

# Development and Validation of a Customer Satisfaction Measuring Instrument With Laboratory Services at The University Hospital of Kinshasa

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## Research Article

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## Abstract

**Background:** In clinical laboratory, monitoring customers' satisfaction is an important indicator of the quality management system and required by laboratory quality standards, such as ISO 15189: 2012 and ISO17025: 2017. However, there is no reliable and valid scale to measure clinical laboratory customers' satisfaction in Democratic Republic of the Congo. In this article, an instrument for measuring customer satisfaction with clinical laboratory services is developed and validated.

**Methods:** In order to develop a reliable and valid measurement tool, the general methodological approach recommended by Churchill was followed. Principal component analysis (PCA) with varimax rotation was used to study the dimensionality of the construct. The developed questionnaire was checked for reliability and validity using exploratory and confirmatory analysis. The reliability checks were done using the internal consistency reliability by analyzing the Cronbach's Alpha, composite reliability and Jöreskog Rhô values. Confirmatory Factor Analysis (CFA) was used to determine whether the hypothesis of the conceptual framework is acceptable in measuring customer satisfaction.

**Results:** The PCA results showed a three-dimensionality of Customer Satisfaction. Cronbachs alpha coefficients (0.983, 0.981 and 0.981), Jöreskog Rhô (0.973, 0.970 and 0.967) and composite reliability values (0.95, 0.92 and 0.93) of the latent variables were greater than 0.9, which confirms the very high reliability of the model. Indicator loadings were all greater than the threshold of 0.7 or higher. Also, all the latent variables have average variance extracted (AVE) greater than 0.5, therefore, convergent validity has been achieved. Both the Maximum Shared Variance (0.195, 0.297 and 0.234) and the Average Shared Variance (0.805, 0.703 and 0.766) were lower than the AVE (0.897, 0.839 and 0.875) for all the constructs in the scale. Therefore, Discriminant validity has been achieved. Fit indices used to assess CFA and structural equation model were found to be at an acceptable level for the two-factor model where chi-square/df was 1.6, p=0.476, GFI = .99, AGFI= .99, SRMR= .069 , RMSEA= .000 , CFI= 1.00, NFI= .98, RFI= .98, IFI= .98, TLI= .98.

**Conclusion:** The instrument demonstrated acceptable psychometric properties and thus the tool is fit for measuring customer satisfaction with laboratory services.

## Background

In today's competitive and technology driven world, organizations are starting to go back to the basics – single – minded focus on customers and service experience. The world is shifting from "mass – production" to "mass – customized" to make sure that each customer can be managed as an individual for which the business exists (Neeraj C., 2019).

A high quality organization meets customer's needs. Philip Crosby, one of the founding fathers of the quality movement, defined service quality as meeting the customer's requirements (Donna L., 2015).

The hospital market, which is a service industry, has today changed from a sellers' market to a buyers' market, where the customer is all important. Customer satisfaction is considered as one of the desired outcomes of health care and it is directly related to the utilization of health services (Abede B. et al, 2008). A study done in South Africa concluded that customer satisfaction is a fundamental indicator of equitable quality of care (Myburgh NG. et al., 2005).

Medical laboratory's customer service is part of a Quality Management System (QMS) because if the customer is not well served, the laboratory is not fulfilling its mission. Quality standards, such as ISO 15189 and ISO/IEC17025, and the balanced score card stress the importance of the systematic use of customers' perspectives in clinical laboratories. Both the ISO15189 and ISO/IEC17025 standards encourage an investigative process to search continuously for causes

behind processes that deviate from procedures or are not satisfactory to customers so that proper corrective and preventive action can be initiated (Zelalem A. et al., 2013).

Assessing customer satisfaction is an important process in the laboratory's continuous quality improvement cycle (CQI) program (Donna L, 2015). The Joint Commission on Accreditation of Healthcare Organizations and the College of American Pathologists (CAPs) give accreditation to clinical laboratory programs. The CAPs require the healthcare facility to measure customer satisfaction with the laboratory services every two years. Hence, in several studies performed by Young, R. K and Teklemariam, Z, the overall customer satisfaction score was 70.5% and 87.6%, respectively (Sehr C. et al., 2017). However, no such study has been performed in Democratic Republic of the Congo (DRC) till now because of the absence of a performant measuring instrument. This suggests that there is a need to build an effective tool which would measure customer satisfaction with laboratory services in DRC. The main purpose of this study is to develop a theoretical and operational instrument for measuring customer satisfaction with clinical laboratory services. The specific aim of this study is to present the four findings related to the construct validity of the newly developed instrument measuring customer satisfaction. The findings include: (a) dimensionality of the instrument, (b) reliability of the instrument, (c) validity of the construct, and (d) confirmation of the structure conceptual framework. The paper begins with a literature review of quality of service and customer satisfaction, then explains the methodology employed, followed by the research results and findings' discussion. Some limitations of the present work and some possible directions for future investigation are then discussed. Finally, the paper ends with key conclusions and managerial implications of the study.

## Literature review

The lack of consensus on a definition of satisfaction has created serious problems for customer satisfaction research. First, developing context-specific items becomes difficult given the fact that the conceptual definition of customer satisfaction is not clear. Therefore, most researches use a single-item rating scale to measure customer satisfaction. Single-item scales do not provide sufficient content domain sampling of complex constructs and are generally believed to be unreliable, since they do not allow internal consistency to be calculated (Nunnally, J. C., 1978). Furthermore, Single-item measures provide no guidance to respondents or researchers in interpreting the exact meaning of satisfaction. Consequently, developing multiple-item measures to resolve the measurement difficulties caused by single-item measures is highly recommended (Churchill, G. A., Jr., 1979).

Second, the lack of definitional and measurement standards of customer satisfaction limits theory development in this field, weakens the explanation power of any new theories, and confines the generalization of any empirical findings (Wang YS et al., 2001).

Previous researchers have indicated that *service quality* is a precursor of *customer satisfaction* (Poranki KR et al., 2015).

SERVQUAL is a method intended to measure the "quality of service" in companies; it is mainly used in the private sector. This method is the starting point for most of the work on satisfaction and quality of service (Brensinger, RP, and Douglas ML., 1990). However, there have been a number of studies that question the validity of the 5 dimensions of SERVQUAL and the uniform applicability of the method for all service areas. A number of problems with the SERVQUAL instrument are discussed in the literature. According to an analysis by Thomas P. Van Dyke, Victor R. Prybutok and Leon A. Kappelman, it appears that the use of difference scores in calculating SERVQUAL contributes to problems with the reliability, discriminant validity, convergent validity, and predictive validity of the measure (Van Dyke, T. P., et al., 1999). Consequently, many researchers proposed that a quality measurement scale should be adapted to the specifics of an individual service industry or even an individual service, and that a general scale shouldn't be used at all (Babakus, E.

and G. W. Boller. 1992). Thus, we developed an instrument for measuring customer satisfaction through quality of service in a clinical laboratory.

## Methods

This is a cross-sectional study conducted at the University Hospital of Kinshasa. The study population consists of all attending physicians who were present at the hospital during the study period. The main purpose of this study is to develop a theoretical and operational instrument for measuring customer satisfaction with clinical laboratory services.

### Measurement tool development

In order to develop a reliable and valid measurement tool, we followed the general methodological approach recommended by Churchill (1979): we adopted Churchill's paradigm for the development of service quality measurement scales. Churchill proposed eight steps for developing better measures of marketing constructs. These eight steps are in turn: "specify domain of construct, generate sample of items, collect data, purify the measure, collect new data, assess reliability with new data, assess construct validity and finally develop norms".

After a literature review, we generated a structured questionnaire including SERVQUAL items and other items from customer verbal received complaints. We developed this questionnaire using a 7-point Likert scale to prevent respondents' scores from clustering near the average: the satisfaction was measured on 7 point scale from 0 to 6 indicating the lowest (strongly disagree) and highest (strongly agree) levels of satisfaction. The instrument went through the process of checking for content validity by using a focus group followed by panels of experts before checking the construct validity. The questionnaire was then piloted with a convenient sample of 200 physicians for validity and reliability. We asked 200 physicians practitioners to pilot-test the survey before we administered it to others. The first step in the purification of the measurements is that of the dimensionality of the scales. Before proceeding to factor analyzes, we checked whether the conditions concerning the factorization of the variables were fulfilled.

Principal component analysis (PCA) with varimax rotation was used to study the dimensionality of the construct. Minor adjustments were made based on the pilot testing. The self-report instrument which consisted of 14 items measuring customer satisfaction was conceptually hypothesized to have three sub-constructs, namely the Reliability of tests' results, Responsiveness of services and laboratory personnel's willingness to help. Data were then collected from 330 attending physicians in the University Hospital of Kinshasa. Trained and qualified investigators conducted this study and distributed unified questionnaires to all physicians and then collected the following day. They responded to the questionnaire by writing directly on the paper. The response rate was 100%.

### Research Model and Hypothesis

The following hypothesis was developed to evaluate the influencing factors on customer satisfaction.

H1: There is a positive relationship between Reliability of tests' results (TR) and customer satisfaction (CS).

H2: There is a positive relationship between Responsiveness of services (RS) and customer satisfaction (CS).

H3: There is a positive relationship between laboratory personnel's willingness to help (LP) and customer satisfaction (CS).

To examine the influence of these three factors on customer satisfaction, the linear regression model is used. Therefore, the equation is explained as:

$$CS = \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + E$$

CS= Customer satisfaction

$\alpha_1, \alpha_2, \alpha_3$  = Estimated coefficients for the given factors

X<sub>1</sub> = Reliability of tests' results

X<sub>2</sub> = Responsiveness of services

X<sub>3</sub> = Laboratory personnel's willingness to help

E = error

All data were analyzed by using SPSS 21.0 (SPSS Inc., Chicago, IL, USA). Using a 7-point Likert scale, the results were rated as follows: 0, strongly disagree; 16.6, disagree; 33.3, slightly disagree; 50, average; 66.6, slightly agree; 83.3, agree; and 100, strongly agree.

### **Measurement tool validation**

The developed questionnaire (i.e. from pilot-test survey) was checked for reliability and validity using exploratory and confirmatory analysis. Principal component analysis (PCA) with varimax rotation was used to study the dimensionality of the construct. The Kaiser's criterion (Retain the factors whose eigenvalue is greater than 1) is chosen to determine the number of factors. Communalities and rotated component matrix were used to conduct item analysis for the instrument. The reliability checks were done using the internal consistency reliability by analyzing the Cronbach's Alpha, Jöreskog's Rhô coefficient and composite reliability values. Convergent validity has been achieved where indicator loadings are all greater than the threshold of 0.7 and all the latent variables have Average Variance Extracted (AVE) greater than 0.5. Discriminant validity was established where Maximum Shared Variance (MSV) and the Average Shared Variance (ASV) were both lower than the AVE for all the constructs. Confirmatory Factor Analysis (CFA) was used to determine whether the hypothesis of the conceptual framework is acceptable in measuring customer satisfaction. The scale was also subjected to Structural Equation Modelling (SEM). Because there is no single criterion for the theoretical model fit evaluation obtained as a result of SEM, various fit indices were used to test the model fit according to the Kline criteria. In order to evaluate the structural model, we used the five step structural model assessment procedure proposed by Hair et al.: 1) Assess structural model for collinearity issue; 2) Assess the path coefficient; 3) Assess the level of R<sup>2</sup>; 4) Assess the effect size f<sup>2</sup>; 5) Assess the predictive relevance Q<sup>2</sup>. All the threshold values against to each and every criterion were clearly represented with the results to have comprehensive understand about the evaluation of measurement and structural model.

## **Results**

Before performing a factor analysis, we evaluated sample size adequacy using the Kaiser-Meyer-Olkin test of sampling adequacy (KMO). Furthermore, we assessed whether the factor analysis should be continued or not by employing Bartlett's test of sphericity.

Table 1: Results of KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy			0.934
Bartlett's Test	of Sphericity	Approx. Chi-Square	8249.985
		df	91
		Sig.	0.000

Source: Authors' own analysis, 2020.

As visualized in table 1, both the KMO statistic and Bartlett's test of sphericity indicate an appropriate factor analysis model: the Kaiser, Meyer and Olkin (KMO) test whose value is 0.934 ( $> 0.6$ ) and the Bartlett sphericity test (Bartlett = 8249.985;  $p = 0.000$ ) indicates that the data can be factorized. Thus the factor analysis can be performed in the next step.

The Exploratory Factor Analysis (EFA) was performed using a Principal Component Analysis (PCA) with Varimax rotation method and Kaiser Normalization.

Table 2. Total variance explained, initial eigenvalues

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	9.915	70.825	70.825	9.915	70.825	70.825	4.786	34.182	34.182
2	2.029	14.491	85.315	2.029	14.491	85.315	4.398	31.412	65.594
3	1.143	8.165	93.481	1.143	8.165	93.481	3.904	27.886	93.481
4	0.156	1.112	94.592						
5	0.129	0.920	95.512						
6	0.119	0.849	96.361						
7	0.098	0.702	97.063						
8	0.084	0.599	97.662						
9	0.080	0.568	98.230						
10	0.066	0.473	98.703						
11	0.062	0.445	99.147						
12	0.051	0.362	99.509						
13	0.042	0.300	99.809						
14	0.027	0.191	100.000						

Source: Authors' own analysis, 2020.

The leftmost section of table 2 shows the variance explained by the initial solution. Only three factors in the initial solution have eigenvalues greater than 1. Together, they account for almost 93.481% of the variability in the original

variables. This suggests that three latent influences are associated with customer satisfaction, but there remains room for a lot of unexplained variation.

The second section of this table shows the variance explained by the extracted factors before rotation. The cumulative variability explained by these three factors in the extracted solution is the same as above i.e. about 93.481%.

The rightmost section of this table shows the variance explained by the extracted factors after rotation. The rotated factor model makes some small adjustments to the three factors.

Source: Authors' own analysis, 2020.

The scree plot confirms the choice of three components.

Table 3. Components matrix after varimax rotation

Item Code	Item Description	Communalities	Components		
			1	2	3
<b>Reliability of Tests' Results (TR)</b>					
TR1	Laboratory results are accurate	0.920	<b>0.865</b>	0.334	0.247
TR2	We rarely need to contact the laboratory because of missing test results	0.969	<b>0.921</b>	0.280	0.209
TR3	We rarely need to contact the laboratory because of erroneous test results	0.933	<b>0.897</b>	0.283	0.219
TR4	The laboratory result report form is convenient	0.934	<b>0.893</b>	0.286	0.233
TR5	Laboratory tests' normal reference ranges are fit for use	0.925	<b>0.908</b>	0.256	0.189
<b>Responsiveness of services (RS)</b>					
CC1	Laboratory doctors answer efficiently most of our enquires	0.943	0.355	<b>0.821</b>	0.379
CC2	Laboratory technologists answer efficiently most of our enquires	0.912	0.297	<b>0.844</b>	0.334
CC3	Communication with laboratory personnel is smooth	0.945	0.334	<b>0.854</b>	0.323
CC4	Abnormal results notification is adequate	0.940	0.318	<b>0.849</b>	0.344
CC5	Laboratory's notification of the changes in services is adequate	0.911	0.335	<b>0.825</b>	0.343
<b>Laboratory Personnel's willingness to help (LP)</b>					
LP1	Laboratory doctors are courteous	0.934	0.192	0.392	<b>0.862</b>
LP2	Laboratory technologists are courteous	0.923	0.252	0.372	<b>0.849</b>
LP3	Laboratory personnel has a positive attitude toward our research projects	0.954	0.241	0.286	<b>0.902</b>
LP4	Laboratory's employees are willing to help customers	0.945	0.258	0.300	<b>0.888</b>

Source: Authors' own analysis, 2020.

Three clear factors emerged from this PCA as shown in Table 3. The three factors restore 93.481% of the variance explained (see table 2).

The first factor to emerge is composed of 5 items; the second factor is made up of 5 items and the third factor is made up of 4 items. Concerning the validity or quality of the items that composed each factor, table 3 shows that each of the 14 items has a loading higher than .82. Thus, as to the items' quality, 100% of them were classified as excellent.

In summary, it appears that the variable "customer satisfaction" is a three-dimensional concept. Based on previous analysis, a comprehensive model for measuring customer satisfaction is presented (see figure 3) below.

After confirming the dimensionality of the scale, we prove its reliability, convergent validity and discriminant validity.

Table 4. Reliability and Validity of the sub-dimensions that emerged after the PCA

Dimensions	AVE	MSV	ASV	Cronbachs alpha	$\rho$	Composite Reliability
Reliability of tests' results	0.897 0.195		0.805	0.983	0.95	0.973
Responsiveness of services	0.839 0.297		0.703	0.981	0.92	0.970
Personnel's willingness to help	0.875 0.234		0.766	0.981	0.93	0.967

AVE: Average Variance Extracted;

MSV: Maximum Shared Variance;

ASV: Average

Shared Variance;

$\rho$  : Jöreskog Rhô.

Source: Authors' own analysis, 2020.

Table 3 shows that indicator loadings are all greater than the threshold of 0.7 or higher. Also, table 4 shows that all the latent variables have AVE greater than 0.5, therefore, convergent validity has been achieved.

Table 4 shows that the three factors registered a Cronbach's alpha score greater than .90, indicating the scale has a very high degree of reliability. The Jöreskog Rhô and Composite Reliability are greater than 0.7 which allow us to further confirm the good reliability of the construct. Furthermore, both the MSV and the ASV are lower than the AVE for all the constructs in the scale. Therefore, Discriminant validity has been achieved.

Table 5. Summary of model adjustment indicators

Fit	Indices	Cut-off for good fit*	Null model		One-factor model		Two-factor model	
			value	Global fit	value	Global fit	value	Global fit
Absolute	$\chi^2$ (p)	p > .05	365.59 (0.000)	No	123.81 (0.000)	No	9.57 (0.476)	Yes
	GFI	$\geq .90$	-	-	0.91	Yes	0.99	Yes
	AGFI	$\geq .90$	-	-	0.79	No	0.99	Yes
	SRMR	< .10	-	-	0.062	Yes	0.069	Yes
	RMSEA	$\leq .08$	-	-	0.19	No	0.000	Yes
Incremental	CFI	$\geq .90$	-	-	0.82	No	1.00	Yes
	NFI	$\geq .90$	-	-	0.849	No	0.978	Yes
	TLI	$\geq .90$	-	-	0.276	No	0.975	Yes
	RFI	$\geq .90$	-	-	0.863	No	0.972	Yes
	IFI	> .90	-	-	0.847	No	0.975	Yes
Parsimony	$\chi^2/\text{df}$	< 2	1.83 (df = 200)	Yes	0.55 (df=223)	Yes	1.6	Yes

\* Cutoff criteria for good model fit recommended by Kline (2005).

Goodness of Fit Indices (GFIs) for a series of Confirmatory Factor Analysis (CFA) assessing the null, one-factor, two-factor (generated by combining in all possible ways the three theoretically defined components) models of customer satisfaction are presented in table 5. According to Kline criteria, the two-factor model provided for a good fit.

Table 6. Results of hypothesis testing and predictable power

Hypothesis	Relationship	VIF	$\beta$ -value	t-value <sup>a</sup>	p-value	R <sup>2</sup>	Effect size <sup>b</sup> f <sup>2</sup>	Effect size <sup>c</sup> q <sup>2</sup>	Std error	Decision
H1	TR	CS	1.782	0.691	45.79**	0.024	0.958	0.067	0.016	0.022 Supported
H2	RS	CS	2.559	0.422	2.78***	0.000	0.615	0.000	0.000	0.027 Supported
H3	LP	CS	2.046	0.315	1.69*	0.056	0.511	0.000	0.000	0.026 Supported

<sup>a</sup>t-values for two-tailed test:

\*1.65 (sig. level = 10%)

\*\*1.96 (sig. level = 5%)

\*\*\*2.57 (sig. level = 1%) (Hair et al., 2017)

Notes: \*\*\*p<0.01, \*\*p<0.05, \*p<0.10

Effective size: 0 - none, 0.02 – small, 0.15 – medium, 0.35 – large (Cohen, 1988)

Effect sizes calculated using the following formulas:

$$^b f^2 = R^2 \text{ included} - R^2 \text{ excluded} / 1 - R^2 \text{ included}$$

$$^c q^2 = Q^2 \text{ included} - Q^2 \text{ excluded} / 1 - Q^2 \text{ included}$$

The results of the structural model analysis are shown in table 6 which meet the criteria of the Evaluation of Assessment Model based on the Partial least Squares Structural Equation Modeling (PLS-SEM) analysis procedure. Table 6 shows that:

1. The Variance Inflation Factor (VIF) coefficients are less than 4.0 (1.782, 2.559 and 2.046), which ensure there are no collinearity issues among constructs.
2. There is significant correlation between latent variables and customer satisfaction:
  - There is significant relationship between reliability of tests' results and customer satisfaction ( $\beta = .691$ ,  $t = 45.79$ ,  $p = .024$ ). This finding confirms H1.
  - There is a significant relationship between responsiveness of services and customer satisfaction ( $\beta = .422$ ,  $t = 2.78$ ,  $p = .000$ ). Hence, H2 is confirmed.
  - There is a significant relationship between laboratory personnel's willingness to help and customer satisfaction ( $\beta = .315$ ,  $t = 1.69$ ,  $p = .056$ ). This finding confirms H3.
3. R-square values (.958, .615 and .511) are considered as substantial (greater than 0.26). Thus, a high predictive power of the model.
4. Based on the results of  $f^2$  effect size, only the quality of tests' results (TR) has small effect size ( $f^2 = .067$ ).
5. In terms of the prediction relevance of the individual exogenous variables, the  $q^2$ -value of 0.016 for the variable TR determines a small effect.

## Discussion

We developed a new customer satisfaction measurement scales model and test its reliability and validity. Given that the quality of a study's results are related directly to the quality of the instrument used to collect data, it is easy to see the importance of collecting data by means of reliable and valid instrument (Andrew DPS, et al, 2001).

Our sampling was exhaustive. The criterion recommended by Hair et al., says that for an adequate sample size, it is necessary to have between 5 and 10 individuals for each instrument item (Hair et al, 2009). To Tabachnick and Fidell, factor analysis validity is compromised with less than 300 individuals (Tabachnick, BG., & Fidell, LS., 2007). Our new instrument had 14 items in its application version, which would require a minimum sample size of 70 people, according to Hair et al. (2009) criterion. Three hundred and thirty people composed our sample that attended to both criteria, allowing the exploratory and confirmatory validations to be performed.

Before performing a factor analysis, the literature suggests evaluating the sample size adequacy using the Kaiser-Meyer-Olkin test of sampling adequacy (KMO). Furthermore, it is necessary to assess whether the factor analysis should be continued or not by employing Bartlett's Test of Sphericity (Schmidt and Hollensen, 2006, pp.302-303). These two tests indicate the suitability of the data for structure detection. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy is a statistic that indicates the proportion of variance in the variables that might be caused by underlying factors. Kaiser gave the KMO test standard about whether it is suitable for factor analysis:  $KMO > 0.9$ , quite suitable;  $0.9 > KMO > 0.8$ , suitable;  $0.8 > KMO > 0.7$ , generally suitable;  $0.7 > KMO > 0.6$ , not quite suitable;  $KMO < 0.5$ , not suitable. (Ershi Qi et al,

2013). Bartlett's test of sphericity tests the hypothesis that correlation matrix is an identity matrix, which would indicate that variables are unrelated and therefore unsuitable for structure detection. Small values (less than 0.05) of the significance level indicate that a factor analysis may be useful with data. Table 1 shows that in the present test, the KMO value of the variables was 0.934, which indicated sampling adequacy such that the values in the matrix was sufficiently distributed to conduct factor analysis (George D. and Mallery P., 2016.). The value obtained by Bartlett's test of sphericity, Approx. Chi-Square was 8,249.985, which was highly significant at  $p < 0.001$  level, indicating that the data were approximately multivariate normal (Pallant J., 2013.). The results of KMO and Bartlett's Tests proved satisfactory for further analysis (table 1). So the variables that the paper selects are quite suitable for factor analysis.

In factor analysis, methods of Principal Component Analysis (PCA) and varimax rotation were employed because they maximize variance and facilitate the interpretation of the constructs deduced. In view of the arbitrary nature of factor extraction, and practicability and meaningful interpretability, the following three criteria were observed in data reduction: (1) the eigenvalue was greater than 1 and there were more than 3 items in one factor; (2) factor loadings lower than 0.4 were deleted and not counted in any factor; (3) when double loadings occurred, decisions were made on meaningful interpretations. (Xu Q. and Liu J., 2018).

Based on the three criteria mentioned above, three common factors were extracted from the questionnaire. Table 2 shows that the accumulative contribution rate of three extracted common factors is 93.481%, which is bigger than 85%, i.e., the extraction of common factor is effective (Huang C. et al, 2020). Scree plot also flattened out after the first three factors. The original 14 indexes can be integrated into three common factors. According to the principle of factor analysis, the three common factors have no correlation with each other, but each common factor is highly correlated with its own contained original variables.

The three common factors extracted were named according to the items included. Table 3 shows the correlation coefficient between common factors and their own contained original variables. As a result, it is suitable to use reliability of tests' results (TR), Responsiveness of services (RS) and Laboratory Personnel's willingness to help (LP) to represent the original variables and evaluate customer satisfaction with laboratory services.

The World Health Organization (WHO) indicates that evaluations of client satisfaction might address various aspects of the provided services: reliability and consistency of the services, the responsiveness of services, and the willingness of providers to meet client's expectations and needs (WHO, 2000). Our construct meets the WHO recommendations.

The validity or quality of the items that composed each factor was also analyzed, based on Comrey and Lee classification. Comrey and Lee classified items with loadings higher or equal .71 as excellent; higher or equal .63 as very good; higher or equal .55 as good; higher or equal .45 as reasonable; and higher or equal .32 as poor (Comrey, A. L., & Lee, H. B., 1992). Thus, as to the items' quality, 100% of them were classified as excellent.

Questionnaires must be both reliable and valid in order for researchers to have confidence in the data collected with the instrument. Reliability, the consistency of the results obtained, concerns the extent to which the instrument yields the same results in repeated trials (Andrew DPS, et al, 2001). The most common test for a construct's internal reliability is Cronbach alpha. However, more recently composite reliability and Jöreskog's Rhô have become more pertinent measures of construct reliability in research studies that utilize Structural Equation Modeling (SEM) and Confirmatory Factor Analysis (CFA) as part of their data analysis. There is a consensus in the literature that a score of 0.7 or higher is indicative of a construct's reliability (Hair, 2010; Nunnally, 1978; Malhotra, 2010). In this study, Cronbach alpha, Jöreskog Rhô and Composite Reliability are greater than 0.7 which confirm the good reliability of the construct (table 4).

Validity, the extent to which an instrument accurately measures the target it was designed to measure, helps a researcher determine whether or not an instrument addresses its designed purpose (Andrew DPS, et al, 2001). Testing of

construct validity concentrates not only on finding out whether an item loads significantly on the factor it is measuring (convergent validity) but also on ensuring that it does not significantly load across or measure other factors (discriminant validity) (Usunier JC and Stoltz J., 2016). Our results confirmed the convergent validity and discriminant validity of the constructs (table 4).

CFA were performed to compare three different models: (1) a null model; (2) a one-factor model and (3) a two-factor model. To determine how well the specified factor model represented the data, goodness-of-fit indices were examined (table 5). There are several indices to assess model-fit and they are categorized into three groups, namely absolute fit indices, incremental fit indices and parsimony fit indices (Frikha A., 2019). The two-factor model was chosen as the best fit model based on the cutoff criteria for good model fit recommended by Kline (Kline R.B., 2015).

In order to assess the structural model, Hair et al., (2014) proposed five step structural model assessment procedure. 1) Assess structural model for collinearity issues 2) Assess the significance and relevance of the structural model relationship 3) Assess the level of  $R^2$  (coefficient of determination) 4) Assess the effect size  $f^2$  5) Assess the level of  $q^2$  effect size. The results of the structural model analysis, shown in table 6, meet the criteria of the Evaluation of Assessment Model based on the Partial least Squares Structural Equation Modeling (PLS-SEM) analysis procedure. Thus, our three hypotheses were confirmed: the three latent variables have a positive influence on customer satisfaction.

### **Limitations of the study and future research directions**

This study's limitations must be acknowledged. Since this is the first instrument of its kind to have been fully validated, there are no gold standards to evaluate criteria against it. Criterion related validity cannot be established for this instrument. The major inherent limitation is the generalization of the outcome of the study. Since the study was limited to only the University Hospital of Kinshasa and not the entire hospital market in Democratic Republic of the Congo (DRC), attempt to generalize the results should be made with caution since the study was not cross-sectional across the entire health system in DRC. Future research should, therefore, reproduce the study in other hospitals in order to confirm the results of our findings across the health system. Because we surveyed attending physicians only, we can't confirm that the developed instrument is reliable or valid for patients. Additional research could develop another instrument for measuring customer satisfaction among patients and other customers who attain the clinical laboratory. Finally, the test-retest reliability of the instrument should be evaluated. Measures of reliability include the stability of an instrument over time. Therefore, the stability of this new instrument, including short- and long-range stability, should be further investigated using the test-retest correlation method.

## **Conclusion**

This study has developed a new instrument for measuring customer satisfaction in clinical laboratory. Data were analyzed using exploratory factor analysis, confirmatory factor analysis and structural equation model (SEM). An instrument with a 3-factor structure shows strong potential for construct validity. The results confirmed our hypothesis, showing the three-dimensionality of Customer Satisfaction. We found that reliability of tests' results, responsiveness of services and laboratory personnel's willingness to help have a significant influence on customer satisfaction. The new customer satisfaction measurement scales model showed good reliability and factor-based and construct validity. The authors encourage practitioners and researchers to use this instrument for various applications, particularly in customer satisfaction surveys.

### **Managerial and theoretical implications**

The above conclusion provides valuable practical and managerial implications for researchers and laboratory managers. It highlights principal areas where managerial attention is required for improving customer satisfaction. It is important for clinical laboratory managers to consider customer satisfaction with laboratory services as a multi-dimensional construct, where reliability of tests' results, responsiveness of services and laboratory personnel's willingness to help are important, because focusing only on one or another service quality is too narrow approach. We recommend that the laboratory develop a program to measure service quality and customer satisfaction on regular basis to meet the changing trend of customer tastes and preferences. The present study has some theoretical implications as well. This paper, being the first study to attempt a comprehensive psychometric validation of an instrument that measures customer satisfaction with clinical laboratory services in DRC, has contributed to filling the gap in the literature. Additionally, findings on the service quality dimensions that are of highest importance to customers are still subjective, and the current study theoretically contributes to increasing the knowledge insight in the field of marketing.

## Abbreviations

**AGFI:** Adjusted Goodness of Fit Index; **ASV:** Average Shared Variance; **AVE:** Average Variance Extracted; **CAPs:** College of American Pathologists; **CFA:** Confirmatory Factor Analysis; **CFI:** comparative fit index; **CQI:** Continuous Quality Improvement; **CS:** Customer Satisfaction; **DRC:** Democratic Republic of the Congo; **EFA:** Exploratory Factor Analysis; **GFI:** Goodness of Fit Index; **IFI:** Incremental Fit Index; **ISO:** International Organization for Standardization; **ISO/IEC:** International Organization for Standardization/International Electrotechnical Commission; **KMO:** Kaiser-Meyer-Olkin test of sampling adequacy; **LP:** laboratory personnel's willingness to help; **MSV:** Maximum Shared Variance; **NFI:** Normed Fit Index; **PCA:** Principal Component Analysis; **PLS:** Partial Least Squares; **QMS:** Quality Management System; **RFI:** Relative Fit Index; **RMSEA:** Root Mean Square Error of Approximation; **RS:** Responsiveness of services; **SEM:** Structural Equation Modelling; **SRMR:** Standardized Root Mean Square Residual; **TLI:** Tucker-Lewis Index; **TR:** Reliability of tests' results; **UNIKIN:** University of Kinshasa; **VIF:** Variance Inflation Factor;  **$\rho$ :** Jöreskog Rhô.

## Declarations

### Ethics approval and consent to participate

Before implementing the study, ethical clearance was obtained from the ethical review committee of the Public Health School, University of Kinshasa. The respondents were informed of the purpose of the study and assured of confidentiality and their right to withdraw from the study. Verbal consent was obtained after the study objectives were explained to each participant. Informed consent was obtained from each respondent, and confidentiality was maintained throughout the study.

### Consent for publication

Not applicable

### Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

### Competing interests

The authors declare that they have no competing interests.

## Funding

Not applicable

## Authors' contributions

CBA wrote the initial draft, guided the working group's process and incorporated working group comments. MMMR, KNNJ, MMH and KND contributed to the background. TAK and JMM contributed to the results analysis. HNS provided overall guidance and editing. All authors read and approved the final manuscript.

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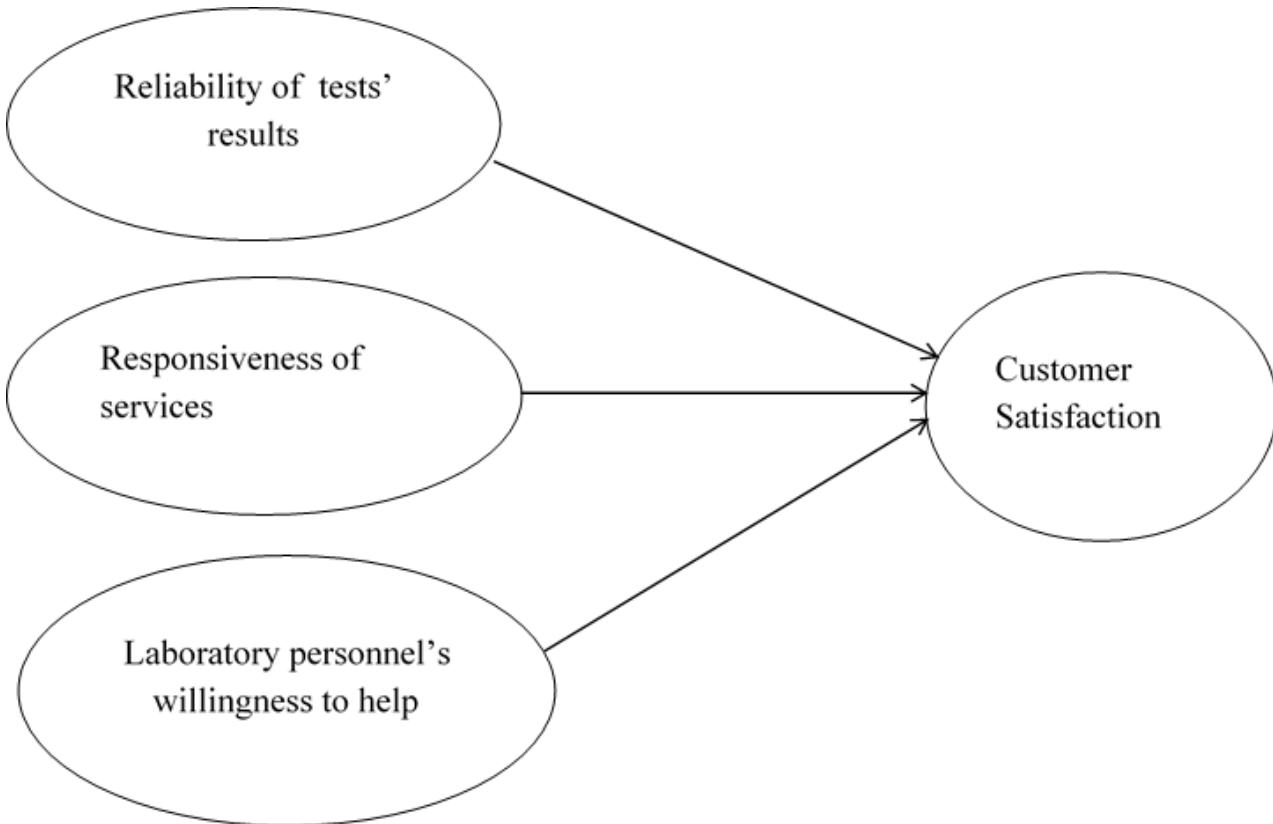
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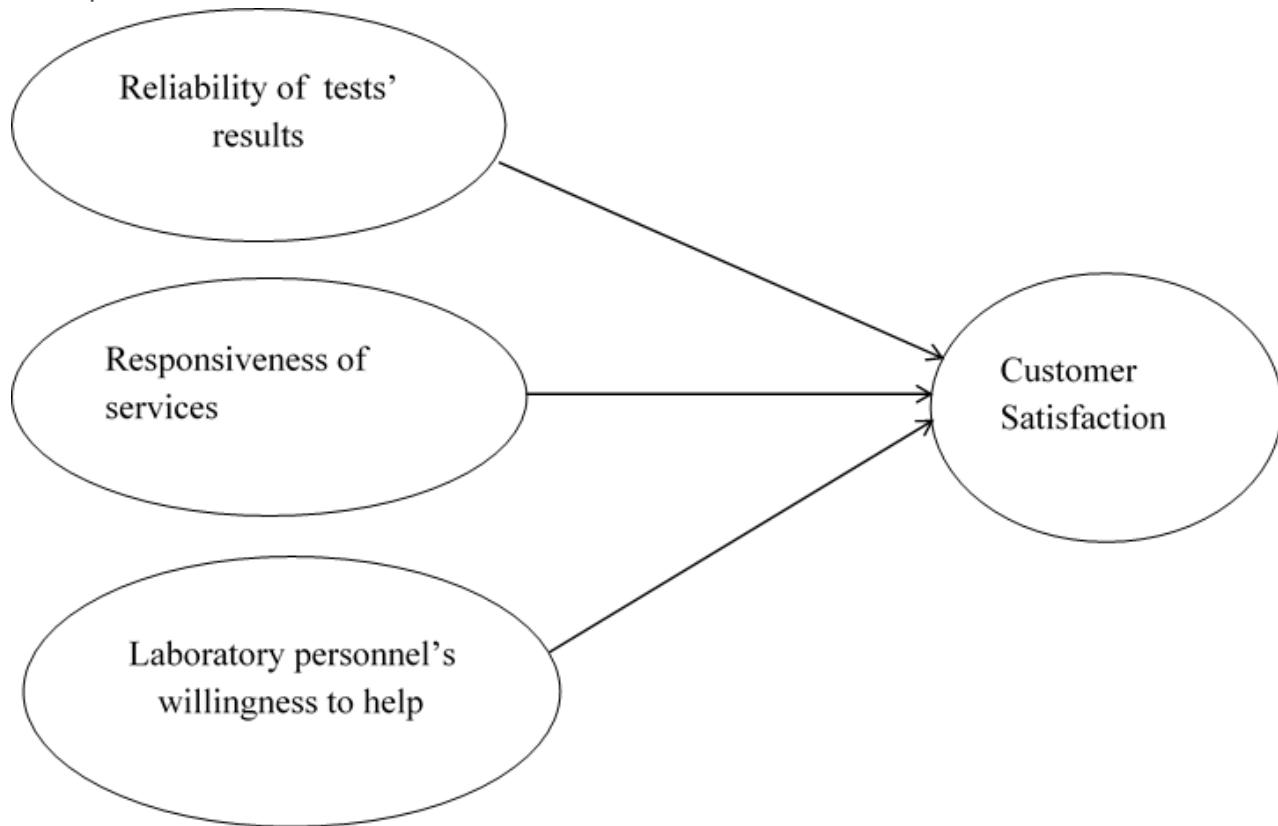
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## Figures



**Figure 1**

Conceptual framework



**Figure 1**

Conceptual framework

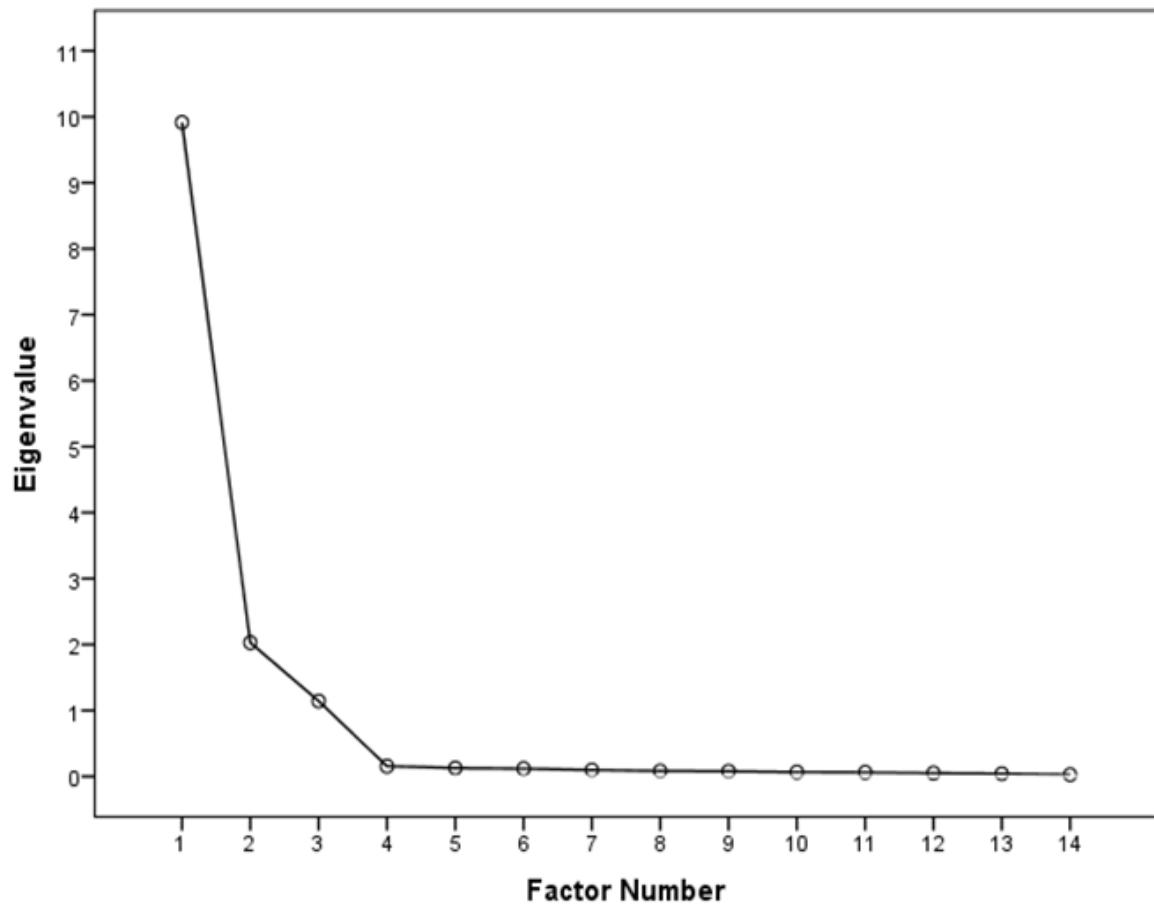


Figure 2

Scree plot

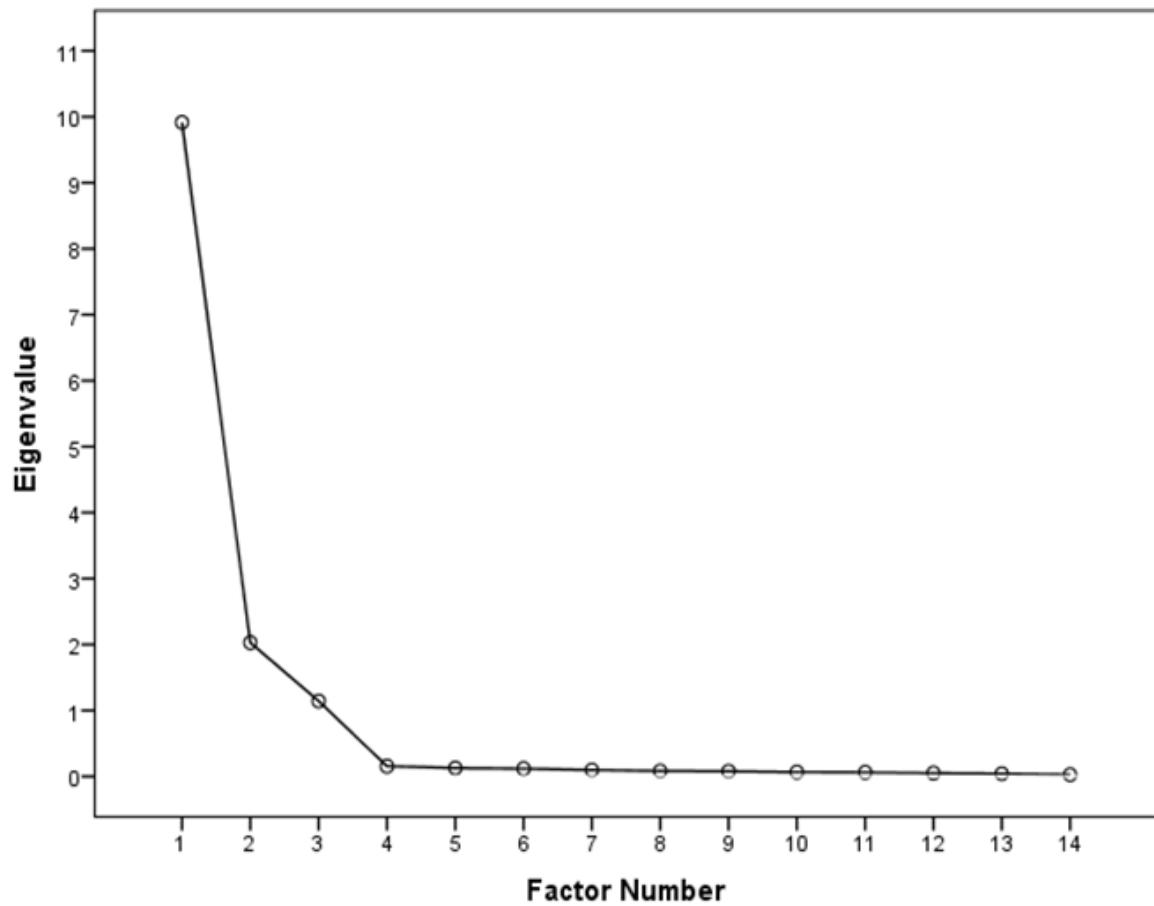
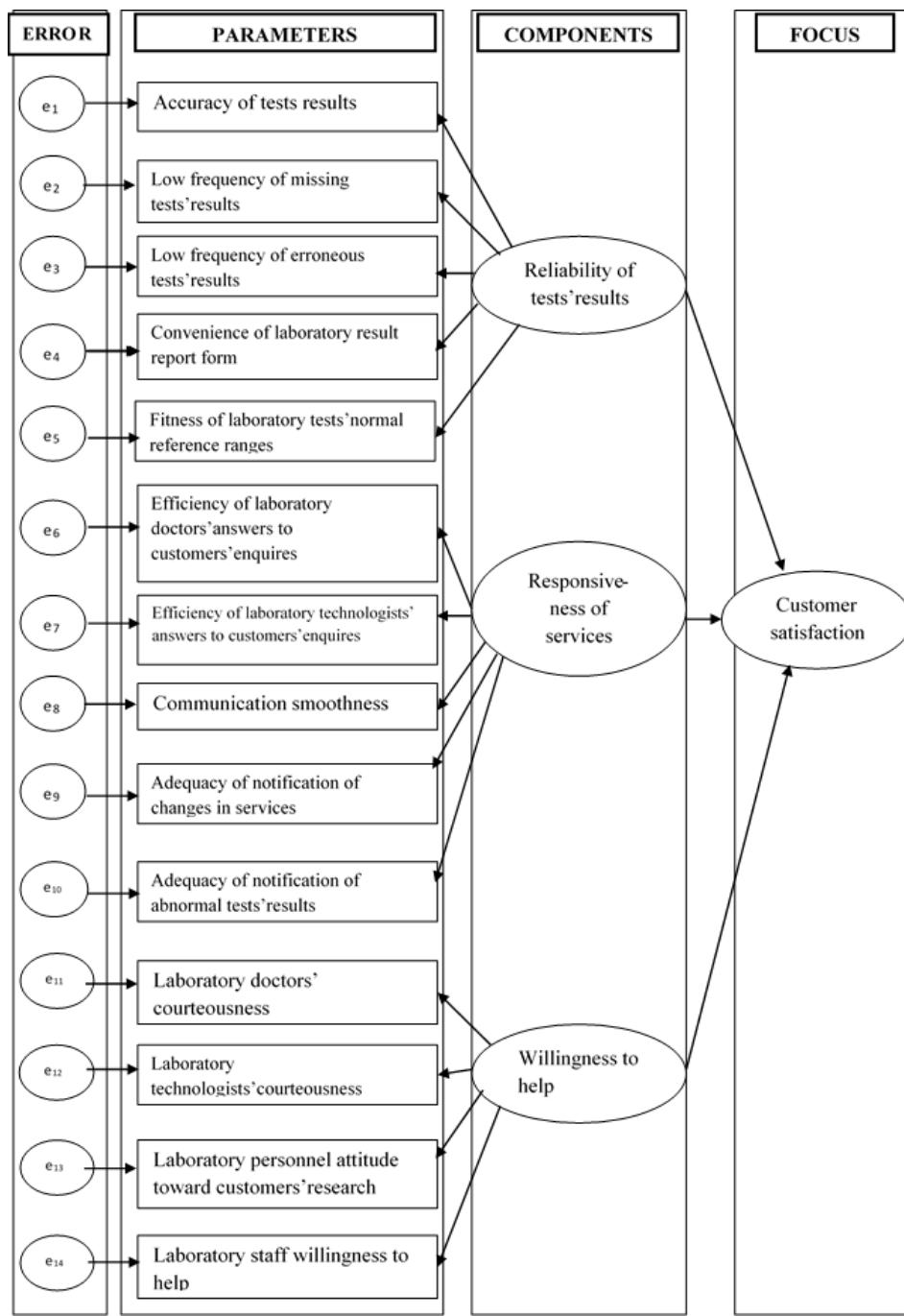


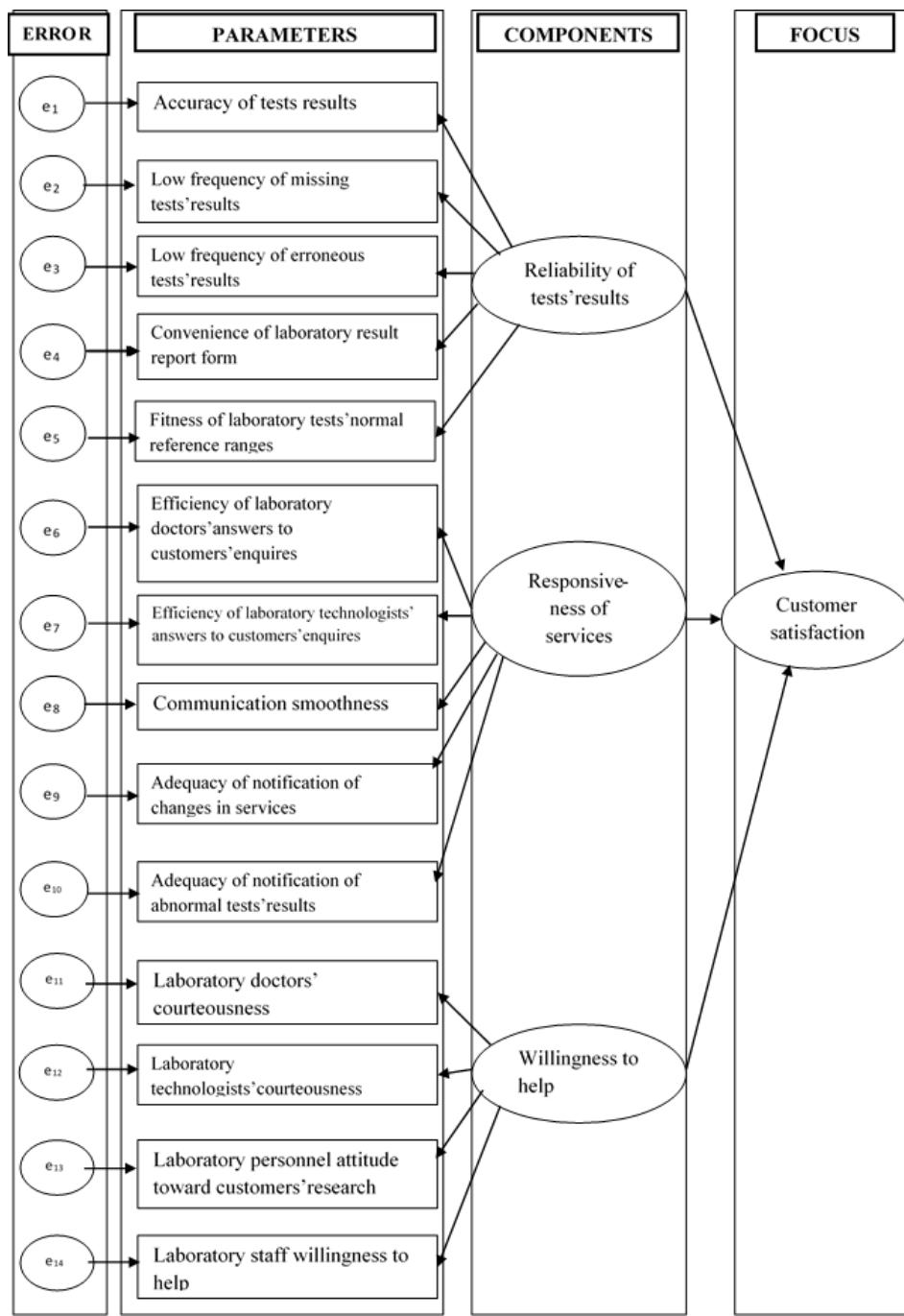
Figure 2

Scree plot



**Figure 3**

Research Framework of Consumer Satisfaction with clinical laboratory quality



**Figure 3**

Research Framework of Consumer Satisfaction with clinical laboratory quality