) Implementing Computerized Technology

Several studies have tried to explain what might lead to successful adoption of innovations. However, as noted in the literature, most of these studies address only the initial stage of innovation adoption, what could be referred to as decision to adopt stage. But one study which came up with a model that looked at the whole process of implementation, from initial decision making to innovation effectiveness was by Klein et al (2001). This work has been greatly cited, reviewed, critiqued and modified. Klein et al (2001) studied implementation of computerized technology and proposed a model. Specifically, the study looked at manufacturing resource planning (MRP) that was a software integrated by manufacturing firms to assist in their processes. The software assisted firms in tracking

production schedules, inventory control, supply of parts management and management of sales. The study focused on plants that had gone live with the MRP system utmost 24 months before commencement of the study. 39 plants based in United States were considered for the study. Respondents for the survey tool used were plant managers, other managers and supervisors that were involved with the system, team involved in the implementation of the system and users of the system. In total there were 1219 respondents. The survey tool mainly used a 5-point Likert scale measures with the plant being the unit of analysis.

In their regression analysis findings, the following variables were found to be significant and thus could be used to measure computerized technology implementation effectiveness: financial resource availability ($r=0.42$, $p<0.01$); management support ($r=0.31$, $p<0.05$); implementation climate ($r=0.40$, $p<0.01$); implementation policies and practice ($r=0.37$, $p<0.001$). The study used structural equation modelling to test overall fit of model. The study noted that although it was a preliminary study, it was the significantly contribution to implementation research that had gained little attention. Further they noted that success in implementing innovations had great influence on organization's survival. The study therefore noted that that for first time it elicited the information that management support, financial resource availability, policies and practices and implementation climate would see different organisations either make the implementation process effective or not. Maditino, Hatzoudes and Tsairidis (2011) studied the factors that affect the effective implementation of ERP system. Maditino et al (2011) study adopted kelin et al (2001) model. They came up with a questionnaire that was distributed to 361 companies in Greece. The September to December 2008 data collection saw 108 usable questionnaires returned. Structural Equation Modelling (SEM) was used to analyze data. Just like Klein, et al (2001), they noted that top management support greatly determined effective implementation. Other factors included: user support, consultant support, communication effectiveness, conflict resolution and knowledge transfer.

As noted, the Klein et al (2001) study only relied on survey method and thus might have ignored the details behind the figures. This is an area that further research would have looked into. The study also looked at only one innovation, which meant that there was limitation in generalization.

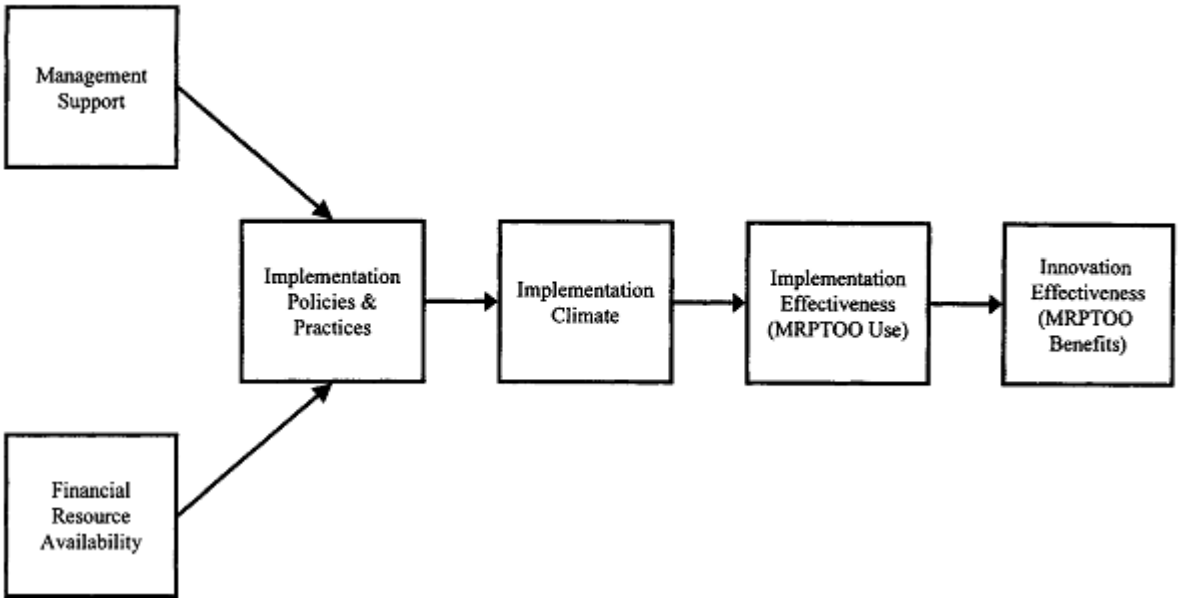

Figure 1: Klein, Conn and Sorra's (2001) model's Innovation Implementation Effectiveness Model

2.1.2 Weiner, Lewis and Linnan(2009) Effective implementation of worksite health promotion programs

Weiner et al (2009) studies the implementation effectiveness based on worksite health promotion programs. This was one of the many studies that have adopted Klein et al (2001) implementation effectiveness model. Weiner et a l (2009) study noted that although Klein , et al (2001) was based on technological innovations, it could also apply in health promotions study.

Weiner et a l (2009) study focused on Working Well Trial that involved four centres , Harvard/Dana Farber Cancer Institute, Brown/Miriam Hospital, MD Anderson Cancer Center and University of Florida. This was an experimental study that involved reduction of cancer risk. The strategy was to increase " employees' consumption of dietary fibre and reducing consumption of dietary fat and use of tobacco products and changing the worksite environment to support these employee health changes." (P. 295). The study found the following as key in determining implementation effectiveness: Organizational readiness for change (extent to which employees were ready to make organizational changes in policy and practice, to make the innovation a success); Implementation policies and practices (strategies put into place to support innovation use); Implementation climate (employee believe that the innovation is needed, supported and rewarded); Innovation-values fit (employee believe that the innovation will be of benefit to their work). As noted, Weiner et al (2009) introduces another variable, value fit.

The Weiner et al (2009) model had not been empirically tested. For example, the study was not clear on what testes were done to confirm that the determinants were key to effective implementation. Further, the authors state that they concentrated on parsimonious set of organizational constraints. They encourage those who adopt it to add more constructs for accuracy. Many of the constructs proposed are those in Klein, et al (2001) model. This makes the model's application quite plausible in implementation effectiveness study,

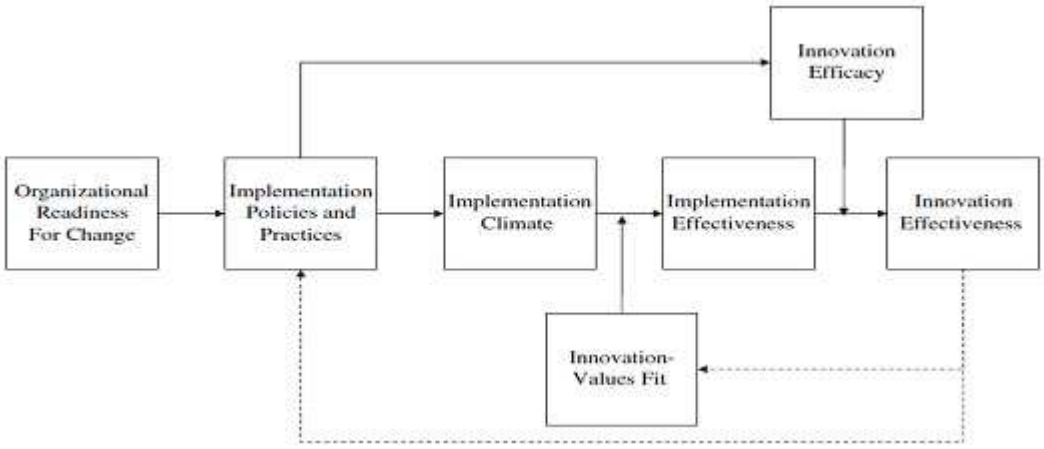

Figure 2: Weiner, Lewis and Linnan (2009) Determinants of implementation effectiveness

2.1.3 Sawang and Unsworth (2011) Organizational Innovation Implementation Effectiveness in Small To Medium Firms

Sawang and Unsworth (2011) study aimed at validating an earlier model by Sawang, Unsworth and Sorbello (2007) that proposed on implementation effectiveness. The Sawang, Unsworth and Sorbello (2007) model was a test of Klein et al (2001) model and was more of a comparison between Thai and Australian firms. In the 2011 study, Sawang and Unsworth (2011) surveyed 135 organisations. In this study, the human resources was noted as a significant contributor to implementation effectiveness. Specifically, the study found out that the skilled employees' availability was positively related to implementation

effectiveness of innovations in firms. The initial model that this study adopted had the variables; Financial resources availability; Top management support ;Implementation policies and practices; implementation climate. Some 750 firms were selected from Australian Business Register where the unit of analysis was firm itself. From the sampled firms, only 135 firms, which the study computed as 18% response rate responded. From the study, the following variables were found to be significant: Financial resources availability with □ = 0.76 and two items within; Top management support with three items and □ = 0.77; Implementation policies and practices with six items and □ = 0:81; Implementation climate with three items and □ = 0:92; Implementation effectiveness where the employees in the firms were asked to describe their experience with innovation. Again the variable was tested for internal reliability and had an □ = 0.74. Human resources availability had two items that were adapted from Nystrom et al's(2002) study. The internal reliability estimate was 0.73. The enhanced model had adequate fit to the sample in the study.

Like Klein, et al (2001) study, Sawang and Unsworth (2011) study used only survey method. This means that some underlying issues could not be brought out. This study therefore adapted the determinants stipulated by Sawang and Unsworth (2011) viz: financial availability, top management, organizational culture but while extending this to incorporate monitoring and evaluation, project efficacy and team leadership. Further, the variable financial availability will add financial motivation as a component.

2.1.4 Conceptual Model of Innovation Implementation Effectiveness

In this study, previous models in innovation implementation effectiveness were used as the basis for the proposed conceptual model (Figure 3). The empirical models of Klein et al (2001); Weiner et al. (2009) and Sawang and Unsworth (2011) formed a basis for coming up with the conceptual model. These models integrate social/human factors in determining implementation effectiveness. The research will therefore aim to describe the key constructs emerging from the study that is relevant to the study.

This study proposes to adopt and modify constructs used in implementation effectiveness of IT (Weiner et al, 2009) and Sawang and Unsworth (2011). The proposed conceptual model took a social angle in studying IT implementation effectiveness. The proposed conceptual framework assumed that the dependent variable, IT Implementation effectiveness, was influenced by various variables. These determinants included: Implementation climate (workflow/ workload, changes, new reporting systems, provide feedback), monitoring and evaluation (held project workshop, milestones, evaluator feedback, and lobby with management), financial motivation (availability of money when needed, compensation), project leadership (knowledge of project management, ICT knowledge, commitment) and top management (appoint leaders, appoint internal monitoring team, and provide resources).

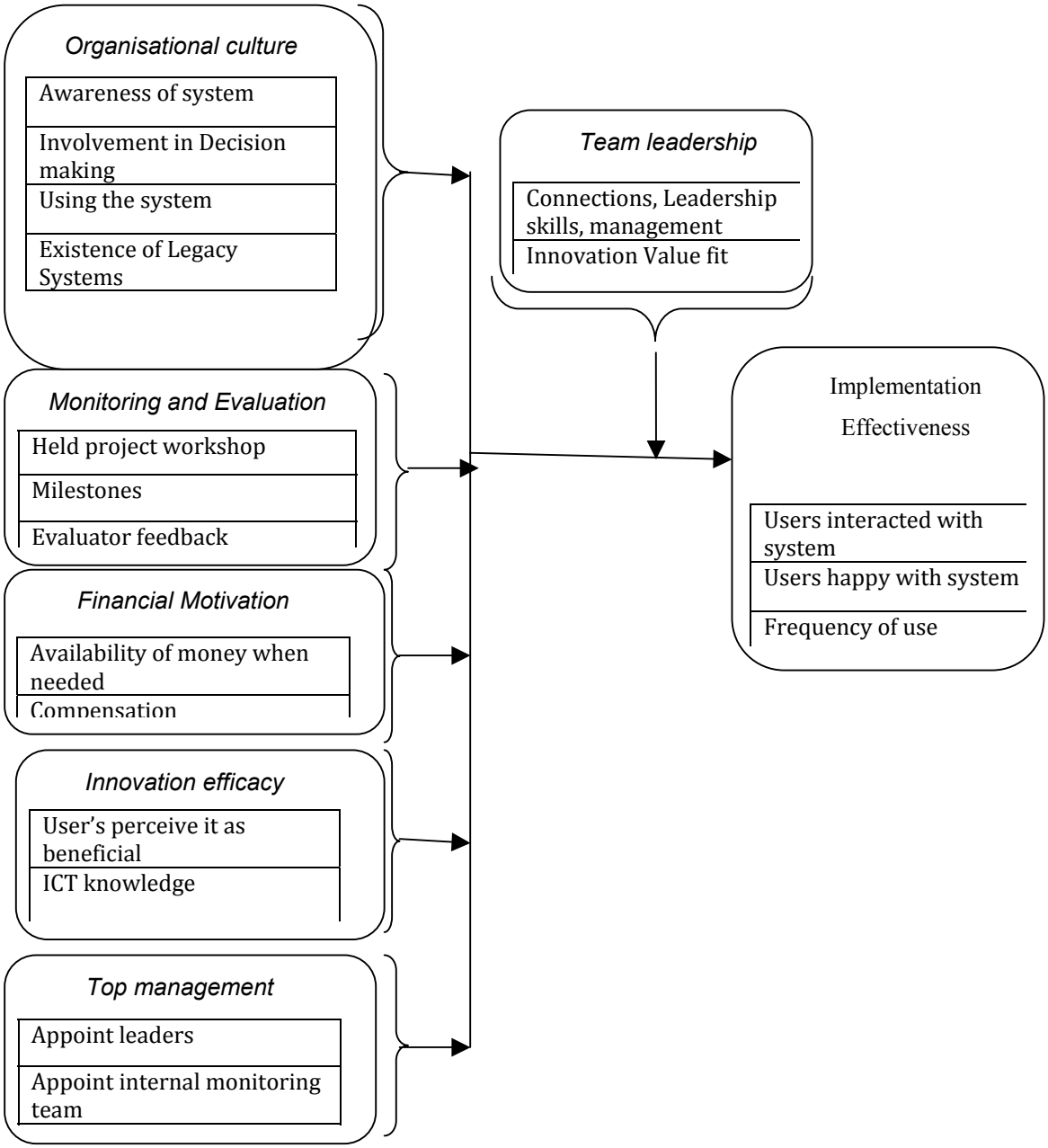

Figure 3: Conceptual Model

3. Methodology

The study was based on the PHEA-ETI projects run in six countries in Africa. The projects were run between 2008 and June 2012. The study used both survey questionnaire and interviews. The survey questionnaire was distributed through email. For this study, respondents were working on technology projects, were based in HEI and were predominantly using computers to implement the projects. Further, respondents were drawn from different countries and Thus, the use of emailed questionnaires was most suitable for the type of respondents targeted by the questionnaires. The wide geographical spread of respondents made it not economically viable for face-to-face administration and equally costly for posting the questionnaire. In this study, out of the expected 163 respondents, there were 105 completed survey responses giving a response rate of 64.4%. This response rate was also far much higher than what was recorded in similar studies in the implementation science domain (e.g. Helfrich et al 2007, Sawang, Unsworth & Sorbello

2007, Sawang & Unsworth 2011). Schmid et al (2012) argued that 20% was a too low while 80% was a de facto standard response rate. The 64.4% response rate in this study could therefore be regarded as acceptable from cited literature.

In-depth interviews with overall project team leaders in each university and specific project team leader were conducted. Further, focus group discussions were held with implementation teams and users. The interviews were transcribed verbatim and then theoretical thematic analysis was conducted. The transcribed write-up was read and re-read and the analysts extracted the overarching themes, referred to as thematic analysis (Smith et al 2011, Fillion 2009a). Smith et al (2011) contended that thematic analysis was one of the common method of analysis in qualitative research, an observation that was agreed with Malik et al (2008) argument. Theoretical thematic analysis framework ensured that units with meanings that were related to the study objectives were identified. The meanings were coded against subcategories as per the framework adopted.

3.1 Measures

The following were measured.

Implementation Effectiveness. This attributes determined whether the project had gone live or not at the end of the project duration.

Monitoring and Evaluation. Montgomery and Zint (2010) in their online publication define evaluation as critical examination of a program. They posit that evaluation involves: collecting and analyzing information on program activities, characteristics and outcomes. They see the purpose of evaluation as making judgment so as to improve the program's effectiveness thus informing programming decision.

Organisational culture. Ke and Wei (2010) believed that organizational culture was critical in ensuring that an organization tapped the benefits attributed to IS. In citing Martinsons and Chong (1999), the authors note that a good technology might fail to be adopted the stakeholders felt it interfered with their social systems.

*Top management***.** Top management is usually involved in initial decision to adopt the technology. They also play a role in financial support and motivation. Top management also carry the organizational vision and in most cases, they appoint the implementation team.

Team leadership. Once the top management has made a decision to adopt a given technology, they hand over the implementation process to a team. This team oversees the implementation process. The activities of the team can therefore lead to successful implementation or failure.

Financial availability and motivation. Finances are key to acquisition of necessary resources including human resource for innovation implementation. Finances could also be used as an inducement to those who participate in the implementation process. This could be honorarium or facilitation for travelling and compensating for time spent in implementing the innovation.

Innovation efficacy (fit). How well the users believe that the innovation will assist them in daily work would be a great boost in implementation process. When users can identify with an innovation, then they become active participants and even drive for its implementation. When users cannot identify with an innovation, then they see like its being to them by top management.

Table 1 Measurement of variables

Variable	**Parameters to be measured/ Indicators/Factors**
Implementation Effectiveness *(Dependent)*	Implementation Effectiveness (Y)
Organizational Culture *(Predictor)* Implementation climate *(Composite Predictor variable)*	Rewards and incentives (X_1)
	Workflow/ workload changes (X_2)
	New reporting systems (X_3)
	Provide feedback (X_4)
Monitoring and Evaluation *(Composite Predictor variable)*	Held project workshop (X_5)
	Milestones(X_6)
	Evaluator feedback (X_6)
	Lobby(X_7)
Financial Motivation *(Composite Predictor variable)*	Availability of money when needed (X_8)
	Compensation (X_9)
Project Leadership *(Composite Predictor variable)*	Knowledge of project management(X_9)
	Commitment(X_{10})
	ICT knowledge(X_{11})
User Involvement *(Composite Predictor variable)*	Individual believe(X_{12})
	Assistance in use(X_{13})
	Perceived Benefits(X_{14})
	Training(X_{15})
	Awareness of system(X_{16})
	Involvement in Decision making (X_{17})
	Using the system (X_{18})
Top management *(Composite Predictor variable)*	Appoint leaders (X_{19})
	Appoint internal monitoring team(X_{20})
	Provide resources (time, financial and human) (X_{21})
Innovation's Efficacy	User's perceive it as beneficial
	Value fit

4. Analysis of Results

The survey questionnaire was reviewed and approved by the institutional review boards at the researchers' university and at PHAETI, the project sponsors. From the survey, 106 responses were obtained from a total of 163 project members, which gives a response rate of 64 percent. A descriptive and inferential analysis was used to identify patterns in the data and draw conclusions. Cronbach alpha internal reliabilities were assessed for each construct. All constructs were "substantially reliable" with their alphas above 0.0.61 (Koch and Landis (1977). Landis and Koch's (1977) benchmarks were employed to determine reliability, that is from (a) 0 to .20 as "slightly reliable"; (b) .21 to .40 as "fairly reliable"; (c) .41 to .60 as "moderately reliable"; (d) .61 to .80 as "substantially reliable"; and (e) .80 to 1.0 as "almost perfect" (Landis & Koch, 1977, p.168). The overall sample size, discussed previously, was 106 respondents

4.1 Reliability Analysis

All items under the demographics were retained. When the items were tested for reliability using SPSS version 16, the determinant financial availability had and index of 0.350 but rose to 0.717 after four (4) iterations. This means four items describing financial availability were dispensed with. Project team test result had an index of 0.645 but rose to 0.722 after two iterations meaning two sub-variables were removed. Top management had a reliability of 0.738 with no iteration. User training had 0.794 after two iterations. System efficacy had a reliability result of 0.774. Organizational culture gave an output of 0.774 after two iterations. When a test of reliability was done on the all contributing factors, it was 0.839 with no iteration. This therefore meant that there was a high consistency in the responses provided and thus all items making up the determinants were considered for this study.

4.2 Significance test of individual items

Table 2: Regression results of financial availability and motivation against implementation effectiveness

Construct	**Variable**	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**
Financial Availability	FIN03	1.18427	0.42048	2.816	0.00486 **
	FiIN08	-1.00525	0.38172	-2.634	0.00845 **
	FIN10	0.77275	0.36717	2.105	0.03533 *
System Efficacy	SI05	0.90022	0.40484	2.224	0.0262 *
	SI04	0.62152	0.34047	1.825	0.0679
Organizational Culture	CU08	1.1704	0.3758	3.114	0.00185 **
	CU09	-0.9207	0.3782	-2.435	0.01491 *

On regressing financial availability and motivation (incentive), the variables FIN03 (Money readily available for project), FIN08 (financial compensation) and FIN10 (financial motivation) were considered as predictors for implementation effectiveness. Under project efficacy, variable SI05 (project is an improvement) was the only variable that came out as significant. However, variable SI04 also came out as very near significant where respondents were asked if they would revert to the old system given a chance. When regression of the variables under organization culture against implementation effectiveness was done, CU04 (availability of ICT technical persons), CU08 (time availability), CU09 (Staff given time off for project) came out as the significant factors. That meant these were

the items to be considered under the variable. When items under monitoring and evaluation were regressed against implementation effectiveness, none came out as significant. They were therefore dropped from final model.

Table 3: Regression results of team voluntariness and Project Leadership

Construct	Variable	Df	Deviance Resid.	Pr(>Chi)
Team Voluntariness	TIM03	1	5.2781	0.02159 *
	TIM13	1	3.8432	0.04995 *
Project Leadership	LE04	1	3.11699	0.07748

On regressing team voluntariness against innovation implementation effectiveness, TIM01 (individual interest), TIM03 (member works in section) and TIM13 (team member concern) were observed as significant variables. These was confirmed during the interview process as individual interest was very predominant as to why implementers remained in the projects they were in. Further, most implementers by default were implementing innovations within their sections. When items under the variable Top management were regressed against the dependent variable, none came out as significant. This was a great contrast to all studies under implementation of innovation which all showed that top management greatly influenced implementation. When project leadership was regressed against the dependent variable, only LE04 (Interest in project) came out as a significant variable. This therefore was the item that could be considered in the variable.

4.3 Internal Consistency

Internal consistency was done using the split half reliability test. Under this test, if all items are drawn from the same domain, then the two halves should correlate highly with each other. When this test was run on the data, financial availability's reliability was 0.70 after four(4) iterations. Golafshani (2003) argued that iterations helped to stabalise the results. During those iterations, the four items that were noted to have low correlations were removed. The variable project team had an internal consistency of 0.734 after two (2) iterations. Financial motivation had a value of 0.7 after 2 iteration. Top management had an internal consistency of 0.842 while user training had a value of 0.712 after one iteration. System efficacy had a value of 0.831 with no iteration. Organisational culture internal consistency result was 0.735 after three iterations. Team leadership's internal consistency result was 0.661 after three iterations. Finally when a test of internal consistency was done on all the variables included in the model, the result was 0.848 with no iterations. This meant that all the variables had a high internal consistency and thus could all be considered as determinants to innovation implementation effectiveness.

4.4 Test for Multicollinearity

Table 4 below is a score test table that is used to predict whether or not an independent variable would be significant in the model. Looking at the p-values, we can see that only the variables Finance_Availability ($p<0.05$), Project_Team ($p<0.05$), Top_Management ($p<0.05$), System_Importance ($p<0.05$ and Team_Leadership ($p<0.5$) were significant while monitoring and evaluation ($p=0.113$) was close to significance in the estimated model. These variables were considered in the final logistic regression analysis. The other two variables, User_Training ($p=0.317$) and organizational culture ($p=0.4870$) had results that showed that they were not significant and thus were not considered in the final model. The overall statistics shows the result of including all of the predictors into the model. According to the results, the overall model that includes all the independent variables in the

model will be significance (score=7.198, p=0.303). This is also supported by the omnibus tests of model coefficients where the overall model was established to insignificant (χ (6) = 8.094, p=0.231

Table 4: Score test table

	β	S.E.	p-value	Exp(β)
Finance Availability	-.654	0.286	.022	.520
Project Team	1.104	0.359	.002	3.017
Top Management	.768	0.362	.034	2.157
User Training	-.290	0.290	.317	.748
System Importance	-.638	0.282	.024	.528
Organizational Culture	.304	0.431	.480	1.356
Team Leadership	-.850	0.417	.041	.427
ME	.050	0.033	.133	1.051
Constant	.155	0.244	.526	1.167

5. Further Study

The response rate was below 80% which related literature contends is good though not mandatory. Further Hoonakker and Carayon (2010) citing Hox and deLeeuw (1994) agreed a high response rate was a quality criteria for any survey. The non-response could therefore have had ramifications on the validity of a research and its conclusions. As noted in earlier, response rate in web based survey is lower than paper based or face to face. There is therefore a need to integrate multi-method data collection and confirm the results.

The projects were diverse in terms of implementation domains. For example, although most were on content development in LMS, some were on TV, radio and mobile. There is therefore a need to focus on narrow domain for example efficacy of mobile learning or TV and radio learning. This might provide deeper insights onto challenges and determinants to effective implementation.

The lack of cadence in some response between the interviews and questionnaire could have resulted due to the fact this was a self-report and thus some respondents answered in some socially desirable way. For example, while survey tool indicated monetary incentive was not a main motivator to commitment in the innovation process, the interview process clearly showed the contrary. Therefore it would be useful to perform a test-retest on the survey tool.

This study used ordinal scale (categorical) in data collection, specifically, a five-point Likert-type, ranging from 'strongly disagree', 1, to 'strongly agree', 5. This became a challenge in computing the p-value. The survey questions can be customized to use scale measurement and empirically determine how the results compare.

6. Conclusions

The paper describes the determinants of technology innovation implementation in HEIs. This is in a bid to mitigate the low rate in application of technology in technology in teaching and learning. The study adopted previous empirical studies on implementation effectiveness. These studies were further improvement of the Klein et al (2001) technology implementation model. A pilot test was done on the instrument developed and a reliability test of the data received was undertaken. First this study confirmed the findings of earlier studies on implementation science, specifically, that financial resources availability, top

management and organisational are key determinants to innovation implementation. A surprise finding was that top management support was not significant. This study extended earlier studies and tested if innovation efficacy, monitoring and evaluation and team leadership could determine technology implementation. Test results showed that except monitoring and evaluation, the others were significant. However, in the monitoring and evaluation team from SAIDE visibility was more in training than oversight body from implementers perspective and thus this explains the findings from quantitative data. The study showed that monitoring and evaluation and team leadership could be considered with other stipulated determinants, viz: top management, financial availability, organisational culture by stakeholders in technology innovation implementation.

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