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User Centric Model for Development of Mobile Applications for Micro, Small and Medium Scale Enterprises: A case of Kampala, Uganda

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Abstract: Mobile technology presents significant opportunities for Micro, Small, and Medium Enterprises (MSMEs) to enhance operational efficiency, expand market reach, and improve customer engagement. However, many MSMEs, particularly in developing regions such as Uganda, face significant challenges in designing, developing, and implementing mobile applications that reflect real user needs and business realities. This study sought to create a model for guiding user centric development of mobile applications for MSMEs in the context of Uganda. Proposed model constructs were identified through an extensive review of literature covering technology adoption, software development models, and mobile application development in developing countries, focusing on successes, failures, and challenges. In addition, a qualitative exploratory study (*n=30*) aided in confirmation of the constructs identified from literature, as well as adding new constructs. A total of nineteen constructs were identified and categorized into four phases of mobile application development: conceptualization, design, development, and implementation. The model was formulated and validated statistically, guided by the Partial Least Squares Structured Equation Modelling (PLS-SEM). The outcome showed that twelve factors significantly influenced the user centric conceptualization, design, development, and implementation of mobile applications in MSMEs. The factors include: Conceptualization (*Stakeholder input, functional features*), Design (*Task-Fit, Interface Consistency, Compliance and Design Flexibility*), Development (*Quality Assurance, Intuitiveness, Cross-Platform capability and User feedback*), and implementation (*User Training and Updates*)

Keywords: Mobile Applications, MSMEs, User Centric Design, PLS-SEM, Mobile Development Methodology, Uganda

1. INTRODUCTION

1.1 Background

The exponential growth in the uptake and utilization of mobile telephony technology in the last 20 years has significantly transformed the way of life globally. Mobile applications, an offshoot innovation of mobile telephony technology, have revolutionized business operations by providing real-time communication, automating workflows, and enhancing customer experience. For Micro, Small, and Medium Enterprises (MSMEs), digital transformation offers the promise of improved inventory management, enhanced customer retention, and more effective sales tracking [22]. Despite this potential, many mobile applications fail to achieve wide adoption, often because they are not tailored to user needs [23]. The absence of user centered conceptualization, design, development, and implementation results in solutions that are difficult to use, misaligned with business processes, or culturally irrelevant, particularly in low-resource settings like Kampala.[12].

1.2 Statement of Problem

Although there are debates on the need to have a user centric approach in software development, software development models exist that were tailored for desktop application development and thus do not fully align often changing dynamics in mobile application development. There is no clear, context-specific methodology that guides the formulation and validation of a user-centric mobile app development model tailored for MSMEs in emerging markets. This gap leads to inconsistencies in app design, poor usability, and limited impact on MSME productivity.[11].

1.3 Objective of the Study

The objective of this study is to formulate and validate a user-centric development model for mobile applications tailored to the unique operational and contextual needs of Micro, Small, and Medium Enterprises (MSMEs) in Kampala, Uganda.

1.4 Scope

This study focuses on proposing and validating a user centric model for the development of mobile applications for MSMEs in the context of Kampala City in Uganda.

2. REVIEW OF LITERATURE: IDENTIFYING USER-CENTRIC FACTORS

Developing a user-centric model requires a deep understanding of the variables that influence the various phases of the development of the mobile application. The review of literature covered the following areas:

2.1 Literature of Technology Adoption

The key models reviewed to identify strengths and weaknesses towards user centric development of mobile applications for the MSMEs:

Technology Acceptance Model for Mobile Services [25].
• Task-Technology Fit Theory.[4]
• Diffusion of Innovation Theory [20]
• Technology, Organization and Environment [24].

2.2 Literature of Software Development Methodologies

Models reviewed included:
• Waterfall Model [21]
• Agile Software development model. [2]
• Spiral Model. [3]
• Prototyping Model [17]
• Rational Unified Process. [13]

2.3 Literature of Mobile Application Design and Development

The focus was on literature related:
• Success factors in mobile application conceptualization, design, development, and implementation in MSMEs [1]. Failure factors in mobile application conceptualization, design, development, and implementation in MSMEs [18]. The challenges and lessons from experiences in mobile application [19].

2.4 Utilization of Mobile Applications in MSMEs

The focus was on key needs, preferences, experiences, and the Task-Fit in MSMEs utilized applications.[8]

2.5 Qualitative Exploratory Study

This section explored possible key drivers of successful conceptualization, design, development, and implementation in MSMEs

Final List of Constructs

Table 1. Constructs in the User Centric Mobile Application Development Model for MSMEs

Category	Construct	Definition	Source
Conceptualization	Perceived Value (PV)	The extent to which users believe the application provides benefits over costs.	[5,6]
	Functional Features (FF)	The presence of useful functionalities meeting users' operational needs.	[8,9,10]
	Stakeholder Input (SI)	The involvement of users and stakeholders in system planning and decisions.	
	Environmental Characteristics (EC)	External factors (e.g., infrastructure, policy) affect application usage.	[5,6]
	Context of Use (CU)	The specific environment and situation in which the application is used.	[8,9,10]
Design	Interface Consistency (IC)	The uniformity and predictability of the application's layout and behavior.	[14,15,16]
	Task-Fit (TF)	The degree to which application features support user tasks effectively.	[8,9,10]
	Compatibility (CL)	How well the application aligns with existing systems, values, or	[5,6]

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		workflows.	
	Design Flexibility (DF)	The ability of the application's design to adapt to various user needs.	[8,9,10]
	Compliance (CO)	Adherence to legal, regulatory, and ethical standards in application development.	[14,15,16]
Development	Iteration (IT)	Repeated testing and refinement cycles in app development.	[5,6]
	Quality Assurance (QA)	Measures taken to ensure software reliability and performance.	[14,15,16]
	Intuitiveness (IN)	The ease with which users can navigate and understand the application.	[8,9,10]
	Cross-Platform Capability (CC)	The ability of the application to operate across various operating systems and devices.	[5,6]
	Observability (OB)	The visibility of the benefits or functionalities of the application to users.	[14,15,16]
	Trialability (TR)	The extent to which users can test or experiment with the app before adoption.	[8,9,10]
	User Feedback (UF)	Collection and integration of user input for iterative improvement.	[5,6]
Implementation	User Training (UT)	Providing users with the knowledge and skills to effectively use the application.	[14,15,16]
	Updates (UP)	Regular improvements and fixes to enhance performance and security.	[8,9,10]

3. CONCEPTUALIZED USER-CENTRIC MODEL

The identified factors were categorized into independent and dependent variables, and their relationship was hypothesized in a conceptualized user centric model.

Conceptualized User-Centric Model Diagram

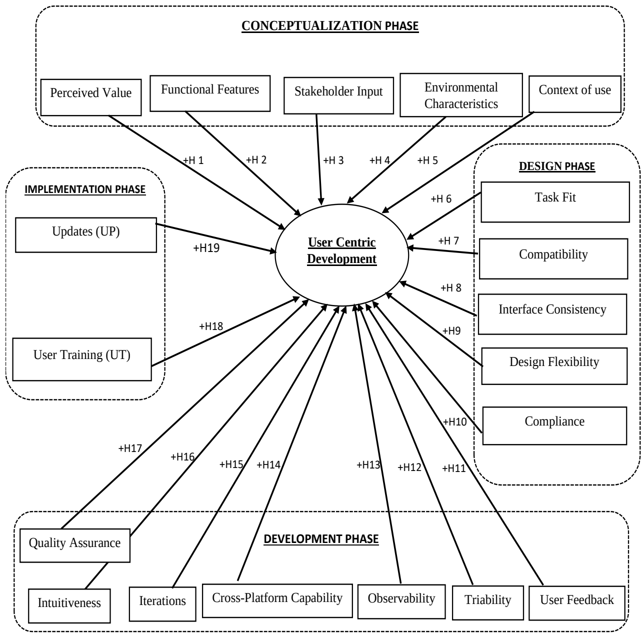


Figure 1: Phased model of user-centric mobile application development for MSMEs.

4. MODEL VALIDATION METHODOLOGY

This study utilized Partial Least Squares Structural Equation Modeling (PLS-SEM) to validate the proposed User-Centric Mobile Application Development Model designed for Micro, Small, and Medium Enterprises (MSMEs). PLS-SEM was chosen for its effectiveness in predictive-oriented research, its ability to manage complex models with multiple constructs and indicators, and its adaptability to non-normal data distributions and moderate sample sizes [5,6] PLS-SEM allows for the simultaneous evaluation of both the measurement model (assessing the reliability and validity of constructs) and the structural model (analysing relationships between latent variables). This dual evaluation is essential for studies like this one, where both construct development and hypothesis testing are fundamental.

The statistical model validation occurred in two stages:

a) Measurement Model Evaluation

i. Internal Consistency - done through computation of Cronbach Alpha coefficient. The rule of the thumb here is that coefficient of 0.7 or higher is deemed sufficient.

ii. Model Reliability – done by assessing:
  - Construct Reliability – Cronbach Alpha Coefficient (Value => 0.7) and Composite Reliability (Value =>0.5)
  - Indicator Reliability (Composite reliability value => 0.5)

iii. Evaluation of Construct Validity – assessed through:
  - Convergent Validity (Average Variance Extracted => 0.5)
  - *Discriminant Validity* (Cross loading => of 0.5)

b) Structural Model Assessment

The structural model investigated the hypothesized relationships among constructs and evaluated the model's explanatory and predictive power using key statistical tests, including:

i. Path coefficients (β) and p-values to assess the significance and direction of hypothesized relationships,

ii. R² (Coefficient of Determination) to determine the variance explained in the endogenous variable (UCD),

iii. f² (Effect Sizes) to gauge the strength of each exogenous construct's influence,

5. RESULTS & DISCUSSION

a) Measurement Model Analysis

Analysis of the measurement model focused on computing the following parameters

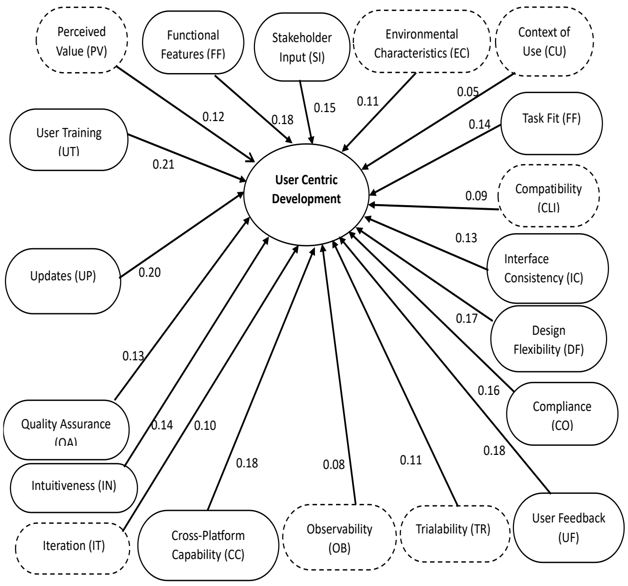
- Cross Loading = (Loading)
- Composite Reliability = (CR)
- Cronbach Alpha = (CA)
- Average Variance Extracted = (AVE)

Model Phase	Construct	Indicator Codes	Measurement Summary
Conceptualization	Perceived Value *(Independent Variable)*	PV1, PV2, PV3	CA= 0.722; Loadings ≥ 0.700; CR = 0.883; AVE = 0.715
	Stakeholder Input *(Independent Variable)*	SI1, SI2, SI3	CA=0.768; Loadings 0.731–0.802; CR = 0.874; AVE = 0.698
	Functionalities *(Independent Variable)*	FF1, FF2, FF3	CA=0.781; Loadings > 0.75; CR = 0.869; AVE = 0.689
	Context of Use *(Independent Variable)*	CU1, CU2, CU3	CA=0.707; Loadings > 0.70; CR = 0.891; AVE = 0.727
	Environmental Characteristics *(Independent Variable)*	EC1, EC2, EC3	CA=0.700; Loadings 0.703–0.810; CR = 0.865; AVE = 0.681
Design	Interface Consistency	IC1, IC2, IC3	CA=0.755; Loadings > 0.80; CR = 0.902; AVE = 0.754
	Task-Fit *(Independent Variable)*	TF1, TF2, TF3	CA=0.779; Loadings 0.73–0.84; CR = 0.888; AVE = 0.726
	Compatibility *(Independent Variable)*	CO1, CO2, CO3	CA=0.701; Loadings > 0.74;CR = 0.891; AVE = 0.748
	Design Flexibility *(Independent Variable)*	DF1, DF2, DF3	CA=0.791; Loadings > 0.70; CR = 0.867; AVE = 0.692
	Compliance *(Independent Variable)*	CL1, CL2, CL3	CA=0.700; Loadings 0.704–0.813; CR = 0.872; AVE = 0.691
Development	Iteration *(Independent Variable)*	IT1, IT2, IT3	CA=0.751; Loadings 0.73–0.81; CR = 0.885; AVE = 0.713
	Quality Assurance *(Independent Variable)*	QA1, QA2, QA3	CA=0.726; Loadings 0.79–0.87; CR = 0.872; AVE = 0.684
	Intuitiveness *(Independent Variable)*	IN1, IN2, IN3	CA=0.763; Loadings > 0.75; CR = 0.881; AVE = 0.701
	Cross-Platform Capability *(Independent Variable)*	CC1, CC2, CC3	CA=0.709; Loadings 0.793–0.861; CR = 0.895; AVE = 0.740
	User Feedback *(Independent Variable)*	UF1, UF2, UF3	CA=0.767; Loadings 0.76; CR = 0.873; AVE = 0.691
	Trialability *(Independent Variable)*	TR1, TR2, TR3	CA=0.764; Loadings 0.79–0.87; CR = 0.899; AVE = 0.741
	Observability *(Independent*	OB1, OB2, OB3	CA=0.727; Loadings 0.72; CR = 0.861; AVE =

	Variable)		0.693
Implementation	User Training *(Independent Variable)*	UT1, UT2, UT3	CA=0.709; Loadings 0.77–0.86; CR = 0.887; AVE = 0.719
	Updates *(Independent Variable)*	UP1, UP2, UP3	CA=0.780; Loadings > 0.79; CR = 0.901; AVE = 0.754
Dependent Variable	User Centric Development *(Dependent Variable)*	UD1, UD2, UD3	CA=0.777; Loadings > 0.74; CR = 0.8221; AVE = 0.703

b) Structural Model Validation

i. **Path coefficients (β)** and p-values to assess the significance and direction of hypothesized relationships



Path	Path Coefficient (β)	p-Value	Significance
PV – UD	0.12	0.062	Not Significant ($p > 0.05$)
SI – UD	**0.15**	**0.019**	**Significant ($p < 0.05$)**
FF – UD	**0.18**	**0.004**	**Significant ($p < 0.01$)**
CU – UD	0.05	0.328	Not Significant ($p > 0.05$)
EC – UD	0.11	0.081	Not Significant ($p > 0.05$)
IC – UD	**0.13**	**0.044**	**Significant ($p < 0.05$)**
TF – UD	**0.14**	**0.030**	**Significant ($p < 0.05$)**
CO – UD	**0.16**	**0.016**	**Significant ($p < 0.05$)**
DF – UD	**0.17**	**0.010**	**Significant ($p < 0.01$)**
CL – UD	0.09	0.148	Not Significant ($p > 0.05$)
IT – UD	0.10	0.105	Not Significant ($p > 0.05$)
QA – UD	**0.13**	**0.038**	**Significant ($p < 0.05$)**
IN – UD	**0.14**	**0.025**	**Significant ($p < 0.05$)**
CC – UD	**0.19**	**0.003**	**Significant ($p < 0.01$)**
UF – UD	**0.18**	**0.005**	**Significant ($p < 0.01$)**
TR – UD	0.11	0.085	Not Significant ($p > 0.05$)
OB – UD	0.08	0.263	Not Significant ($p > 0.05$)
UT – UD	**0.21**	**0.002**	**Significant ($p < 0.01$)**
UP – UD	**0.20**	**0.003**	**Significant ($p < 0.01$)**

ii. R^2 (Coefficient of Determination)

This element focuses on the assessment of the variance explained in the dependent variable (User Centric Development)

Dependent Variable	R^2 / Adjusted R^2	Q^2 (Predictive Relevance)
User-Centric Development (UD)	0.678 / 0.665	0.411

- Adjusted R^2 accounts for the number of predictors and sample size. It slightly lowers the R^2 to provide a more realistic estimate of model fit in the population, but still reflects strong explanatory capability.
- The model explains a large portion of the variance in User-Centric Development ($R^2 = 0.678$) and shows strong predictive relevance.
- Most significant constructs are training-focused, usability-enhancing, or support-driven.

iii. **f^2 (Effect Sizes)** to gauge the strength of each exogenous construct's influence

The Effect Size (f^2) for Each Predictor

Predictor	f^2	Effect Strength
PV	0.042	Small
SI	0.038	Small
FF	0.115	Medium
CU	0.064	Small
IC	0.029	Small
CO	0.011	Negligible
TF	0.089	Small to Medium

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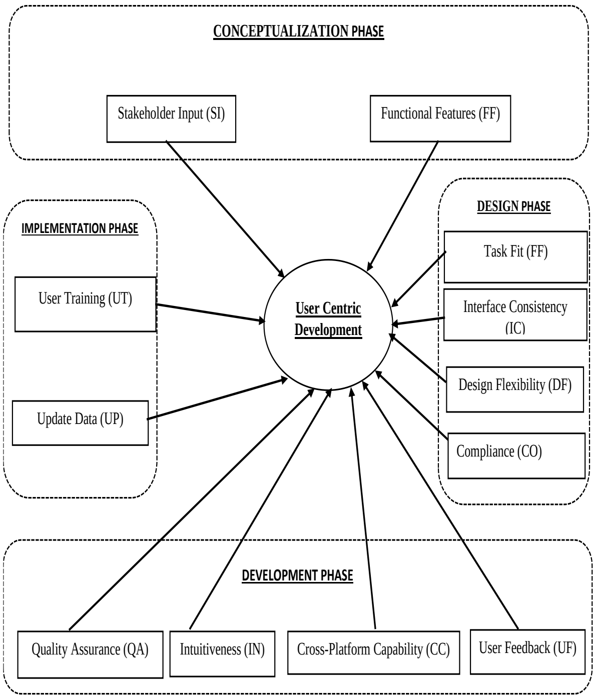
iv. **Q^2 (Predictive Relevance),** assessed through a blindfolding procedure, to evaluate the model's predictive performance.
Predictive relevance was assessed using Stone–Geisser's Q^2, computed via blindfolding procedure. A $Q^2 > 0$ indicates that the model has predictive relevance for the endogenous construct.

The Predictive Relevance (Q^2)

Variable	Q^2 Value
UCD	0.411

The Interpretation here is that the Q^2 value of 0.411 is well above zero, indicating strong predictive relevance of the model for user-centric mobile application development. According to [5,6], this supports the practical applicability of the structural. Model. This was obtained using the blindfolding technique. A Q^2 value above zero indicates that the model has predictive relevance. A value of 0.411 suggests that the structural model is not only explanatory but also has strong predictive accuracy, making it useful for real-world applications among MSMEs. This confirms that the model is both statistically robust and practically relevant for predicting and improving user-centric mobile application development.

Final Model for User Centric Development of Mobile Applications for MSME



6. CONCLUSIONS AND RECOMMENDATIONS

The validated User-Centric Development (UCD) model offers a comprehensive and empirically supported approach to mobile application development, specifically designed for the unique needs of Micro, Small, and Medium Enterprises (MSMEs). It addresses the diverse challenges these enterprises encounter, such as limited digital capacity and inadequate infrastructure, by providing a structured, phase-based roadmap grounded in user experience (UX) principles and contextual relevance [5,6].

The model is divided into four developmental stages—Conceptualization, Design, Development, and Implementation—and integrates both human and technological factors. It has been statistically validated using Partial Least Squares Structural Equation Modeling (PLS-SEM), a method particularly suited for predictive and theory-building research in complex, resource-limited environments like MSMEs. [25,8]

Key constructs such as User Training, Updates, Cross-Platform Capability, Intuitiveness, and Stakeholder Input have emerged as significant predictors of user-centric system development. The model demonstrates strong explanatory and predictive power with an R^2 value of 0.681 and positive Q^2 values [5,6]. This establishes the theoretical strength and practical relevance of the UCD framework for mobile application design in MSMEs, making it valuable for developers, decision-makers, and researchers alike.

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