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STRUCTURAL EQUATION MODELS APPLIED FOR EVALUATING SERVICE QUALITY AND SATISFACTION IN THE HEALTHCARE SYSTEM OF CARTAGENA DE INDIAS D. T. Y C. (COLOMBIA)

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ABSTRACT. This research attempts to answer which is the most recommended structural equation model (SEM) technique while evaluating healthcare services' quality in Cartagena de Indias city (Colombia). CB-SEM and PLS-SEM techniques were used in this paper for comparing the results in the local context. For assessment, robust weighted least squares with mean and variance adjustments (WLS) for CB-SEM technique and PLS-SEM with centroid scheme were utilized. Data were collected with a final valid sample of 582 adults aged over 18 years, residents of Cartagena city. Also used was a questionnaire designed in three parts: demographic profiles, quality perceptions (overall quality services, infrastructure, coverage, and access), and satisfaction levels. In terms of quality, the findings reveal that infrastructure and access have a significant effect on service quality levels and this variable has a strong effect on satisfaction for both techniques. In term of structural equation model (SEM) techniques, the results indicate that coverage does not present a significant effect on service quality only in CB-SEM technique. In this case, the positive association between coverage and overall services quality was rejected. Both techniques were validated with different results, concluding the applicability of CB-SEM and PLS-SEM in this context.

JEL Classification: C12, C35, I11, P46

Keywords: Service quality; Structural Equation Model; Healthcare service; Partial Least Squares SEM; covariance-based SEM, Colombia

Introduction

The healthcare system in Colombia is based on two regimes: contributory and subsidized (Abadia & Oviedo, 2009). Healthcare requirements like access, coverage, infrastructure, and service quality, among others, must be added to this complex and universal

model. The healthcare system is in a state of constant search of incomes to solve the persistent problem of inequity (Calderón *et al.*, 2011). Cartagena de Indias, a tourist city in Colombia, has many problems affecting the healthcare system overall and the satisfaction level among its citizens. In 2015, the city had a 93% coverage between the two regimes mentioned above, but at the same time, only 42% of their users were satisfied (Red de Ciudades Cómo Vamos, 2015). The satisfaction average in the 11 major cities in Colombia was 50%.

The survey used to measure the level of satisfaction in the city registered higher satisfaction in lower socioeconomic strata (Cartagena Cómo Vamos, 2015). The healthcare service was the most prioritized issue for the citizens in terms of better infrastructure, access, and coverage. These elements or constructs can be integrated into a model with the aim to evaluate which one of them has more effect on the satisfaction level. In this sense, this paper proposes a conceptual framework using Structural Equation Modeling (SEM). With SEM, we can figure out the significant relations among the constructs that predetermine the satisfaction levels.

SEM can be applied through two techniques, both used amply in social sciences. The most popular is covariance-based SEM (CB-SEM). CB-SEM is usually applied to evaluate causal models through the differences between the sample covariance matrix and the estimated covariance matrix. The objective of this technique is to calculate the relationships among latent variables and observed variables (Khosrow-Pour, 2014). The CB-SEM can be catalogued as a parametric technique for multivariable analysis, requiring focusing on sample sizes and the normality assumptions of data (Awang *et al.*, 2015).

On the other hand, the variance-based SEM techniques (VB-SEM) appear as a reasonable alternative while estimating SEM models. These non-parametric techniques have been used in explanatory research, and it consist in maximizing the explained variance of the dependent variables without the usual assumptions from CB-SEM models, like normality of observed variables and sample size greater than 200 (Dijkstra, 1983; Hair *et al.*, 2014; Haenlein & Kaplan, 2004; Jannoo *et al.*, 2014; Reinartz *et al.*, 2009; Vinzi *et al.*, 2010; Wan Afthanorhan, 2013). Partial Least Squares (PLS) is a popular VB-SEM technique applied in data analysis for testing theoretical relations among variables (Monecke & Leisch, 2012). A path model usually represents these relations.

If both techniques are supposed to find a solution on SEM models, which is the most recommended one for evaluation of healthcare services quality in Cartagena city? To answer this question, this paper uses both CB-SEM and PLS-SEM, for comparing the results so that to recommend which technique is more appropriate in this context. Using the empirical case study research method, this study will produce recommendations for the local healthcare system so that to improve its satisfaction levels and also for developing new measurement models including another key factor. The main result from this article is validating the theoretical model and technique, and the latter will allow carrying out recommendations on management actions so that to improve the satisfaction level. This study concludes with explaining the research limitations and outlining the directions for future research on the healthcare system and its users.

1. Literature review

For this article, two visions were identified to evaluate the quality of healthcare services. One, applied in the research, it is a holistic vision of the function of the healthcare system, based on the citizens' perceptions. The other point of view considers the evaluation of quality from the patient's perspective and usually referred to a particular organization, procedure, or medical specialities. The first vision requires the definition of overall variables. The first vision requires the definition of overall variables. These variables would represent the attributes of the

healthcare system on the local or national context. Access, clinical categories, characteristics of patients, performance or efficiency, quality of life, coverage, knowledge, facilities, equity, technical practice and public satisfaction are some elements used to assess the quality of services in public healthcare, understand it as a system (Donabedian, 1988; Hunter *et al.*, 2010; Maxwell, 1992; Papanicolas, 2013; Schoen, 2004; Turnock, 2015; Wilson *et al.*, 1995).

The second vision is most common to find in the literature. Lee, Lee & Kang (2012) suggest hospitals have a clear responsibility for improving the inpatient's satisfaction levels through their efficient operations, employee engagement, and service quality. Simple decisions have a direct or indirect effect on the satisfaction levels such as medical practice (Johnson & Russell, 2015; Marley *et al.*, 2004), performance (Cengiz & Kirkbir, 2007; Scotti *et al.*, 2007), interaction of family and residents (Lin *et al.*, 2014), personal relationship (Chang *et al.*, 2013; Senić & Marinković, 2013), service attitudes of the doctors and nurse, and environment (Zhang *et al.*, 2016). The main features found in previous research are shown in *Table 1*.

Table 1. Features found in previous research

Authors	Latent variables	Number of observed variables	SEM Technique	Final Sample size
Scotti *et al.* (2007)	High-Performance Work System, customer orientation, service quality (employee and customer perceptions), customer satisfaction	10	CB-SEM	71526
Cengiz & Kirkbir (2007)	Functional value, emotional value, social value, perceived value	26	CB-SEM	701
Lee *et al.* (2012)	High-performance work system, employee reactions, service quality, customer satisfaction, and customer loyalty	27	CB-SEM	196
Akter *et al.* (2013)	Service quality (mHealth), continuance intentions, customer satisfaction, and quality of life	32	PLS-SEM	480
Chang *et al.* (2013)	Interpersonal based medical service encounters, service quality, patient satisfaction, and patient trust.	8	CB-SEM	285
Azizan & Mohamed (2013)	Infrastructure, interaction, administrative, medical care, nursing care	43	PLS-SEM	109
Lin *et al.* (2014)	Perceived quality, perceive value, and overall satisfaction	24	CB-SEM	180
Johnson & Russell (2015)	Administrative processes, patient flow, patient safety and health, care provider, nurse assistant, overall patient satisfaction	34	CB-SEM	1385
Sergio da Silva *et al.* (2015)	Flexibility, co-innovation, responsiveness, and co-creation	24	PLS-SEM	225
Zhang *et al.* (2016)	Demography characteristics, overall satisfaction, frequency of rounds, attitudes, expenditures, hospital environment.	17	CB-SEM	878

Source: own compilation.

2.1. CB-SEM and PLS-SEM techniques

Sarstedt *et al.* (2014) suggest that when CB-SEM and PLS-SEM are compared, for understanding when to use one technique over the other gets better. Each technique has common components, advantages, and disadvantages. In the case of assessing service quality, CB-SEM is preferred (Chapman & Feit, 2015).

Both CB-SEM and PLS-SEM path have two components: structural model and measurement model. CB-SEM is applied only in explanatory researches, and it uses a maximum likelihood (ML) or generalized least squares (GLS) among others, for proving relationships in conceptual models. PLS-SEM can be used in explanatory and predictive researches, and it includes an additional component called weighting scheme, characteristic of this technique, which in turn is divided into three schemes: centroid, factorial, and path weighting (Monecke & Leisch, 2012).

CB-SEM often require large samples and multivariate normality (Sharma & Kim, 2013), principal reasons why some researchers like to use PLS-SEM (Ringle *et al.*, 2012). Although these requirements, in CB-SEM exists some methods that can solve these limits, for example, bootstrap re-sampling (Sharma & Kim, 2013), asymptotically Distribution-Free (ADF) estimator, scaling methods and robust WLS estimation procedures (Finney & Distefano, 2006). On the other hand, PLS-SEM can be used directly in or with: explanatory and predictive models (Sarstedt *et al.*, 2014), complex situations with low theoretical information (Jõreskog & Wold, 1982), non-normal data, and small sample size (Cassel *et al.*, 1999; Chin & Newsted, 1999; Jörg Henseler, 2010).

2.2. Conceptual frame

For this study, there were included five structural or latent variables: overall service quality, infrastructure, access, coverage, and user satisfaction.

The overall service quality must be understood as a key for decision-making with the proposed to improve the satisfaction levels. These two structural variables – quality and satisfaction – have been used widely in the characterization of services (Vergara-Schmalbach *et al.*, 2010; Vergara-Schmalbach & Quesada, 2013). The assessment of the service quality can be made either on consumer's perceptions or an objective measurement (Kang, 2006). In this sense, Donabedian (1990) identified two sources of data for the healthcare services: one based on the measure of the process compared with the standards and another based on the user perceptions of the systems. The main responsibility of the healthcare system users is to identify their demands and preferences (World Health Organization, 2006).

In addition to service quality and satisfaction, there were measured three dimensions, based on the user perceptions: infrastructure, coverage, and access. This construct was redefined in dimensions to facilitate its measurement and abstraction, permitting to identify the key factors involved (Vergara-Schmalbach & Quesada, 2011; Vergara-Schmalbach & Maza-Avila, 2015). The infrastructure, access, and coverage are critical aspects of the local healthcare system in Cartagena city.

Infrastructure refers to the physical elements involved in the hospital environment, and its uses for the service development (Zeithaml *et al.*, 1988). The coverage expresses the interaction between the users and the service, involving the availability of the resources, the logistics, and the distribution facilities (Tanahashi, 1978). Finally, for this research, access considers the financial capabilities of local citizens for participating or accessing the healthcare system. In literature, there are research findings that show the effect on service quality and satisfaction level by the infrastructure (Akyuz & Ayyildiz, 2012; Brady & Cronin, 2001; Irfan

et al., 2012; Itumalla, 2014; Mekoth *et al.*, 2009; Ramez, 2012; Ramseook-munhurrun *et al.*, 2010; Serrano-del Rosal & Loriente-Arín, 2008; Vandamme & Leunis, 1993; Zaim *et al.*, 2010), coverage (Bañón, 2003; Tanahashi, 1978) and access (Andersen, 1995; Baltussen *et al.*, 2002; Bolton & Lemon, 1999; Penchansky & Thomas, 1981; Peters *et al.*, 2008).

Based on these variables, it was designed an explanatory conceptual model with the aim to test the hypotheses associated with relationships among structural variables. It is worth noting that an explanatory model is used for testing causal theories (Shmueli, 2010).

H_{1a}: There is a positive association between perceived infrastructure and overall service quality.

H_{1b}: There is a positive association between coverage and overall quality services.

H_{1c}: There is a positive association between access and overall quality services.

H_{1d}: There is a positive association between and overall service quality and user satisfaction.

3. Methodological approach

To evaluate the conceptual model, in this research was utilized robust weighted least squares with mean and variance adjustments (WLS) for CB-SEM technique and PLS-SEM with centroid scheme. WLS is recommended for ordinal scales (Bowen & Guo, 2012), non-normal distributed data (Hox & Roberts, 2011; Olsson *et al.*, 2000), and good development with small samples (Newsom, 2015). Both methods were calculated using R software version 3.3.0 with the packages Lavaan version 0.5-20 for CB-SEM and semPLS version 1.0-10 for PLS-SEM.

3.1. Sampling

Data were collected with a final valid sample of 582 adults aged over 18 years, residents of Cartagena city. People interviewed said that they were or have been users of the local healthcare system. A closed-end survey was applied, with five demographic questions and twelve perception items. The response rate was 97% and the maximum error ±2.9%. The sample characteristics are shown in *Table 2*.

Table 2. Sample Characteristics

Variable	Responds	Percentage (%) (based on 582)
Gender	Female	287
	Male	295
Age	< 21	59
	21 - 30	180
	31 - 40	142
	41 - 50	105
	51 - 60	68
	> 60	28
Education	Elementary School	32
	High school	162
	Technique / Technology	166
	Graduate	197
	Postgraduate	21

Variable	Responds	Percentage (%) (based on 582)
Status	Low (1-2)	315
	Middle (3-4)	173
	High (5-6)	94

Source: own compilation.

3.2. Measurement instrument

The questionnaire was designed in three parts: the first part included the demographic questions. The second part was composed of ten items about quality perceptions (overall quality services, infrastructure, coverage, and access). The last section included two items to measure satisfaction levels.

Quality perceptions items were measured on a six-point Likert ordinal scale in which one means strongly disagreed, and six mean strongly agreed. The same scale was used for measuring satisfaction levels, in which one was very dissatisfied, and six was very satisfied. This scale was used to avoid intermediate valuations. Items for each construct variable are shown in *Table 3*.

Table 3. Questionnaire items

Infrastructure
P1 Hospital infrastructure is adequate
P2 Hospital cleanliness and hygiene are adequate
Coverage
P3 There are enough hospitals or clinics in the city
P4 There are enough ambulances in the city
P5 There are enough resources (doctors, nurses, equipment, and beds) in the local healthcare system
Access
P6 Access to hospital services is granted
P7 Access to hospital ambulances is granted
Overall Quality Services
P8 Quality in the attention in hospitals or clinics is good
P9 Quality in hospital services and ambulances are good
P10 General quality in public services is good.
Satisfaction
P11 You are satisfied with the services received in hospitals or clinics
P12 You are satisfied with the public services received in the city

Source: own compilation.

4. Conducting research and results

The observed variables with the highest value were P1 (hospital infrastructure) and P2 (hospital cleanliness and hygiene). In general, these values indicate a poor perception about the healthcare system in the city, coinciding with the results of the last local report "*Cartagena Cómo Vamos*" (2015) (*Table 4*).

Table 4. Observed variables results

Observed variable	Average	Variance
P1	3.29	1.63
P2	3.40	1.72
P3	2.91	1.42
P4	2.73	1.26
P5	2.82	1.48
P6	2.86	1.57
P7	2.71	1.39
P8	3.02	1.36
P9	2.89	1.45
P10	3.23	1.09
P11	2.96	1.43
P12	3.16	1.11

Cronbach's Alpha coefficient was applied to test the reliability of the constructs. The lowest alpha was 0.724, suggesting an acceptable internal consistency (Tavakol & Dennick, 2011).

4.1. PLS model

Validity and reliability were measured before the analysis of the structural model. For test these conditions were employed Dillon-Goldstein's coefficient for composite reliability, average variance extracted (AVE) and discriminant validity through cross loading. The minimum values for Dillon-Goldstein's coefficient and AVE were 0.86 and 0.67, respectively. Both values are over the recommended limit for validity and reliability (Esposito *et al.*, 2010; Hair *et al.*, 2016) (*Table 5*).

Table 5. Dillon-Goldstein's coefficient, AVE, and VIF

Latent variable	Dillon-Goldstein	AVE	VIF
infrastructure	0.91	0.83	1.4286
coverage	0.90	0.74	2.3256
access	0.89	0.81	1.9608
service quality	0.86	0.67	2.0408
satisfaction	0.88	0.79	--

The variance inflation factor (VIF) was below 10, showing non-presence of multicollinearity (Henseler *et al.*, 2009). Through the analysis of cross-loading and comparing the square root of AVE with correlations among constructs, it can be shown the discriminant validity of the model (Roostika, 2011). Each loading among observed and latent variables theoretically associated are greater than the rest (Henseler *et al.*, 2015) (*Table 6*).

Table 6. Cross-loadings

	infrastructure	coverage	access	Service quality	satisfaction
P1	*0.9136815*	0.5277917	0.5183993	0.6695704	0.5981372
P2	*0.909971*	0.5316408	0.5365838	0.6562638	0.5968413
P3	0.5319373	*0.852948*	0.6124984	0.6480874	0.5931535
P4	0.4279866	*0.8564377*	0.6328967	0.584534	0.5168631
P5	0.5314295	*0.873666*	0.6998499	0.7115507	0.7083326
P6	0.5599809	0.6785831	*0.9060885*	0.6987328	0.6645419
P7	0.4782108	0.6802253	*0.8928784*	0.6565114	0.5982933
P8	0.6878404	0.6471145	0.6359704	*0.8334299*	0.6748776
P9	0.5964121	0.6910797	0.685537	*0.8629167*	0.6822504
P10	0.4945492	0.5132885	0.5244273	*0.7623367*	0.7162888
P11	0.6372711	0.7218204	0.7116636	0.800419	*0.9058996*
P12	0.5159723	0.5235737	0.5204882	0.6781138	*0.8660982*

Each coefficient was assessed using bootstrap with 1000 bootstrap sampling and 95% confidence level. All coefficient among the theoretical relationships were significant, and all tested hypotheses were accepted (*Table 7*). The complete path coefficient is shown in *Figure 1*, where the beta coefficient explains the existing correlation between the latent variables during the lam coefficient, the existing correlation between the latent variables and the observable variables.

Table 7. Alternative hypotheses tested

Hypothesis	Result
H_{1a}: There is a positive association between perceived infrastructure and overall service quality.	Accepted
H_{1b}: There is a positive association between coverage and overall quality services.	Accepted
H_{1c}: There is a positive association between access and overall quality services.	Accepted
H_{1d}: There is a positive association between overall service quality and user satisfaction.	Accepted

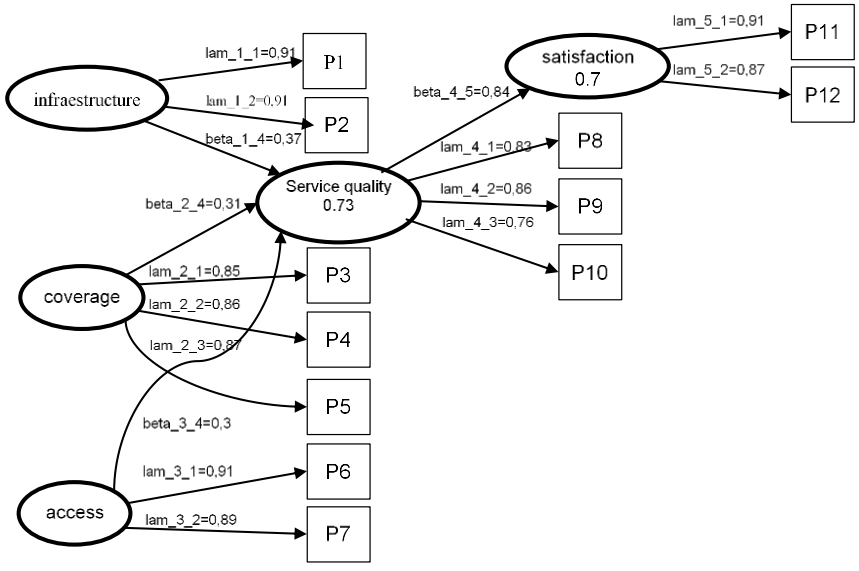


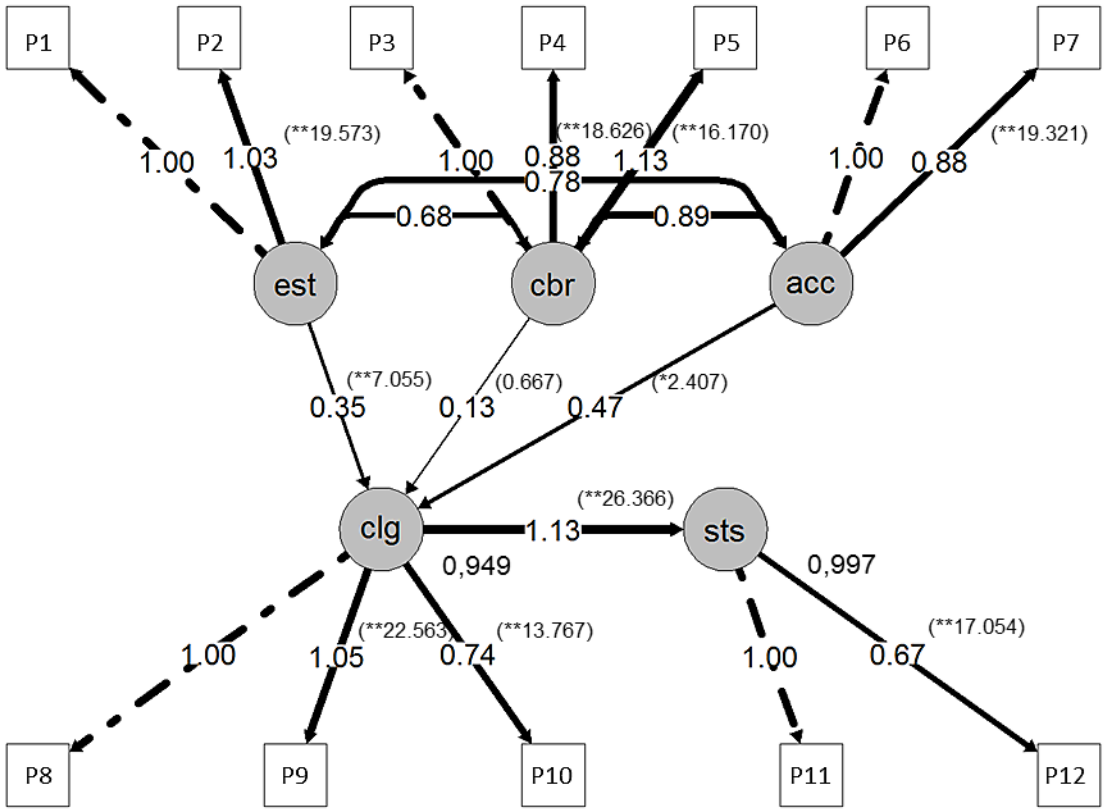
Figure 1. PLS results

4.2. CB-SEM model

SEM fit indexes were calculated using Lavaan package in R: X^2= 68.76, df= 47, $\frac{X^2}{df}$= 1.46, $RMSEA$= 0.028, CFI= 0.997, TLI= 0.996, $WRMR$= 0.939. The results suggest a good fit of the theory model (Tabachnick & Fidell, 2007; Nevitt *et al.*, 2012; Vergara-Schmalbach & Quesada, 2013).

4.2.1. Structural Model and Path Coefficients

The structural model results show that infrastructure, coverage and access variables explain 94.9% of the variability in service quality construct. Otherwise, satisfaction variability is explained by service quality in 99.7%. The path diagram in *Figure 2* includes the coefficient for each relation, which corresponds to the value of the covariance between the latent variables (value located on the arrows), t statistics in parentheses and R^2 for endogenous variables.



est=infrastructure, cbr=coverage, acc=access, clg= service quality, sts=satisfaction
t statistics in parentheses (* significant at 5%, ** significant at 1%)
Figure 2. CB-SEM results

The findings revealed that infrastructure and access have a significant effect on service quality levels (Covariance 0.35 and 0.47, respectively) and this variable has a strong effect on satisfaction (Covariance 1.13). The results indicate that coverage does not present a significant effect on service quality (t= 0.667, for a P-value < 0.05). In this case, the hypothesis related to the positive association between coverage and overall quality services was rejected (*Table 8*).

Table 8. Alternative hypotheses tested

Hypothesis	Result
H_{1a}: There is a positive association between perceived infrastructure and overall service quality.	Accepted
H_{1b}: There is a positive association between coverage and overall quality services.	Rejected
H_{1c}: There is a positive association between access and overall quality services.	Accepted
H_{1d}: There is a positive association between overall service quality and user satisfaction.	Accepted

Table 9 shows the t-value for each estimated coefficient in PLS-SEM and CB-SEM results.

Table 9. CB-SEM and PLS-SEM summary

	CB-SEM			PLS-SEM		
Variable	Estimate	Std. Error	t-value	Estimate	St. Error	t-value
infrastructure -> service quality	0.35	0.049	7.055**	0.37	0.0347	7.069**
access -> service quality	0.13	0.194	2.407*	0.30	0.0428	7.763**
coverage -> service quality	0.47	0.201	0.667	0.31	0.0409	10.592**
service quality -> satisfaction	1.13	0.043	26.366**	0.84	0.0162	51.702**

t-statistics (* significant at 5%, ** significant at 1%).

Conclusion

This study offers an empirical illustration of the application CB-SEM and PLS-SEM for assessment of the healthcare service quality. Having these results at hand, we managed to find answers to three specific questions:

Could CB-SEM and PLS-SEM techniques be applied to assessment healthcare services in Cartagena city? Are the selected constructs relevant and appropriate? And which technique is the most recommended one for this particular case?

Concerning the first question, both techniques were validated, thus, we can conclude about their applicability in this context. Using PLS-SEM, all the hypotheses were accepted, however, in the case of CB-SEM positive association between coverage and overall quality services was not confirmed to be significant.

Secondly, 73% of the variance in quality service was explained by the infrastructure, coverage, and access, as per PLS-SEM model. All the coefficients were found to be significant, where the highest value being between infrastructure and quality (0.91). This finding is coinciding with the research results obtained by (Azizan & Mohamed, 2013). The other two variables (coverage and access) have a minor loading (0.31 and 0.30, respectively). In the case of CB-SEM, infrastructure appears with a significant coefficient at 1%, but coverage registers a coefficient being not significant. Both models show an important effect on service quality and satisfaction. With these results in mind, infrastructure and access have a relevant effect on quality perception. However, coverage presents a significant relation only in the context of PLS-SEM model.

Despite these final results, the coefficients path is found to be significantly different between the two models. Previous research had shown similar results between ML estimation method for CB-SEM and PLS-SEM (Barroso *et al.*, 2010; Awang *et al.*, 2015; Amaro *et al.*, 2015). Note that WLS estimation method was used for non-normal data in this research.

Both methods were used to test the structural model so that to answer what is more convenient for this particular context. In this sense, PLS-SEM demonstrated some advantages over CB-SEM, when applied to the social science area, where data usually is not normally distributed – the discrete data measured on the Likert scale are usually interpreted as not normally distributed, the sample size is small, and the sufficient theory of the model relationship does not exist (Hair *et al.*, 2014; Gye-Soo, 2016). If the research is based on a predictive model, PLS-SEM is a more recommendable alternative (Fornell & Bookstein, 1982). For the analyzed case, the model can be useful for the managers of hospitals and the healthcare system control organizations of Cartagena de Indias.

Importantly, the results indicate that government and healthcare organizations must give priority to the infrastructure and guarantee improvement of the service quality levels. The coverage has a significant effect only on the PLS results, and it might be evaluated with additional information provided to justify its inclusion into the model. The relationship between service quality and satisfaction is significant. For instance, increasing the service quality through infrastructure or access, positive affect can be observed in terms of clients' satisfaction.

Finally, the limitations of this research lie in the estimation methods used for CB-SEM (WLS), the restricted variables and the specific context in which they were applied. For this second aspect, important variables were excluded like socio-demographics, future intentions, empathy, reliability, functionality, among others. These new variables might be included in future research.

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