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# Acceptance of Internet of Things in Developing Countries:
## An Empirical Study Using Value-Based Adoption Model

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### ABSTRACT

This study examines the acceptance of internet of things (IoT) in developing countries. The study adopted value-based adoption model (VAM) and integrated with perceived trust to examine mobile payment as the sample application of IoT. Convenience sampling technique was employed to identify the ideal areas for data collections. Mall intercept technique (MIT) was employed to collect a total of 430 valid cases from mobile payments users in mobile payment centers. Structural equation modeling (SEM) was employed to examine the paths of the hypothesized relationships. The findings show that usefulness, perceived trust, perceived value, and perceived fee have direct and significant influences on acceptance of internet of things in developing countries. Furthermore, perceived fee, technicality, and perceived enjoyment were also found to have significant effects on perceived value. The study has provided theoretical and practical implications to researchers and policymakers on how to increase consumption of IoT services in developing countries.

### KEYWORDS

Acceptance, IoT, Mobile Payments, Perceived Trust, Tanzania, VAM

### INTRODUCTION

The development of technology has resulted into huge connection of different smart objects which have to communicate in providing various services to users. This expansion has given a rise to new concept termed as Internet of Things (IoT) (Karen, Scott, & Lyman, 2015). Various projects related to IoT have been deployed to enable users to interact with smart objects through the internet and make services easily accessible (Hsu & Lin, 2016a). The use of technologies such as mobile payments, biometric identification, smart logistic and internet finance are becoming common in people's life because it enables capturing, processing and dissemination of real-time information which simplify service accessibility (Hu et al., 2017). Radio frequency identification (RFID), intelligent sensors, actuators and mobile phones are networked through wired or wireless to enable fast and easy communication between devices (Hsu & Lin, 2016a; Hu et al., 2017). This connectivity has made the field of IoT to attract more attention in recent years and it is considered as one of the best technologies which could simplify services accessibility if it is clearly implemented and accepted. The rise of IoT could be due to the availability of low-cost technologies, low energy and efficiency wireless sensors, ubiquitous internet and advancement in cloud computing technology (Mattern & Floerkemeier, 2010).

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Real-time data and information sharing is very limited in developing countries particularly sub-Saharan Africa (SSA) as a result different sectors such as agricultural, health, transportation and environment are growing slowly. Therefore, proper implementation of acceptable IoT in SSA could enhance fast development in different sectors (Miazi, Erasmus, Razzaque, Zennaro, & Bagula, 2016). Despite the availability of enabling environment for usage of IoT, there are a lot of challenges which limit IoT acceptance. Different studies have been conducted to identify various pressing technical and social challenges such as cost, connectivity, security, privacy, legal and interpretability which limit the application of IoT (Hsu & Lin, 2016b; Karen et al., 2015). Nevertheless, thorough literature scanning revealed that few empirical studies have been conducted to examine acceptance of IoT in developing countries (AlHogail, 2018; Gao & Bai, 2014; Jaafreh, 2018; Kao, Nawata, & Huang, 2019; Nikbin, & Abushakra, 2019). However, these studies have concentrated on Middle East and East Asia countries. Little evidences have been found on studies related with IoT in SSA (Atayero, Oluwatobi & Alege, 2016). This is because the IoT is still in its early stage of development in developing countries and particularly in SSA (Miazi et al., 2016). Furthermore, studies have shown that technology adoption lags behind in SSA which could also limit acceptance of IoT (Wamboye, Tochkov, & Sergi, 2015). This implies that the acceptance and usage of IoT in SSA will be very difficult if antecedents that may contribute to its acceptance and usage are not clearly understood. Therefore, this study adopts value-based adoption model (VAM) to identify the antecedents that could influence the acceptance and usage of IoT and particularly mobile payments in developing countries, specifically in Tanzania. The findings of this study will benefit the IoT services' providers to understand why and how people will consume their services and thus improve the service.

This study contributes to the literature on the following ways. Firstly, it extends limited knowledge on the acceptance of IoT in sub-Saharan Africa. This is because limited empirical studies have been conducted in sub-Saharan Africa to examine the acceptance of IoT. Secondly, the study extends VAM theory by adding perceived trust to examine its influence on the acceptance of IoT.

The study started with introduction whereas the next section provides extensive literature review on IoT and adoption theories followed by a section on conceptual framework that explains the current study model and the hypotheses. Other sections of the study include methodology, results and implication and limitations.

## LITERATURE REVIEW

### Internet of Things

Internet of Things is defined as the integrated network of smart and connected devices which are uniquely identified by using standard IP address protocol to communicate and share real-time data with minimum human intervention (Evans, 2011; Hsu & Lin, 2016a; Hu et al., 2017). Each thing (object) operates within the existing internet infrastructure. These smart objects are considered to have basic computer capability which enables them to activate actions which have effects on physical reality (Hsu & Lin, 2016a).

IoT is considered to be the next generation of internet which have changed everything in terms of the way we live, work and play due to its ability to gather, organize and distribute data that change to information and assist in making fast and better decision (Evans, 2011; Karen et al., 2015; Mattern & Floerkemeier, 2010). Studies have shown that 50 billion devices will be connected by 2020 of which about seven (7) devices will be connected per person globally (Evans, 2011; Hsu & Lin, 2016a). IoT is considered as superior in closing the gap between poor and rich, distribution of resources and provide better way of being productive. Furthermore, IoT increases productivity and efficiency, reduce risk and downtime, increases innovation meanwhile reducing operational cost as well as enhancing customer experience (Hewlett Packard Enterprise, 2015).

In developing countries particularly in SSA, the number of smart objects such as smartphones and smart cards are increasing and making large percentages of people to be connected to the internet through their smartphones (Evans, 2011). This means, the IoT will be more important to our lives and thus there is a need to understand how users could interact with the IoT technologies. Researches show that as more connected sensor-enabled devices and wireless communication increase, problems related with security and privacy risks also increase (Hsu & Lin, 2016b; Nic, 2008). Several studies have been conducted to provide more understanding on how IoT may be implemented so as to realize its economic and social benefits (Ericsson, 2015; Evans, 2011; Hewlett Packard Enterprise, 2015).

Several empirical studies have been conducted to examine acceptance of IoT in developing countries, most of these studies have been conducted in Middle East and East Asia countries to explaining acceptance of IoT on SME, entrepreneur, wearable fitness devices and domestic appliances (AlHogail, 2018; Gao & Bai, 2014; Jaafreh, 2018; Kao, Nawata,& Huang, 2019; Nikbin, & Abushakra, 2019). However, empirical behavioural studies on acceptance of IoT on SSA are less in literature despite the increase in services provided through mobile technologies in SSA. This could limit people in SSA to realize the potential benefits of IoT services. Therefore, this is the research gap to be addressed by this study.

## Value-based Adoption Model (VAM)

Different technology adoption models such as Technology Acceptance Model, Theory of Reasoned Action and Unified Theory of Acceptance and Use of Technology are prominent and mostly used in examining the acceptance and usage of various traditional technologies such as spreadsheet and word processor (Ajzen, 1985; Davis, 1989; Venkatesh, Morris, Davis, & Davis, 2003). However, these theories have applicability limitation in new ICT environment where mobile based technologies are considered to dominate the ICT industry (Hsu & Lin, 2016b; Kim, Chan, & Gupta, 2007; Kim, Park, & Choi, 2017). Kim et al (2007) explained that the prior theories did not consider the influence of perceived value in explaining adoption of technology which is very important in adoption of mobile internet technologies. This is because in new ICT environment's (Mobile Internet Technology) users are mostly using technologies for their personal purposes while in traditional environment most of the users were considered as employees where technologies were used for work purposes (Kim et al., 2017). Therefore, the current users of mobile internet technologies are more concerned with values offered by the technology before adoption. Due to this, Kim, Chan and Gupta (2007) proposed value-based adoption model (VAM) which is to be used when technology is used by individual instead of being used in organization settings. This is because traditional technologies were mostly used for work purposes in which the cost of using the technology was tolerated by the organization and therefore value maximization is less considered by the users. The situation is different for personal users, the usage of the services is voluntarily and the cost of adopting and usage of the technology is tolerated by an individual and therefore the users are emphasizing on value maximization (Hsu & Lin, 2016b; Kim et al., 2017). Since IoT is mostly used by individuals in their daily life activities to increase their work efficiency and performance, IoT users would be more emphasizing on value maximization. This is because most users would prefer the behaviour which will have the highest payoff. Most of the previous empirical studies examining acceptance and adoption of IoT in developing countries have employed TAM, UTAUT2 and technology trust model (AlHogail, 2018; Gao & Bai, 2014; Jaafreh, 2018; Kao, Nawata,& Huang, 2019; Nikbin, & Abushakra, 2019). Since these theories does not take into account the issue of value maximization offered by IoT, then developing model using these theories could lead to missing of useful and valuable information to researchers and practitioners on acceptance of IoT service. Therefore, the current study adopt VAM to examine the acceptance IoT in SSA and mainly in Tanzania

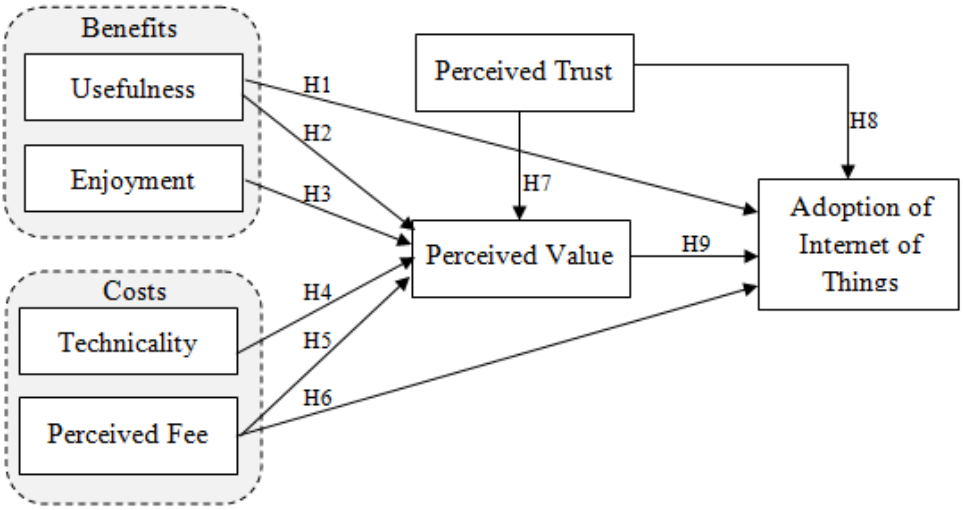
## The Need Of Trust In Iot

Trust is considered as one of the main elements of online communication (Brynjolfsson & Smith, 2000). Trust provides the means to assure service's users that their personal identified information are protected and user's information is only used as per available agreed purposes. In mobile ecosystem privacy and security of connected devices have been considered as the major issue (Cision, 2016). Studies have shown that 60% of the mobile users globally are worried about connected mobile devices (Cision, 2016). This is to say that, large percentage of mobile users is uncomfortable with their privacy and security in IoT. Similarly, previous studies have clearly shown that security and privacy are major challenges for users to adopt IoT (Gao & Bai, 2014; Medaglia & Serbanati, 2010). This affects the rate of IoT technology uses. The study conducted by Li, Da Xu and Zhao (2015) pointed out that a trusted IoT service should highly consider interoperability, compatibility, reliability and effectiveness factors. Therefore, there is a need for organizations that are providing their services through IoT to build consumers trust based on the above factors. Despite the importance of trust on IoT services, little empirical studies have been conducted in this area to examine the influence of trust on adoption of IoT in developing countries like Tanzania. Therefore, this study extends VAM with trust variable to examine its influence on adoption of IoT in developing countries particularly in Tanzania.

## Conceptual Model and Hypotheses Development

This study adopt value-based adoption model (VAM) to explain the acceptance of IoT in developing countries. Studies have shown that perceived value is the main factor in explain adoption of technologies for personal users (Kim et al., 2017; Roostika, 2012). Perceived value is defined by two main factors which are benefit and cost. Benefit factor is defined by usefulness and enjoyment whereas cost factor is defined by technical issues (non-monetary) and fee (monetary) associated with technology adoption. The model was further modified to examine the direct relationship between usefulness and behavior intention because TAM depicted that usefulness has direct effect on behavior intention (Davis, 1989). Similarly, UTAUT2 illustrate that consumers are sensitive to the monetary cost associated with service and therefore could directly affect their behavior intention to adopt technology (Venkatesh, Thong, & Xu, 2012). Therefore, examining the direct effect of usefulness and perceived cost on behavior intention in presence of perceived value as mediating variable could provide new insight and useful information to IoT service providers and researchers. Nevertheless, VAM has not specifically considered the issues of trust, given the fact that on mobile internet technologies trust is very important to examine the effect of perceived trust on acceptance on mobile internet technologies (Guangming & Yuzhong, 2011; Xin, Techatassanasoontorn, & Tan, 2013). Therefore, the adopted model was extended by using perceived trust variable. This is because, several studies have shown that privacy and security are the major issues which limit usage of IoT (Cision, 2016). Therefore, examining the influence of perceived trust in acceptance of IoT in this study could clearly provide information to researchers and organization's policy makers on the importance of perceived trust when integrated in examining the acceptance of IoT in developing countries.

**Figure 1: Research Model for adoption of Internet of Things**




Usefulness is considered as the total value perceived by the user when using a new technology (Roostika, 2012). Furthermore, Davis (1991) defines perceived usefulness as the degree to which an individual believes that using a particular system/ technology could improve his/her job performance. This means, users evaluate their behaviour of using the technology based on the usefulness of the technology and their choice is based on the desirability of the technology usefulness. Several empirical studies have been conducted to examine the influence of usefulness on mobile technology adoption and concluded to have positive and significant effect on behavioural intention (Gao & Bai, 2014; Kwon & Seo, 2013; Roostika, 2012). Based on the previous studies, this study hypothesizes that when IoT's users perceive the technology to be useful their likelihood to adopt IoT technology will be very high. Therefore, this study posits that:

H1: Usefulness will have positive and significant effect on behavioural intention to use IoT.
H2: Usefulness will have positive and significant effect on perceived value.

Enjoyment is considered as one of the elements of intrinsic and affective benefit (Gao & Bai, 2014). Enjoyment is defined as the extent to which the activity of using a service/product is perceived to be enjoyable in its own right apart from performing the intended work (Kim et al., 2007). Previous empirical studies have shown that when technology's users perceive the technology to be enjoyable (fun and pleasure) its value tends to increase and hence the likelihood of technology adoption tends to increases (Gao & Bai, 2014; Kim et al., 2007; Roostika, 2012). Similarly, when IoT users perceive the IoT to be enjoyable they will consider the IoT to be of high value thus the likelihood for accepting IoT will be very high. Hence this study predicts that:

H3: Enjoyment will have positive and significant effect on behavioural intention to use IoT.

Technicality is considered as the degree to which the technology is perceived to be excellent in providing the intended services (Kim et al., 2007). The issue of technicality is highly associated with ease of use of the technology/ system which defines the extent to which users perceive that using a

system could be free of physical and mental effort (Davis, 1989). Various issues such as readability, connectivity and efficiency have been considered as the main factors which define ease of use of the system or technology (Kim et al., 2007). Similarly, in IoT where users are using different mobile objects to establish connection to other existing objects, the issues of readability, connectivity, efficiency, interoperability increase more complexity which could slow down the usage of IoT. Furthermore, several studies have shown that lack of adequate standards which define interoperability in middleware and interface tends to reduce competitiveness of IoT (Li et al., 2015). Based on the above explanation, technical issues listed above could lower the perceived value of IoT and therefore reduce the likelihood of prospective users to adopt the technology. Several empirical studies have shown that technicality have significant negative effect on perceived value (Kwon & Seo, 2013; Roostika, 2012). Therefore, this study predicts that:

H4: Technicality will have negative and significant effect on perceived value.

Perceived fee is considered with fee associated with selling of a product or services (Arvidsson, 2014). The fee associated with mobile internet technology is based on pay as you use structure. Mobile internet service's users are considered to compare the mobile internet usage with mobile phone calls. If customers perceive that the fee to use the mobile internet is very high, the likelihood of considering the internet services to have high value is considered to be low and hence low adoption. Various empirical studies have established that, perceived fee have negative effect on perceived value (Arvidsson, 2014). Based on previous studies, this study predicts that:

H5: Perceived fee will have negative and significant effect on perceived value.
H6: Perceived fee will have negative and significant effect on behavioural intention to use IoT.

Trust is considered as one of the factors which reduce uncertainty and risk which is associated with the uses of the services. In the context of IoT, most of the users particularly in developing countries are less inexperienced with the uses of electronic services in which some of them involve financial transactions (Anthony & Mutalemwa, 2014). Most of the electronic service's users are very concerned with their security and privacy when it comes to conducting electronic transactions and communicating their data via various connected smart objects due to fear (Kabanda & Brown, 2015). This means if the service's users have high level of trust they will likely to consider IoT services to have very high value as well as their likelihood to accept IoT services will be very high. Several empirical studies have concluded that trust have significant positive influence on adoption of IoT services (Masele & Taluka, 2017; Xin et al., 2013). Based on the previous studies, this study hypothesizes that:

H7: Perceived trust will have positive and significant effect on perceived value.
H8: Perceived trust will have positive and significant effect on behavioural intention to use IoT.

Perceived value is considered as the individual assessment between perceived benefits(what is received) and perceived cost (what is given) associated with using mobile technology (Zeithaml, 1988). Several empirical studies have been conducted to examine the influence of perceived value on acceptance of mobile internet technologies and they concluded to have strong significant influence on acceptance of the technologies (Ko, Kim, & Lee, 2009; Roostika, 2012). This means, if IoT users perceive that the IoT add more value to their daily activities, their likelihood to accept and use it will be very high. Based on the above arguments, this study hypothesizes that:

H9: Perceived value have positive and significant influence on adoption of IoT.

## METHODOLOGY

### Questionnaire Development

This study has used mobile payment services as specific application of IoT which enable payments for various internet services (Thiesse et al., 2007). Using a specific application of IoT could enhance the rigor and exactitude of this study (Gao & Bai, 2014). Mobile payment is one of the important areas in IoT which is considered to significantly minimizes transactions cost as well as speed up business processes (Wilson & Mbamba, 2017). Mobile companies have invested a lot of resources to make sure that people particularly those who are living in rural and remote areas could be able to make electronic transaction instead of depending on physical cash. However, studies have shown that mobile payments have not taken off as fast as it was expected in Tanzania (Mutalemwa & Anthony, 2014), therefore using mobile payment to examine acceptance of IoT services could improve how IoT services including mobile payments could be deployed and consumed by users in developing countries.

The questionnaire used in this study contains three main sections, the introductory part (section which introduces respondent to the research being conducted), and demographic information and measurement items. The introduction section was important to familiarize the respondents on the mobile payment services as one of the application of IoT. Demographic details were collected for the purposes of segmenting the data and compare the respondents. All the measurement items used were borrowed from previous empirical studies. Measurement items related with perceived values were borrowed from Kim et al. (2007), usefulness (Amoroso & Hunsinger, 2009; Ng & Ghobakhloo, 2018), enjoyment (Sun & Zhang, 2006), technicality (Kim et al., 2007), perceived fees (Kim et al., 2007), perceived trust (Ayyash et al., 2011) and behavior intention (Amoroso & Hunsinger, 2009; Boonsiritomachai & Pitchayadejanant, 2017) as shown in Appendix A. all borrowed measurement items statement were customized to suite the current IoT context. Five-point Likert measurement scales were used to measure degree of consumer's perception with each statement. The developed questionnaire was pre-tested using two stages: The focus group which comprises of IS research experts, this was conducted to check if the questionnaire was clearly developed and all the necessary information was included in the questionnaire (Czaja, 1998; Kragt, Bennett, & Jakeman, 2010). After corrections based on experts' recommendations, the questionnaire was translated to Swahili by Linguistic expert to enable respondents to clearly understand the questionnaire items. The second stage which is pre-testing survey was conducted using 20 mobile payment users to check if the intended respondents could be able to understand clearly the questionnaire (Gao & Bai, 2014; Grimm, 2010). Some of the observations and suggestions from pre-testing survey were considered for improvement of the final questionnaire to be used for main survey.

Sample size used in this study was determined by using rule-of-thumb which state that at least 200 cases or 20 cases per parameters should be used when Structural Equation Modeling is applied in data analysis (Jackson, 2003; Kline, 2011). Based on these guidelines, this study used a minimum of 430 cases which is higher that the recommended sample size threshold when using rule-of-thumb or number of cases in each case.

### Sampling Procedure

The study was conducted in Dar es Salaam city because mobile payments are highly practiced in Dar es Salaam which is the business city of Tanzania (Economides & Jeziorski, 2017). Data were collected from all five districts (Ilala, Kigamboni, Kinondoni, Temeke and Ubungo) of the region to ensure variability within the population of interest is represented (Butler, 2008). In each district, the data were collected from famous centres which use mobile payment services. Since it was difficult to establish list of mobile payments' users in each district, then convenience sampling technique was employed to locate centres where mobile payments users may be obtained (Etikan, Musa, & Alkassim, 2016). The study was conducted for 12 weeks to collect the data from the mobile payment's users. Mall Intercept survey technique was employed to select respondents because the method is considered to be

viable on hard to reach segment (Bush & Hair Jr, 1985; Rice & Hancock, 2005). Research assistants were positioned on various mobile payment points and requesting all shoppers who are paying using mobile payments to fill the questionnaire. Other questionnaires were left on the service provision points which accept payments via mobile payments for distribution to shoppers. Respondents who were willing and ready to fill in the questionnaire were given the hard copy questionnaire to fill on the spot. Other questionnaires were left at the mobile payment points for other customers to fill in at their own convenient time and they were collected later.

### Data Analysis

Structural equation modeling (SEM) was employed to analyze the relationship between the constructs. SEM was preferred over traditional statistics techniques (traditional Ordinary Least Square) because SEM has ability to handle measurement errors in observed variables which increases the precision of items used to measure respective constructs (Hair, Black, Babin, Anderson, & Tatham, 2010). Handling of measurement errors in each item enables quality output of the findings (Hair et al., 2010). Furthermore, SEM allows simultaneous test of the relationships between dependent and independent variables in just one analysis (Hair et al., 2010; Tarhini, Hassouna, Abbasi, & Orozco, 2015). Covariance-Based SEM (CB-SEM) was preferred over PLS-SEM because the objective of the study was to examine the hypothesized relationships which are entirely theory-driven, therefore using CB-SEM provides more valid and reliable results (Hair, Sarstedt, Ringle, & Mena, 2012; Ng & Ghobakhloo, 2018). Two steps data analysis techniques were employed in this study: Confirmatory factor analysis was employed to examine validity and reliability of the measurement model while structural model analysis was employed to examine the path-coefficients between the constructs (Hair et al., 2010). IBM AMOS software version 22.0 was employed to analyze the data because it is more fast as compared to previous version, efficient and user-friendly (Awang, 2015)

## RESULTS

A total of 440 questionnaires were received. Ten (10) questionnaires were discarded due to the large number of missing values and suspicious patterns, therefore 430 questionnaires were used for data analysis. Table 1 shows that male person are the most users (56%) of the mobile payment technologies in Tanzania. The youth are the majority (48.1%) who are using mobile payment technologies. Most of the mobile payment technology' users are Swahili speakers (92.6%). Furthermore, most of the users (58.8%) are using mobile payment technologies occasionally.

**Table 1. Descriptive Analysis**

| Characteristics | Groups | Number | Percentage |
|---|---|---|---|
| Gender | Male | 241 | 56.0 |
| | Female | 189 | 44.0 |
| Age | 15-34 | 207 | 48.1 |
| | 35-54 | 177 | 41.2 |
| | 55 and above | 46 | 10.7 |
| Language | Swahili | 398 | 92.6 |
| | English | 32 | 7.4 |
| Mobile payment Usage | Very rare | 253 | 58.8 |
| | Moderate | 118 | 27.5 |
| | Frequent | 59 | 13.7 |
| | | | |

## Missing Data and Normality Assessment

Data collected were analyzed for missing values and data normality in order to produce valid and reliable results (Kwak & Kim, 2017). Ten (10) were discarded due to large number of missing values and suspicious pattern. Fifteen (15) questionnaires had minor missing values of which Little's MCAR test was used to analyze its effect (Li, 2013). The findings show that missing values have insignificant effect ($x^2$ *(494) = 465.24, p = 0.819*) and therefore all missing values were retained and replaced by using Expectation Maximization (EM) method as suggested by Pigott (2001). Normality assessment was assessed by using skewness and kurtosis values. Awang (2015) suggests that when analyzing data using SEM with Maximum Likelihood Estimator (MLE) method, normal distribution is achieved when the absolute values for skewness and kurtosis are below 2 and 3 respectively. Table 2 shows that all absolute values for skewness and kurtosis are below 2 and 3 respectively which denote normal distribution of the data. This provides the room for further analysis of measurement model.

## Measurement Model Analysis

Confirmatory Factor Analysis (CFA) was used to validate the measurement model by examining the reliability and validity using pooled measurement model with 28 items. The findings show that, the initial measurement model did not attain unidimensionality due to the three items (RA4, RA5 and TCH3) which have produced loading values below 0.5. Hair, Anderson, Tatham and Black (2006) suggest that, all loading values with inadequate threshold values (value below 0.5) should be discarded one after another. Therefore, all three items were removed to attain unidimensionality (Awang, 2015). An adjusted measurement model was produced in which all items produced adequate loading values. Similarly, Table 3 shows that the adjusted measurement model achieved construct validity since all fit indices produced acceptable good-of-fit thresholds (Awang, 2015).

**Table 2. Dana Normality Testing**

| Construct | Variable | Min | Max | Skew | C.R. | Kurtosis | C.R. |
|---|---|---|---|---|---|---|---|
| Perceived Trust | PT1 | 1 | 5 | -0.331 | -2.724 | -0.828 | -3.409 |
| | PT2 | 1 | 5 | -0.339 | -2.79 | -1.082 | -4.454 |
| | PT3 | 1 | 5 | -0.346 | -2.852 | -0.796 | -3.278 |
| | PT4 | 1 | 5 | -0.39 | -3.209 | -0.715 | -2.946 |
| Perceived Fee | PF1 | 1 | 5 | -0.822 | -6.767 | 0.636 | 2.619 |
| | PF2 | 1 | 5 | -0.84 | -6.915 | 0.6 | 2.469 |
| | PF3 | 1 | 5 | -0.975 | -8.03 | 1.032 | 4.251 |
| Technicality | TCH1 | 1 | 5 | -0.744 | -6.13 | -0.327 | -1.349 |
| | TCH2 | 1 | 5 | -0.734 | -6.049 | -0.552 | -2.274 |
| | TCH3 | 1 | 5 | -0.777 | -6.398 | -0.535 | -2.202 |
| | TCH4 | 1 | 5 | -0.415 | -3.419 | -1.164 | -4.792 |
| | TCH5 | 1 | 5 | -0.529 | -4.358 | -0.985 | -4.055 |
| Enjoyment | ENJ4 | 1 | 5 | -0.379 | -3.124 | -1.084 | -4.463 |
| | ENJ3 | 1 | 5 | -0.23 | -1.891 | -1.166 | -4.8 |
| | ENJ2 | 1 | 5 | -0.447 | -3.684 | -0.823 | -3.388 |
| | ENJ1 | 1 | 5 | -0.662 | -5.451 | -0.403 | -1.658 |
| Usefulness | USE5 | 1 | 5 | -0.849 | -6.996 | -0.573 | -2.358 |
| | USE4 | 1 | 5 | -0.687 | -5.657 | -0.761 | -3.133 |
| | USE3 | 1 | 5 | -0.862 | -7.102 | -0.072 | -0.298 |
| | USE2 | 1 | 5 | -0.993 | -8.175 | 0.466 | 1.92 |
| | USE1 | 1 | 5 | -1.125 | -9.265 | 0.559 | 2.303 |
| Perceived Value | PV4 | 1 | 5 | -0.715 | -5.89 | -0.116 | -0.477 |
| | PV3 | 1 | 5 | -0.673 | -5.543 | 0.029 | 0.12 |
| | PV2 | 1 | 5 | -0.718 | -5.916 | -0.019 | -0.079 |
| | PV1 | 1 | 5 | -0.505 | -4.162 | -0.1 | -0.41 |
| Behavioural Intention | BI3 | 1 | 5 | -0.899 | -7.408 | 1.225 | 5.046 |
| | BI2 | 1 | 5 | -1.169 | -9.63 | 1.898 | 7.817 |
| | BI1 | 1 | 5 | -0.683 | -5.627 | 0.708 | 2.916 |
| | Multivariate | | | | | 66.66 | 16.405 |

**Table 3. Index and its Level of Acceptance**

| Model/Goodness of fit measures | *p-value* | RMSEA | GFI | CFI | $\chi 2$/df |
|---|---|---|---|---|---|
| Acceptance level | > 0.05 | < 0.08 | > 0.90 | > 0.90 | < 5.0 |
| Initial measurement Model | *** | 0.036 | 0.918 | 0.956 | 1.534 |
| Adjusted Measurement model | *** | 0.034 | 0.933 | 0.968 | 1.475 |

Notes: *** p<0.001; RMSEA: Root Mean Square Error of Approximation; CFI: Comparative Fit Index; GFI: Goodness of Fit Index; $\chi 2$/df: Normed Chi-square

Further assessment was conducted to examine internal consistency of the measurement model. The reliability of the model was assessed by using composite reliability (CR) since loading of each indicator is considered differently which is different from Cronbach's Alpha (Ahmed & Manab, 2016). Table 4 shows that reliability was attained because all CR values for all constructs exceed the required threshold of 0.6 (Awang, 2015). Furthermore, average variances extracted (AVE) for all constructs are greater than required threshold of 0.5 (Zait & Bertea, 2011). Therefore, the measurement model attained convergent reliability. Furthermore, discriminant validity was evaluated by comparing the diagonal values (square root of AVE) with values (correlation between respective constructs) in its respective column and row in Table 4. The finding shows that the diagonal value is greater than all values in column and row which denotes that discriminant validity was also attained (Zait & Bertea, 2011). Therefore, these findings show that the research model is valid and reliable for hypothesis testing.

**Table 4. CFA Results**

| | CR | AVE | USEF | BEH | ENJOY | PFEE | PTRUST | PVALUE | TECH |
|---|---|---|---|---|---|---|---|---|---|
| **USEF** | 0.755 | 0.508 | **0.713** | | | | | | |
| **BEH** | 0.706 | 0.546 | 0.265 | **0.739** | | | | | |
| **ENJOY** | 0.848 | 0.584 | 0.046 | 0.446 | **0.764** | | | | |
| **PFEE** | 0.764 | 0.522 | 0.161 | 0.265 | 0.309 | **0.723** | | | |
| **PTRUST** | 0.815 | 0.527 | -0.063 | 0.379 | 0.401 | 0.118 | **0.726** | | |
| **PVALUE** | 0.858 | 0.602 | 0.019 | 0.275 | 0.209 | -0.013 | 0.358 | **0.776** | |
| **TECH** | 0.814 | 0.523 | 0.161 | 0.334 | 0.293 | 0.384 | 0.311 | 0.164 | **0.723** |

**Notes:** USEF: Usefulness; BEH: Behaviour Intention; ENJOY: Enjoyment; PFEE: Perceived Fee; PTRUST: Perceived Trust; PVALUE: Perceived Value; TECH: Technicality

## STRUCTURAL MODEL ANALYSIS

Structural model analysis was conducted by using variance-covariance matrix input with maximum likelihood estimation algorithm. The findings show that the structural model attained unidimensionality since all items loaded with values above 0.5 and all model fit indices produce acceptable as shown in Figure 2 (Awang, 2015).

Table 5 shows that most of the hypothesized hypotheses were supported. Perceived fee, Perceived Trust, Usefulness and Perceived value have direct and significant influence on behaviour intention to accept IoT and therefore were supported. Furthermore, perceived trust, enjoyment, technicality and perceived fee have indirect effect on behaviour intention to accept IoT through Perceived Value and were supported. Only one hypothesis was against author's expectation in which relationship between usefulness and perceived value was found to be insignificant and therefore was not supported. All significant variables explain 36% of the total variance of the intention to adopt IoT.

**Figure 2. Structural Model of Adoption intention towards Internet of Things**

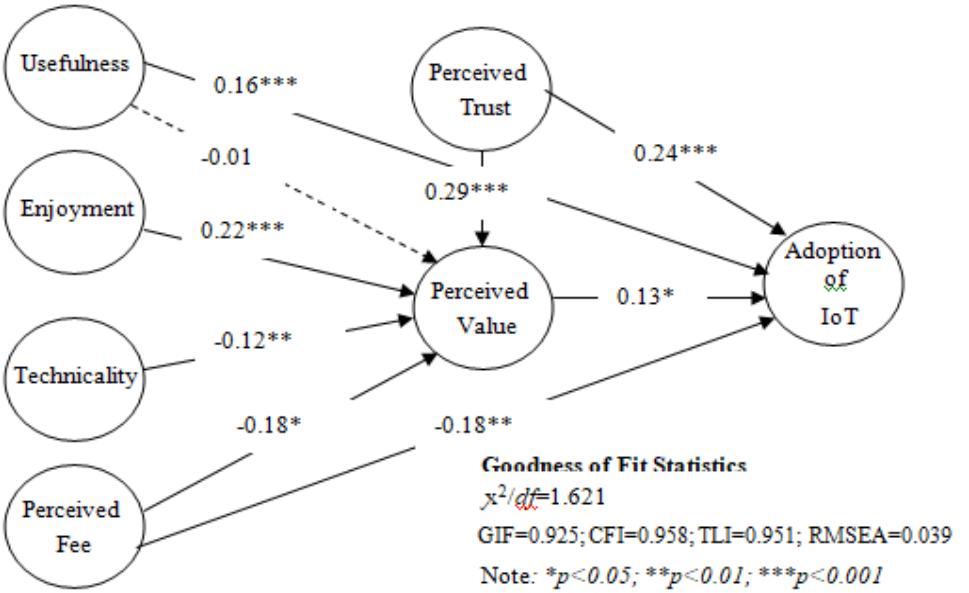



**Table 5. Hypotheses Testing**

| Hypothesis | Hypothesized Paths | | | Estimate | S.E. | C.R. | P | Remarks |
|---|---|---|---|---|---|---|---|---|
| H1 | USEF | ® | BEH | 0.16 | 0.039 | 4.138 | *** | Supported |
| H2 | USEF | ® | PV | -0.007 | 0.05 | -0.143 | 0.887 | Not Supported |
| H3 | ENJOY | ® | PV | 0.229 | 0.065 | 3.544 | *** | Supported |
| H4 | TECH | ® | PV | -0.117 | 0.045 | -2.628 | 0.009 | Supported |
| H5 | PF | ® | PV | -0.184 | 0.079 | -2.319 | 0.02 | Supported |
| H6 | PT | ® | PV | 0.292 | 0.067 | 4.336 | *** | Supported |
| H7 | PF | ® | BEH | -0.181 | 0.054 | -3.377 | *** | Supported |
| H8 | PT | ® | BEH | 0.244 | 0.048 | 5.129 | *** | Supported |
| H9 | PV | ® | BEH | 0.136 | 0.046 | 2.993 | 0.003 | Supported |

**Notes:** USEF: Usefulness; BEH: Behaviour Intention; ENJOY: Enjoyment; PF: Perceived Fee; PT: Perceived Trust; PV: Perceived Value; TECH: Technicality

## DISCUSSION OF THE RESULTS

The findings of this study show that perceived trust is the strongest determinant ($\beta$=0.244) of the behaviour intention to accept IoT relative to other factors. This means IoT' consumers are more sensitive to trust and they are likely to use the IoT applications if they believe the application is much secured. This could be due to the fact that mobile payment transactions change financial data without consumer's prior knowledge which affect the trust level of the users (Wu & Wang, 2005). Also distrust on online transactions and reliability of services are factors which may be the reason

of perceived trust to be the strongest determinant (Wu & Wang, 2005). This finding conforms to previous studies (Masele & Taluka, 2017; Xin et al., 2013).

Furthermore, perceived fee was found to be the second strongest determinant ($\beta$=0.181) of the behaviour intention to adopt IoT. This means consumers are very concerned with fee associated with usage of IoT. If the usage fee is very high the likelihood of consumers to accept IoT will be very low. This could be due to the fact that in mobile internet technologies, the consumers are adopting technologies for their personal usage and therefore they are responsible for all cost associated with usage of IoT (Roostika, 2012). Furthermore, most of people in developing countries are considered to have low income and therefore they are cost sensitive (Chauhas, Gupta, & Jaiswal, 2018). The finding is consistent with the previous findings in technology adoption (Chauhas et al., 2018).

Usefulness was also found to have significant effect on behaviour intention to accept IoT ($\beta$=0.160). This means consumers are likely to use IoT if they perceive that using IoT could produce better results than using the other payment methods. However, this result opposes TAM's findings which depict that usefulness is the major determinant in technology adoption (Davis, 1989). In this study perceived trust is the major determinant. The reason behind this could be that, mobile internet customers are focusing more on the cost issues than the benefits associated with technology because all cost are covered by the users (Kim et al., 2007). Also, TAM was mostly used to examine technologies used in organization settings in which most of the cost associated with adoption are handled by the companies/employer and not users of the technology. This result collaborates with the previous results which show that usefulness is positively influencing IoT adoption (Kim et al., 2007; Kowatsch & Maass, 2012; Mital, Choudhary, Chang, Papa, & Pani, 2018; Roostika, 2012).

Perceived values is also found to have positive and significant influence on intention to accept IoT ($\beta$=0.136). This means consumers who perceive IoT services to have any value are likely to accept the services. These findings support the claims presented in value-based adoption model that perceived value is very important in acceptance of mobile internet technologies (Kim et al., 2007). Also the study's findings is consistent with the previous findings (Ko et al., 2009; Roostika, 2012).

Perceived trust was found to have positive and significant effect on perceived value ($\beta$=0.292). This means, a trusted IoT application will increase the value of the service and hence consumers will adopt the service. Similar finding was found on previous studies (Chunxiang, 2014). Perceived enjoyment was also found to have positive and significant effect on perceived value ($\beta$=0.229). This means availability of "fun, joy and pleasure" elements in IoT service will add value on the service which will make consumers to accept the IoT application. Presence of hedonic value in IoT services will make the IoT services worthwhile for consumers (Ko et al., 2009). Similar findings were found on other studies (Ko et al., 2009; Liu, Zhao, Chau, & Tang, 2015). Perceived fee was found to be significant, but with negative impact on perceived value ($\beta$= -0.184). This means if consumers perceive usage fee to be very high, the perceived value of IoT services is considered to be very low. The same findings were reported by Liu et al. (2015). Furthermore, technicality was also found to have negative and significant effect ($\beta$= - 0.117) on intention to accept IoT, users are likely to use mobile payment if they perceive that IoT services could be easy to use, reliable and they take short time to respond. This finding supports the previous findings which show that technicality have significant negative impact on perceived value (Chunxiang, 2014; Roostika, 2012)

Surprisingly, perceive usefulness was not found to be a predictor of perceived value as predicted in this study. This finding is against previous findings which have shown that perceived usefulness has significant effect on perceived value (El-Haddadeh et al., 2019; Hsu & Lin, 2016b; Thi-Hong-Linh et al., 2018). This discrepancy may be due to the reason that, users of mobile payments expects more than utilitarian value which are currently provided through mobile payments services. Since this finding is quite different from most of the findings, further research required to examine this phenomenon in SSA context.

## IMPLICATIONS

Effective sharing of real-time data and information through IoT has changed the way services in different countries are delivered. Development of countries also depends on availability and easy accessibility of information. Failure to have easy sharing of information could slow down the development and it increases gap in information accessibility. While real-time information sharing in SSA is still ineffective, development of IoT could improve accessibility and sharing of information and speed up development. Therefore, the findings of this study could assist researchers and policy makers to understand clearly how they could implement acceptable IoT application.

The findings of this study have both theoretical and practical implications. This study have extended VAM model with perceived trust variable. Perceived trust is mostly integrated with prior theories of adoption such as TAM, TRA, TPB and UTAUT (Wu & Wang, 2005; Wu & Chen, 2005). Fewer studies have integrated perceived trust with theories used to examine adoption of mobile internet technologies. Given the fact that trust is considered to be one of the major determinates on mobile internet technologies adoption, integrating perceived trust with VAM to examine acceptance of IoT in SSA makes this study to extend researchers' knowledge on the effect of perceived trust on behaviour intention through VAM theory.

Furthermore, majority of IoT studies have been conducted in developed countries where technologies are well established. Very few studies have been conducted in developing countries particularly in SSA to examine the acceptance of IoT. Therefore, the findings of this study extend researches' knowledge on the antecedents of IoT in SSA and in Tanzania particularly.

This study also provides practical contributions to the policy makers in various companies which are providing their services through IoT. The study has shown that perceived trust is the major determinant of IoT acceptance, this means policy makers should increase much effort on improving security issues as well as provide awareness on various issues related with trust. Furthermore, this study has shown that perceived value is the key determinant of the behaviour intention to adopt IoT. This means policy makers should concentrate on increasing enjoyment while taking care of technicality and perceived cost issue. In this case, utilitarian approach should be used in IoT transactions by capitalizing on the benefits while reducing the costs (Ko et al., 2009). Through enjoyment attribute the values of IoT will increase. Also, policy makers should make sure that fee associated with usage of IoT is affordable. This could be achieved by making sure that the IoT application is useful, trusted and enjoyable. This could increase the number of consumers of the IoT application and eventually reduce the cost associated with the usage.

Furthermore, the study found that enjoyment is one of the determinants of perceived value. This means policy makers should concentrate in making IoT application more enjoyable to increase its value. This can be achieved by developing promotion strategies that emphasis on emotional appeal and positive feelings that IoT applications elicit. Furthermore, policy makers should emphasis on more personalized or customizable IoT services which could increase the value of IoT services. Also policy makers should increase more effort on decreasing the consumer's perception on perceived fee. Special offers may be provided through IoT services to reduce consumer's perception of fee which can increase the value of IoT services. Also, policy makers should concentrate more on making IoT services more reliable, easy to use and improve its connectivity. Making IoT services which operate without uninterrupted connection and optimized services will improve technicality issues and hence increase the value perception.

## LIMITATION OF THE STUDY

Despite the useful findings presented above, this study has some limitations. Firstly, the model has produced low explanatory power. This means they could be other factors more than those included

in the model. Therefore, future studies can extend the model by adding more variables in order to increase the explanatory power of the model.

Secondly, the study has used cross-sectional research design to collect the data. This technique has limitations in explaining the change in behaviour of the consumer; therefore further studies should be done by using longitudinal study.

Thirdly, the study has examined acceptance of IoT by using only mobile payment technology as application of IoT, however there are so many different applications of IoT with different settings and operational environment. Therefore, the findings presented in this study may be limited in their applicability to other IoT applications. Therefore, further studies could be conducted to examine acceptance of IoT in other applications.

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