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SMS-Based Alert Notification for Credit Applications Queuing Systems

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ABSTRACT: This paper defines the building blocks and derives basic queuing systems that provide some sort of services by moving customers in a particular order to a specific service according to the customer requirements and also integrated Alert Notification via SMS to be sent to customers updating them of the progress as they wait. The study focuses on the bank line system mostly on credit applications, the different queuing algorithms that are used in banks to serve the customers, and the average waiting time. The main aim of this research is to develop a Model that integrate Alert notification via SMS on credit applications during queuing system and analyze the queue status to decide on which customer to serve. The researcher adopted empirical approach to achieve his objectives. The target population covers mainly the customers at Bank. The researcher applied a probability sampling technique to select respondents. There were a couple of interviews and questionnaires conducted to bank customers to find out their satisfaction level about the current system and acceptance of the proposed system during data collection which enable easy of analysis. The data was then tabulated and presented in a graph for presentation purposes. The researcher used the research study findings to design and develop a model. The requirements for this model were obtained from the responses that the target population gave. Some of the variable loaded low than the theoretical established entry values were therefore dropped, while the ones that loaded higher than these thresholds were retained. These are the ones that were included in the final loaded model constructed using AMOS software.

KEYWORDS: Building Blocks, Model, Queue System, Algorithms.

ABBREVIATIONS:

SMS:	**S**hort **M**essaging **S**ervices
AMOS:	**A**nalysis of **MO**ment **S**tructures

1 INTRODUCTION

Alert Notification via SMS is an system that uses Short Messaging System (SMS) to notify customers from their remote mobile phone on the progress of their loan applications. It is incorporated on customer credit applications services. According to Zudiana,(2006), Short Message Services (SMS) allow for the delivery of short, text-based messages, usually between wireless devices such as cell phones which can be used for making decision. Alerts are typically delivered through a notification system and the most common application of the service is machine-to-person communication (Jennifer Rizzo, 2011).

Queuing system is defined as a mathematical study of waiting lines, or queues. According Sundarapandian, (2009), queuing theory intends to develop model to assist in predicting the queue lengths and waiting times. The delays in receiving service, which lead to queuing, are the usual problems in banking services (Harchol-Balter, 2012). This is majorly affect the credit application services where the customers wait in vain for the confirmation of their credit application progess (Van , 2014).

In this paper, the researchers investigated three basic elements associated with queuing systems and which are thought to be service oriented: Priorities, state dependent arrivals and SMS Notifications which covers the application cycle in Model development. Queuing systems are particularly suitable for organizations which offer services that rely on the physical appearance of their customers. This physical appearance usually leads to queues of people when those services are frequented extensively (Lothar , 2014). The system enables these customers to be updated automatically instead of visiting the banks, hence are able to perform other useful economic activities.

The paper used the Innovation Diffusion Theory to examine the Integration of Alert Notification via SMS on credit application on queuing systems. The empirical analysis was based on the observed data of credit application services at the credit department unit of a bank. These data were analyzed and analysis of moment structures method was used to design and develop an adoption model for SMS-Based Alert Notification For Credit Applications Queuing Systems (SBANCA). The developed queuing model could enhance customer service, improving efficiency, track the progress and reducing time. This is possible through building a homogenous way that analyze the queue status and take decisions about which customer to serve by using the appropriate scheduling algorithm.

2 Related Work

2.1 Queuing Systems Characteristics & Scheduling Algorithm

In his research Hardik, (2010), the characteristic of a queuing system consists of one or more servers that provide service to arriving customers during their application. It is extremely useful in predicting and evaluating system performance in an institution. Figue1 below show the building blocks of a typical queuing system.

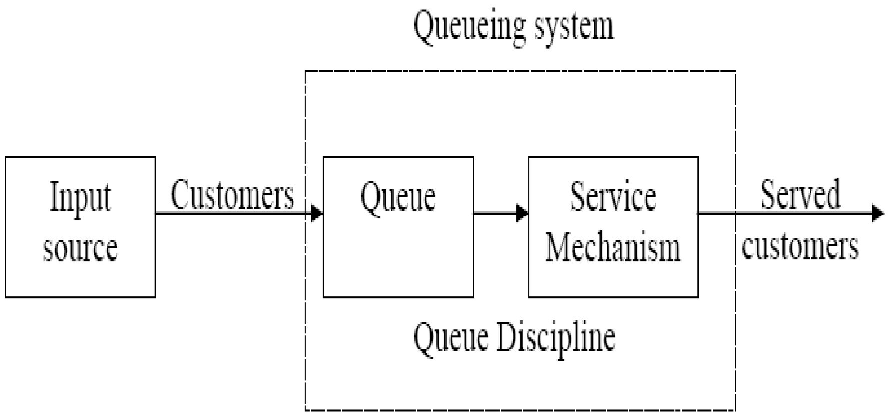

Figure 1: Characteristics Of Queuing System

Characteristics of a queuing system can be completely described by the input or arrival pattern (customers), the service mechanism (service pattern), the "queue discipline", the customer's behavior and the arrival to the service center in a random fashion (Ahmed, 2011). Queue represents a certain number of customers waiting for service. The capacity of a queue is either limited or unlimited. Bank is an example of unlimited queue length.

According to Sarka (2011), the number of arrivals of customers during some time period T, can be predicted by equation 1 below. The distribution appears as in equation 1and is obtained by finding the probability of exactly n arrivals during T. If the arrival process is random, the distribution is the Poisson (Little, 2013), and the formula is:

$$PT(n) = (\lambda T)^n e^{-\lambda T}/n! \quad (1)$$

The average utilization of the bank teller is given by relation 2 as:

$$\rho = \lambda/\mu \quad (2)$$

where ρ *is the* ratio of total arrival rate to service rate for a single *teller,* λ *is the* Arrival rate *and* μ *is the* service rate.

The average number of customers in the waiting line is given by relation 3:

$$Lq = \lambda^2/\mu(\mu - \lambda) \quad (3)$$

The average number of customers in the system is given by equation 4:

$Ls = \lambda/\mu - \lambda$ (4)

Average waiting time in the bank line is as given by equation 5:

$Wq = Lq/\lambda$ (5)

Average waiting time in the system is obtained by using the equation 6:

$Ws = Ls/\lambda$ (6)

The above equations were considered during the process of developing the proposed model.

2.2 SCHEDULING ALGORITHM

In his study, Mohamad, (2011) noted that the most general scheduling algorithms are

- FCFS (First Come First Serve): The customers are served in the order of their arrival, which is most visibly fair because all customers think of themselves as equal.
- RSS (Random Selection for Service): In this algorithm, customers are selected for service at random, so each customer in the queue has the same probability of being selected for service irrespective of his/her arrival in the service system.
- PRI (Priority Service): The customers are grouped in priority classes according to some external factors. The customer with the highest priority is served first.
- SPF (Shortest Processed First): The algorithm assumes that the service times are known in advance. When several customers are waiting in the queue, the SPF algorithm picks the shortest service time first.

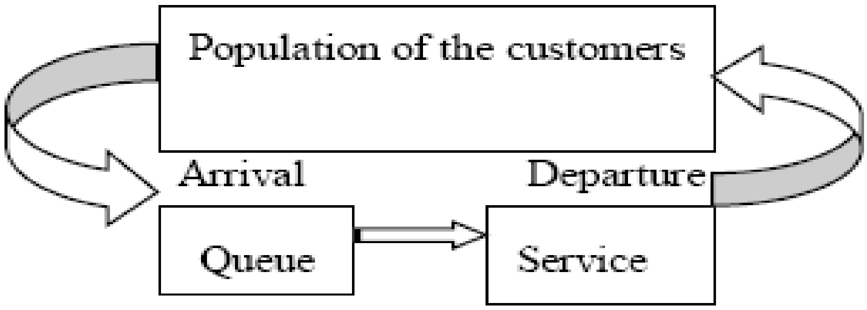

Figure 2: Simplest Queuing System

The departure represents the way customers' application leave the system. According to Huda (2011), queuing system consist of models such as:

Single Queue: In this model each customer waits till the service point is ready to take him for servicing.

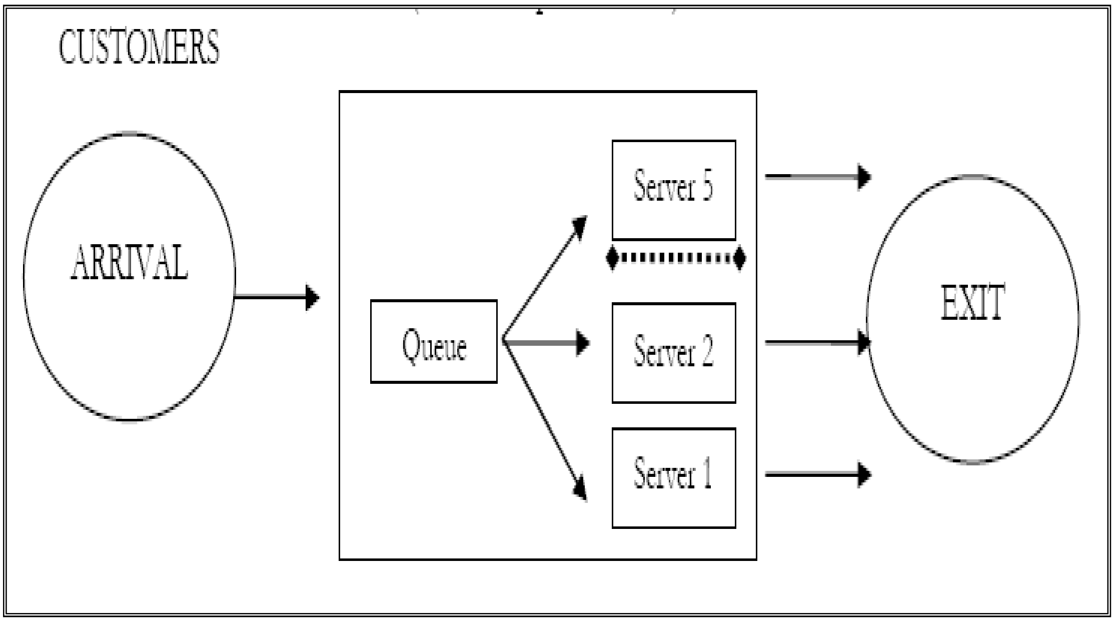

Figure 3: Single Queuing Model With Single –Queue And Multiple Parallel Servers

- **Multiple Queues:** In this model each customer tries to choose the shortest queue from a number of individual queues.

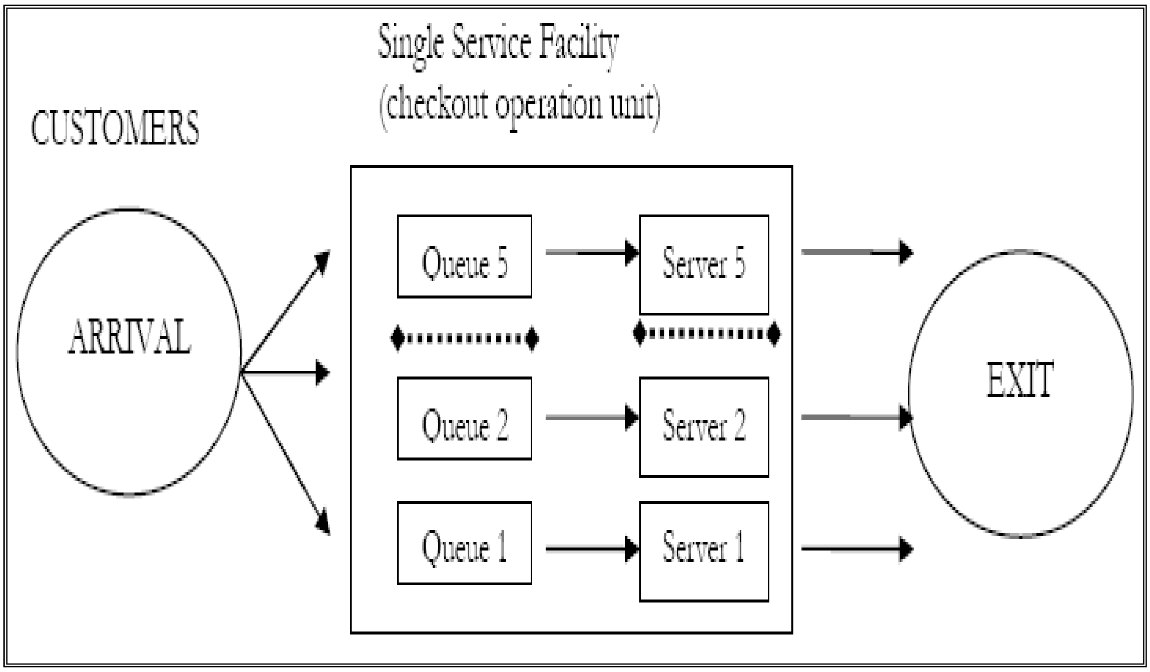

Figure 3: Single Stage Queuing Model With Multiple –Queue And Multiple Parallel Servers

- **Diffuse Queue:** In this model each customer take a ticket from a ticket machine with single or multiple buttons each for specific service. After the customer registers his/her place in the queue by a ticket he/she will monitor the ticket number being served. The customers can not estimate when they will be served.

3 METHODOLOGY

According to Rajasekar(2013), methodology is a science of studying how research is to be carried out, essentially, the procedures by which researchers go about their work of describing, explaining and predicting. A survey methodology was adopted for this research study.

Queuing Theory is a mathematical method of analyzing the congestions and delays of waiting in line during a service. It examines every request of waiting in line to be served, including the arrival process, service process, number of servers, number of system places and the number of customers (Ben McClure, 2014). Researchers in the area of Information Systems and Information Technology are interested in investigating the theories and models that will have power in predicting and explaining behaviour across many domains. The key objectives of these researches are to investigate how to promote usage and also examining what hinders usage and intention to use the technology.

The researchers used the innovation diffusion theory (IDT) to design and develop the proposed SMS-Based Alert Notification for Credit Applications Queuing Systems (SBANCA). The conceptual model of this IDT I shown in Figure 4 below.

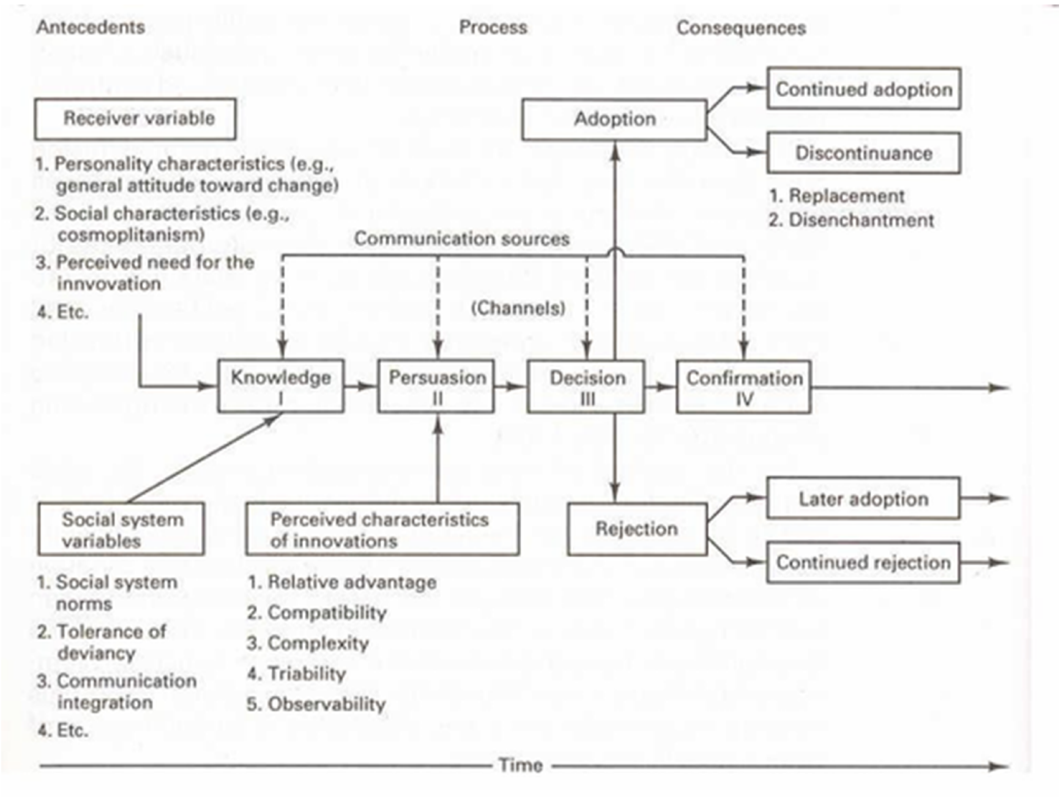

Figure 4: Conceptual Framework Of The Innovation Diffusion Theory

The researchers modified the IDT by adding ten observable variables. The Receiver Variables included three variables: Flexibility To Accommodate Change (FTAC), Faster Decision Making Process (FDMP), and Quick System Response (QSR). The Social Systems Variables incorporated three variables: Level Of Education Of The Customers (LOEOC), Experience Of The Customers With Technology (EOCWT) and Financial Status Of Customers (FSOC). Finally, the Perceived Characteristics Of Innovation was measured using three variables: Convenience (CONV), Efficiency (EFF), Compatibility With Existing GSM Phones (CWEGP) and Easy Deployment (ED). The Receiver Variables (RVs), Social Systems Variables (SSVs) and Perceived Characteristics Of Innovation (PCOI) formed the latent variables for the study. From these variables, ten null and alternate hypotheses were derived as follows. The researchers then used the P-value method to determine if the null hypotheses should be rejected or adopted.

Receiver Variables (RVs)

H1RVs - Customers' flexibility to change can positively influence SMS-Based Alert queuing system adaption

H_0: μ_F-μ_S =0; H_A: μ_F-μ_S ≠0; H_0 is the null hypothesis, H_A is an alternate hypothesis; μ_F is mean for flexibility while

μ_S is the mean for SMS-Based Alert queuing system adaption

H2RVs – Faster decision making process positively influence SMS-Based Alert queuing system adaption

H_0: μ_D-μ_S =0; H_A: μ_D-μ_S ≠0; H_0 is the null hypothesis, H_A is an alternate hypothesis; μ_D is mean for decision making while μ_S is the mean for SMS-Based Alert queuing system adaption

H3RVs – Quick system response positively influences SMS-Based Alert queuing system adaption

H_0: μ_R-μ_S =0; H_A: μ_R-μ_S ≠0; H_0 is the null hypothesis, H_A is an alternate hypothesis; μ_R is mean for response while

μ_S is the mean for SMS-Based Alert queuing system adaption

Social Systems Variables (SSVs)

H1SSVs – Customers' level of education affects their adoption of SMS-Based Alert queuing system

H_0: μ_E-μ_S =0; H_A: μ_E-μ_S ≠0; H_0 is the null hypothesis, H_A is an alternate hypothesis; μE is mean for education while

μ_S is the mean for SMS-Based Alert queuing system adaption

H2SSVs – Customers' experience with technology affects their adoption of SMS-Based Alert queuing system

H_0: μ_X-μ_S =0; H_A: μ_X-μ_S ≠0; H_0 is the null hypothesis, H_A is an alternate hypothesis; μ_X is mean for experience while μ_S is the mean for SMS-Based Alert queuing system adaption

H3SSVs – Customers' financial status affects their adoption of SMS-Based Alert queuing system

H_0: μ_F-μ_S =0; H_A: μ_F-μ_S ≠0; H_0 is the null hypothesis, H_A is an alternate hypothesis; μ_{FS} is mean for financial status while μ_S is the mean for SMS-Based Alert queuing system adaption

Perceived Characteristics Of Innovation (PCOI)

H1PCOI – Convenience of an SMS-Based Alert queuing system can positively influence its adoption

H_0: μ_{CON} -μ_S =0; H_A: μ_{CON}-μ_S ≠0; H_0 is the null hypothesis, H_A is an alternate hypothesis; μ_{CON} is mean for convenience while μ_S is the mean for SMS-Based Alert queuing system adaption

H2PCOI – Efficiency of an SMS-Based Alert queuing system can positively influence its adoption

H_0: μ_{EF}-μ_S =0; H_A: μ_{EF}-μ_S ≠0; H_0 is the null hypothesis, H_A is an alternate hypothesis; μ_{EF} is mean for response while μ_S is the mean for SMS-Based Alert queuing system adaption

H3PCOI – Compatibility with existing GSM phones of an SMS-Based Alert queuing system can positively influence its adoption

H_0: μ_{COM}-μ_S =0; H_A: μ_{COM}-μ_S ≠0; H_0 is the null hypothesis, H_A is an alternate hypothesis; μ_{COM} is mean for response while μ_S is the mean for SMS-Based Alert queuing system adaption

H4PCOI – Easy deployment of an SMS-Based Alert queuing system can positively influence its adoption

H_0: μ_{DEP}-μ_S =0; H_A: μ_R-μ_S ≠0; H_0 is the null hypothesis, H_A is an alternate hypothesis; μ_{DEP} is mean for response while μ_S is the mean for SMS-Based Alert queuing system adaption

A survey was conducted to collect sample data to examine the proposed research model. The sample selected for the analysis was some appropriate IT innovation project, which were useful to validate the proposed model. The methods utilized include the descriptive statistics methods to deal with the raw data from the survey, and the statistical inference methods (use of Independent Samples t-test)) to prove the hypotheses above. The conceptual model that was utilized was as follows.

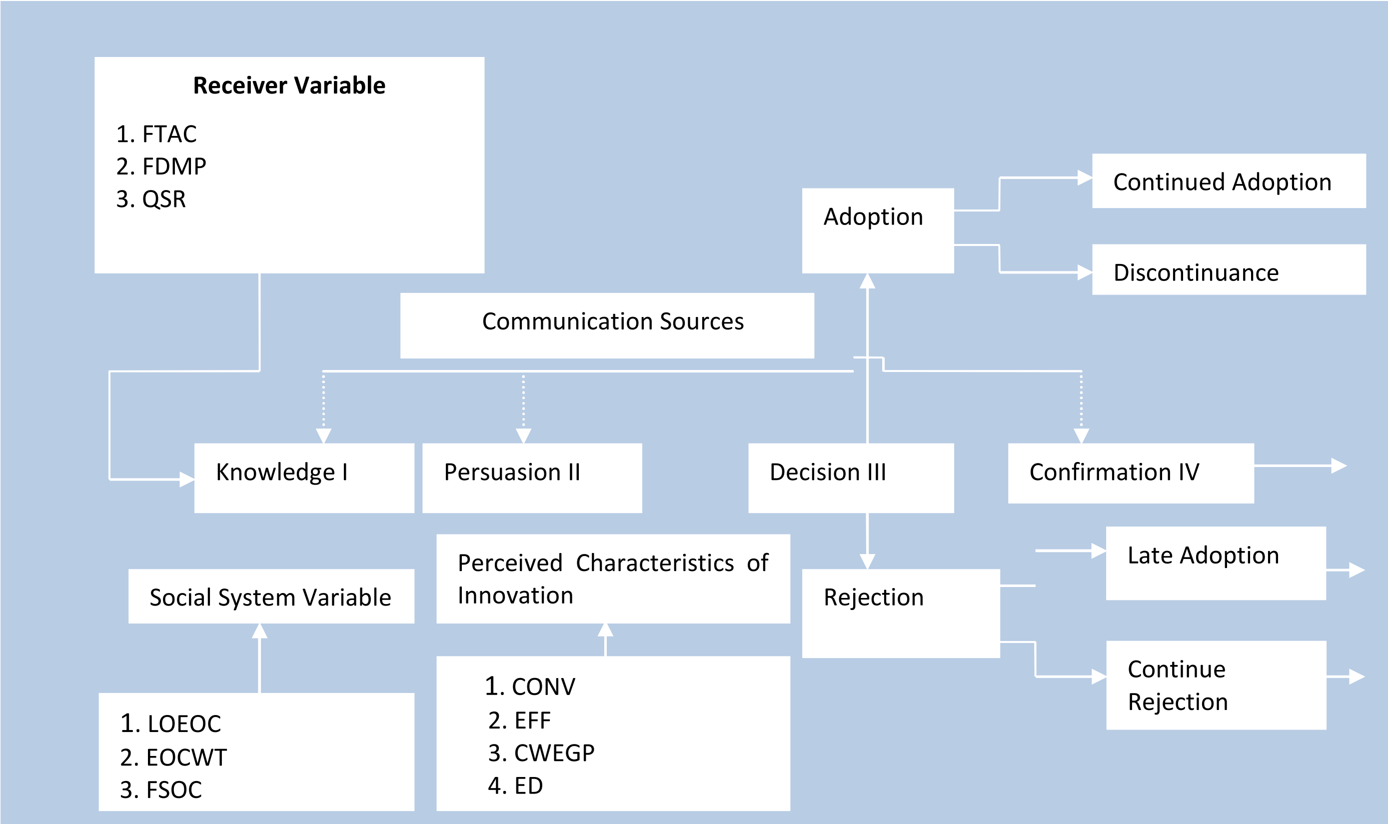

Figure 5: Conceptual Model

4 Results And Discussion

The added variables in Figure 5 above were formulated into a questionnaire that was then availed to the bank credit services customers. To accept or reject the null hypotheses above, P-value was used. This "Sig" value is what is referred to as the P-value. It is the probability of seeing a test score this extreme or more [in the direction of the alternative hypothesis] if the null hypothesis is true. The smaller the number, the more rare our test score is under Ho and the more likely that the null hypothesis isn't true. Using the .05 significance level (Petrović, 2013) as our cutoff various null hypotheses proposed above were tested. The essence was to determine if there is a statistical difference in the adoption of an SMS-Based Alert queuing system of and the various factors that influence its adoption. Sine Sig is 2-tailed, we divided by 2, subtract this value from 1 to get the actual value for the P-value.

Scenario 1 - H_0: μ_F-μ_S=0; H_A: μ_F-μ_S≠0

Independent Samples Test								
	Levene's Test for Equality of Variances		t-test for Equality of Means					
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
FTAC Equal variances assumed	6.618	.026	-.972	11	.352	-.475	.488
Equal variances not assumed			-1.111	10.941	.290	-.475	.428

Figure 6: Independent Samples T-Test For FTAC Against Adoption

The P-value was 0.352/2= 0.176; 1-0.176=0.824, which was above the cutoff of 0.05, leading to the adoption of the null hypothesis, that is flexibility and adoption are correlated (*H_0: μ_F-μ_S =0; Strongly accepted*).

Scenario 2 - *H_0: μ_D-μ_S =0; H_A: μ_D-$\mu_S \neq 0$;*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
FDMP	Equal variances assumed	.004	.951	-.492	11	.632	-.225	.457
	Equal variances not assumed			-.470	7.415	.652	-.225	.479

Figure 7: Independent Samples T-Test For FDMP Against Adoption

The P-value was 0.632/2= 0.316, 1-0.316=0.686, which was above the cutoff of 0.05, leading to the adoption of the null hypothesis, that is flexibility and adoption are correlated (*H_0: μ_D-μ_S =0; accepted*).

Scenario 3 - *H_0: μ_R-μ_S =0; H_A: μ_R-$\mu_S \neq 0$;*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
QSR	Equal variances assumed	.081	.781	.055	11	.957	.025	.457
	Equal variances not assumed			.052	7.415	.960	.025	.479

Figure 8: Independent Samples T-Test For QSR Against Adoption

The P-value was 0.957/2= 0.479, 1-0.479=0.521, which was above the cutoff of 0.05, leading to the adoption of the null hypothesis, that is flexibility and adoption are correlated (*H_0: μ_R-μ_S =0; loosely accepted*).

Scenario 4 - *H_0: μ_E-μ_S =0; H_A: μ_E-$\mu_S \neq 0$;*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
LOEOC	Equal variances assumed	12.692	.004	-1.188	11	.260	-.250	.211
	Equal variances not assumed			-1.528	7.000	.170	-.250	.164

Figure 9: Independent Samples T-Test For LOEOC Against Adoption

The P-value was 0.260/2= 0.130, 1-0.13=0.87, which was above the cutoff of 0.05, leading to the adoption of the null hypothesis, that is flexibility and adoption are correlated (*H_0: μ_E-μ_S =0; Strongly accepted*).

Scenario 5 - H_0: μ_X-μ_S=0; H_A: μ_X-$\mu_S\neq0$;

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
EOCWT	Equal variances assumed	3.291	.097	-.777	11	.453	-.125	.161
	Equal variances not assumed			-1.000	7.000	.351	-.125	.125

Figure 10: Independent Samples T-Test For EOCWT Against Adoption

The P-value was 0.453/2= 0.227, 1-0.227=0.773, which was above the cutoff of 0.05, leading to the adoption of the null hypothesis, that is flexibility and adoption are correlated (*H_0: μ_X-μ_S=0; Moderately accepted*).

Scenario 6 - H_0: μ_F-μ_S=0; H_A: μ_F-$\mu_S\neq0$;

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
FSOC	Equal variances assumed	.662	.433	-.794	11	.444	-.325	.409
	Equal variances not assumed			-.743	6.938	.482	-.325	.437

Figure 11: Independent Samples T-Test For FSOC Against Adoption

The P-value was 0.444/2= 0.222, 1-0.222=0.778, which was above the cutoff of 0.05, leading to the adoption of the null hypothesis, that is flexibility and adoption are correlated (*H_0: μ_F-μ_S=0; Moderately accepted*).

Scenario 7 - H_0: μ_{CON}-μ_S=0; H_A: μ_{CON}-$\mu_S\neq0$;

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Convience	Equal variances assumed	.019	.893	-1.282	11	.226	-.650	.507
	Equal variances not assumed			-1.279	8.572	.234	-.650	.508

Figure 12: Independent Samples T-Test For CONV Against Adoption

The P-value was 0.226/2= 0.113, 1-0.113=0.887, which was above the cutoff of 0.05, leading to the adoption of the null hypothesis, that is Convenience and adoption are correlated (*H_A: μ_{CON}-$\mu_S\neq0$; strongly accepted*).

Scenario 8 - H_0: μ_{EF}-μ_S=0; H_A: μ_{EF}-$\mu_S\neq0$;

Independent Samples Test									
		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
EFF	Equal variances assumed	.504	.492	-.429	11	.676	-.250	.583
	Equal variances not assumed			-.433	8.876	.676	-.250	.578

Figure 13: Independent Samples T-Test For EFF Against Adoption

The P-value was 0.676/2= 0.338, 1-0.338=0.662, which was above the cutoff of 0.05, leading to the adoption of the null hypothesis, that is Convenience and adoption are correlated (H_A: μ_{EF}-$\mu_S \neq 0$; *accepted*).

Scenario 9 - H_0: μ_{COM}-μ_S =0; H_A: μ_{COM}-$\mu_S \neq 0$;

Independent Samples Test								
		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
CWEGP	Equal variances assumed	.657	.435	.429	11	.676	.125	.291
	Equal variances not assumed			.368	5.274	.727	.125	.340

Figure 14: Independent Samples T-Test For CWEGP Against Adoption

The P-value was 0.676/2= 0.338, 1-0.338=0.662, which was above the cutoff of 0.05, leading to the adoption of the null hypothesis, that is Convenience and adoption are correlated (H_A: μ_{COM}-$\mu_S \neq 0$; *accepted*).

Scenario 10 - H_0: μ_{DEP}-μ_S =0; H_A: μ_R-$\mu_S \neq 0$;

Independent Samples Test								
		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Easy Development	Equal variances assumed	1.244	.288	-.608	11	.556	-.325	.535
	Equal variances not assumed			-.634	9.790	.541	-.325	.513

Figure 15: Independent Samples T-Test For FTAC Against Adoption

The P-value was 0.556/2= 0.278, 1-0.278=0.722, which was above the cutoff of 0.05, leading to the adoption of the null hypothesis, that is Convenience and adoption are correlated (H_A: μ_{DEP}-$\mu_S \neq 0$; *Moderately accepted*).

To further determine the correlation weight of these constructs in regard to other constructs and modulating constructs, AMOS was run .The researchers then used the path coefficients cut-off (0.05) to accept and reject some constructs.

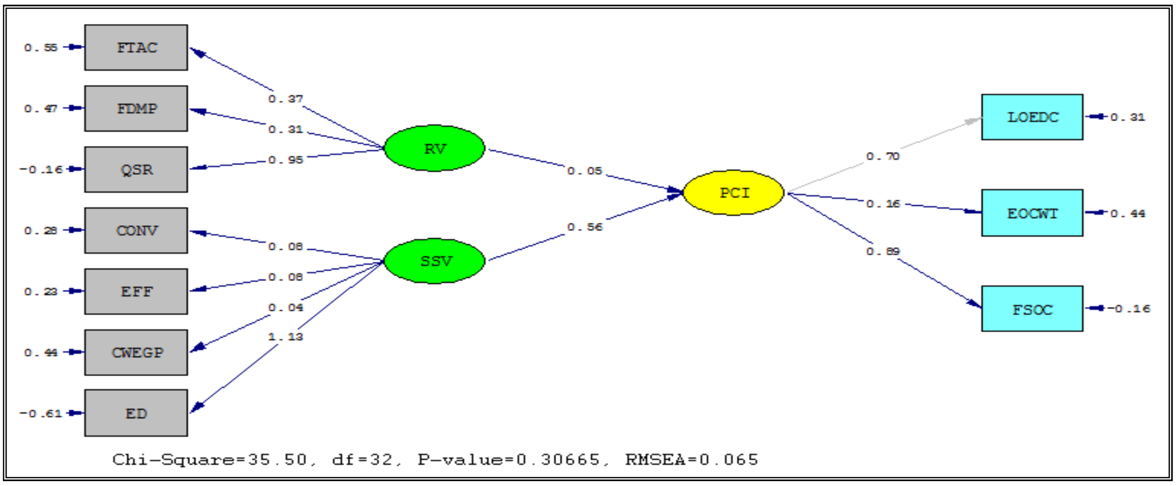

Figure 16: Correlation Weights For SBANCA Model

Construct CWEGP loaded 0.04, 0.01 below the threshold value and was therefore dropped. Of the ten constructs, FTAC, LOEOC and CONV were strongly accepted, ED, FSOC and EOCWT were moderately accepted, EFF and FDMP were accepted while QSR was loosely accepted. The final model was then developed as shown in Figure 17 below.

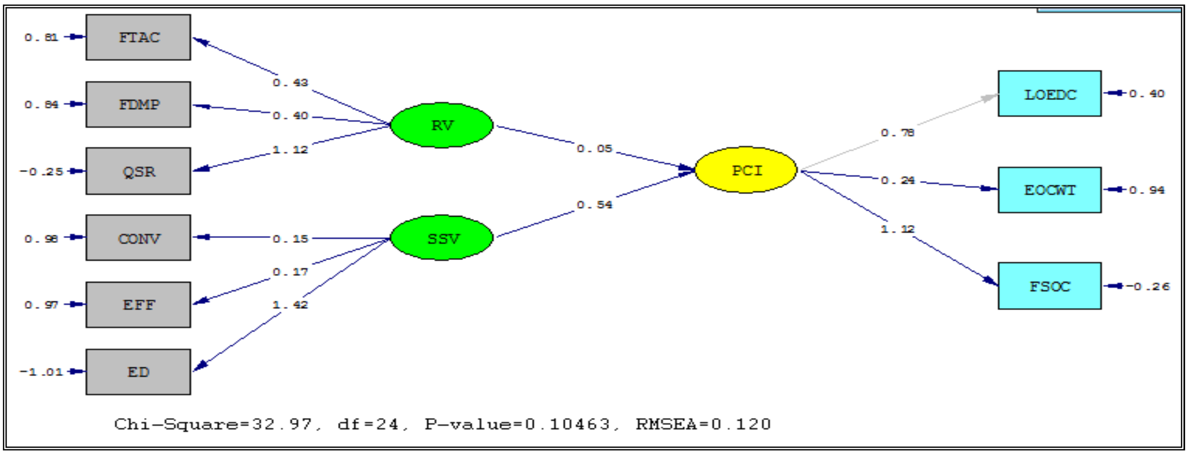

Figure 17: Final SBANCA Model

5 CONCLUSIONS

This research aimed to create an SMS-Based Alert queuing system model, which can be utilized to improve the adaption rate of Information Technology innovations. The main contribution of the proposed model is considering the growth and flexibility of the IT innovation projects. Since it has potential to grow, it would be easier to adapt the innovation. The consideration of flexibility can help to measure an innovation more completely. It is a better model to select the IT innovation project and to consider its future development. The research findings indicate that nine of the proposed hypothesis were significant at levels greater than 0.05. Therefore flexibility, convenience, easy of deployment, faster decision making, quick system response, level of education, experience of the customer with technology, financial status of the customers and efficiency are key for the adoption of an SMS-Based Alert queuing system.

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