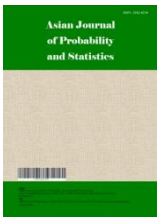

Asian Journal of Probability and Statistics

17(3): 49-60, 2022; Article no.AJPAS.86159
ISSN: 2582-0230

Partial least Square Structural Equation Modeling (PLS-SEM) of Patient Satisfaction on Service Quality in Katsina Public Hospitals

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJPAS/2022/v17i330426

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/86159

Case Study

Received 18 February 2022
Accepted 23 April 2022
Published 09 May 2022

Abstract

This research examines the influence of Hospitals' service quality on Patient satisfaction in Katsina metropolis, Nigeria. It is a survey research where by questionnaires were randomly administered on patients of four hospitals conveniently selected for the study (General Hosptial Katsina, Federal Medical Centre Katsina, Turai Yaradua Maternity and Children's hospital and General Amadi Rimi Orthopedic Hospital Katsina). Structural equation modeling technique was employed in this research. Results show that the hospitals' service quality positively influences patients' satisfaction at hospitals. The study then concludes that hospitals' service quality determines patient satisfaction. Patients' level of satisfaction is increased by improving tangibility reliability, responsiveness, assurance and empathy dimensions of hospitals service quality.

Keywords: Service quality; patient satisfaction; structural equation modeling; convergent validity; discriminant validity.

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1 Introduction

Structural Equation Modeling (SEM) is a multivariate data analysis that is widely employed in the behavioral sciences. SEM combines both factor analysis and regression or path analysis and it allows scholars to examine a set of regression equations simultaneously. SEM is often built on theoretical constructs, which are expressed by the latent factors. The relationships among the theoretical constructs are usually shown by path coefficients concerning the factors. SEM model describes a covariances structure for the observed variables, otherwise known as covariance structure modeling. Though, the extension of the model can include means of observed variables or factors in the model, but suggests a less accurate covariance structure modeling. It gives a universal and appropriate basis for statistical analysis that comprises of several traditional multivariate procedures, for example factor analysis, regression analysis, discriminant analysis, and canonical correlation, as special cases [1]. The factor analysis defines the covariance relationship among many variable reduced to a few essential, but unobservable, random variables called factors [2].

Patient satisfaction is a vital and ordinarily used indicator for determining the quality in health care. It determines medical outcomes, patient retention, and medical malpractice claims [3]. A Patient satisfaction is not a clear but rather an abstract concept. Real index of the state of satisfaction varies from individual to individual, goods to product and service to service [4,5]. It is also determined by the number of psychological, economic and physical factors [6].

In Nigerian healthcare system, patients usually experience many sort of delays ranging from having to wait for hours or days before seeing a doctor to patients waiting for bed in hallways [7]. A patient paying a visit to any health facility wish to be served without unnecessary delays and competently [8]. Regrettably, patients experienced dissimilar situations in our hospitals. Non adherence to hospitals working ethics, ill- managed queue management practices and attitude of working staffs are reasons for the delays of services in our hospitals. Queue develops as a results of competition for limited resource [2,9,10].

2 Methodology

2.1 Data for the Research

Descriptive research design was adopted in this study. It has to do with characteristics of an individual, or of a group, event or situation [11]. Structured questionnaires involving 5 likert scale questions (see appendix) were used to collect data for this research. Public hospitals conveniently selected in Katsina Metropolis are General Hosptial Katsina, Federal Medical Centre Katsina, Turai Yaradua Maternity and Children's hospital and General Amadi Rimi Orthopedic Hospital Katsina. The reasons for selecting these hospitals is because of their larger registered patients. Patients who attend these public hospitals in Katsina Metropolis were randomly selected and administered with the questionnaires. Structural equation modelling was employed to test the hypotheses of the effect of service quality dimensions on patient's satisfaction. The population of patients who patronize hospitals' service in Katsina metropolis could not be ascertained due to lack of proper records and is relatively large). According to Kriejcie and Morgan (1970) table, for a relatively large population the minimum sample size should be at least 384. A relatively large random sample of 1080 patients was considered in this study.

2.2 Research Model and Hypotheses

Based on the direction of most of the studies e.g [12-14], the research model of this study is depicted Fig. 1. Some research hypotheses were also derived from Fig. 1 as follows:

Hypothesis 1: there is no significant effect of tangibility of hospital services on patients' satisfaction

Hypothesis 2: there is no significant effect of reliability of hospital services on patients' satisfaction

Hypothesis 3: there is no significant effect of responsiveness of hospital services on patients' satisfaction

Hypothesis 4: there is no significant effect of assurance of hospital services on patients' satisfaction

Hypothesis 5: there is no significant effect of empathy of hospital services on patients' satisfaction

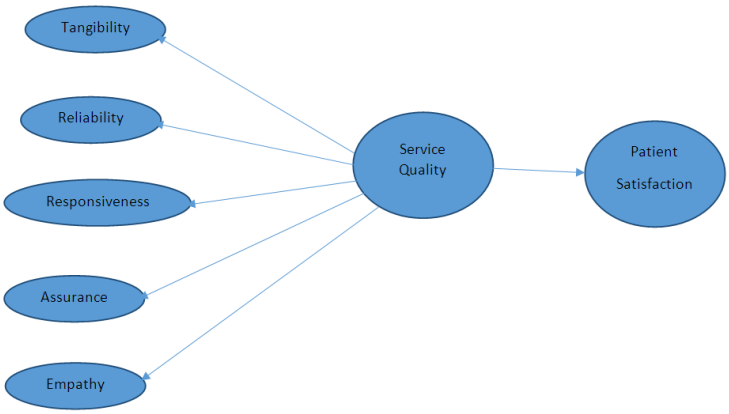

Fig. 1. Proposed research model

2.3 Structural Equation Models

SEM uses Partial Least Square (PLS) and comprises of: (1) the structural model connecting latent variables to one another through a use of simultaneous equations, and (2) the measurement model connecting latent variables to observable ones through a confirmatory factor model. The structural model is presented as

$$\eta = C\eta + K\gamma + \varepsilon \tag{1}$$

Here η represents endogenous latent variables, γ represents exogenous latent variables vector, ε represents error vector, and the regression coefficients of endogenous and exogenous variables are represented by C and K.
The measurement model is given as:

$$y = \Lambda_y + \delta \tag{2}$$

And

$$X = \Lambda_X + \tau \tag{3}$$

Where Λ_y and Λ_X represent observable variables regression coefficients, and δ and τ represent their respective errors.

The observable variables are the proxies of the latent unobserved SERVIQUAL measured in five-point -likert scales as: strongly disagree (1) , disagree (2), undecided (3) agree (4), and strongly agree (5) and customer satisfaction measured in five point –likert scale as very unsatisfied (1), Unsatisfied (2), Neural (3), Satisfied (4) and very satisfied (5) (see appendix 1 and 2)

2.4 PLS Modelling Selection Criteria

2.4.1 Multicollinearity

Multicollinearity exists when there is high correlation among two or more independent variables. Exogenous latent constructs in partial least estimation procedures are not supposed highly correlated [15]. Given that paired data $\{(x_1y_1), \ldots\ldots\ldots, (x_ny_n)\}$ consisting of n pairs, a Pearson's correlation coefficient which is commonly represented by r_{xy} is defined as

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2}\sum_{i=1}^{n}(y_i-\bar{y})^2} \quad (4)$$

2.4.2 Reliability and validity

This research used composite reliability and average variance extracted (AVE) to measure internal consistency reliability of constructs' scales. A construct reliability measures internal consistency of items expressed in scales, similar to Cronbach's alpha [16]. It represents the total amount of true score variance proportionate to the total scale score variance [17]. On the other hand, it's an "indicator of the shared variance among the observed variables used as an indicator of a latent construct" [18]. Hair et al. [19] recommended a composite reliability of 0.7 and above being acceptable value.

The formula for calculating a composite reliability is given as

$$\text{CR}=\frac{\left(\sum_{i=1}^{p}\lambda_i\right)^2}{\left(\sum_{i=1}^{p}\lambda_i\right)^2+\sum_{i}^{p}V(\delta_i)} \quad (5)$$

$\lambda_i = completely\ stadardied\ laoding\ for\ the\ ith\ indicator,$
$V(\delta_i) = vriance\ of\ the\ error\ term\ for\ the\ ith\ indicator,$
$p = number\ of\ indicators\ .$

On the other hand, AVE is the ratio of the variance of the construct to that of the measurement error. The AVE first appeared in the work of Fornell & Larcker [18] and they recommended a minimum value of 0.5 as acceptable. The formula for calculating AVE is given as follows:

$$AVE==\frac{\sum_{i=1}^{k}\lambda_i^2}{\sum_{i=1}^{k}\lambda_i^2+\sum_{i=1}^{k}Var(e_i)} \quad (6)$$

Where $k\ is\ the\ number\ of\ items$
$\lambda_i\ is\ the\ factor\ laoding\ of\ item\ i$ and $Var(e_i)\ is\ the\ variance\ of\ the\ error\ of\ item\ i.$

Discriminant validity is confirmed by an indication of no high theoretical correlations among the constructs. Basically, it ought to be lesser in amount than convergent validity values [20-23]. In trinitarian approach to validity, they indicate construct validity (Hubley & Zumbo, 1996). The aim of discriminant validity is to separate among measures constructs that are not similar.

2.5 PLS Validation Techniques

2.5.1 Coefficient of determination (R^2)

Coefficient of determination is the variance of endogenous variable that being accounted for by the exogenous variable(s). It can be calculated as follows:

$$R^2 = 1 - \frac{RSS}{TSS} \quad (6)$$

$$RSS = \sum(y - \hat{y})^2 \quad (7)$$

$$TSS = \sum(y - \bar{y})^2 \quad (8)$$

Where $RSS = residual\ of\ sqaures\ (RSS)$
Chin [24] states the cutoffs of 0.19, 0.33 and 0.67 as being "weak", "moderate" and "substantial" correspondingly.

$TSS = total\ sum\ of\ sqaures\ (TSS)$

2.5.2 The effect size (f^2)

F-Square measures change in coefficient of determination in the event of removing an exogenous variable from the model. F-square value of greater than or equal 0.02, 0.15 and 0.035 are regarded as small, medium and large respectively [25].

The formula for calculating f^2 is given as below by Cohen [25]:

$$f^2 = \frac{R^2\ included - R^2 excluded}{1 - R^2\ included} \tag{9}$$

2.5.3 Assess the predictive relevance (Q^2)

Q-square establishes if the model has predictive relevance or not. It states that the model has good predictive relevance for the endogenous constructs when its values are greater than. It can be calculated as follows:

$$Q^2 = 1 - \frac{PRESS}{TSS} \tag{10}$$

$$PRESS = \sum (y - \hat{y})^2 \tag{11}$$

$where\ PRESS = Predictive\ residual\ Error\ sum\ of\ sqaures$
$TSS = total\ sum\ of\ sqaures$

3 Results and Discussion

Table 1 depicts the socio-demographic features of 1,080 patients interviewed. It shows that 515(47.7%) and 565(52.3%) of the interviewees are of male and female gender respectively. It also shows that 79(7.3%), 514(47.6%), 352(32.6%) and 135(12.5%) of the respondents have ages ≤20 years, between 21 and 40 years, between 41 and 60 years and ≥ 60 years correspondingly. Educational status of patients shows that 132(12.2%), 234(21.7%), 408(37.8%) and 306(28.3%) have Quranic/Islamiyya, Primary school certificate, Secondary School certificate and tertiary certificate correspondingly. The table also reveals that 145 (13.4%), 96(8.9%), 361(33.4%), 138(12.8%) and 340(31.5%) of the patients interviewed are civil servants, retired workers, self-employed, students and others correspondingly. Lastly the table shows that 305(28.2%), 446(41.3%), 181(16.8%), 125(11.6%) and 23(2.1%) of the patients interviewed are single, married, divorced, widowed and separated correspondingly.

Multi collinearity is a situation when exogenous latent constructs are highly interrelated. Hair et al. [15] opined that the variables with correlation of 0.9 and above are termed as highly correlated. Table 2 indicates that there is no high correlation among the latent constructs. Hence, there is no multicollinearity problem among latent variables.

The measurement model which is otherwise known as outer model shows the relationships among the constructs and the indicator variables. This study measured six models namely tangibility, reliability, responsiveness, assurance, empathy and patient satisfaction. Each of these constructs was measured by three indicators except responsiveness which was measured by two indicator variables (see Fig. 1). Individual item reliability, internal consistency, content and convergent validity, and discriminant validity are confirmed using measurement model [26].

Reliability and validity remain two major methods for assessing the quality of the measurement model [27]. Table 2 contains reliability and convergent validity of the indicator variables. The latter, which define to what degree multiple items measuring the same concept are in harmony [28]. Factor loadings, composite reliability and the average variance extracted are usually employed to access convergent validity [19]. Table 2 indicated that the all the items' factor loadings have reached the threshold value of 0.5 [19]. Table 3 showed that all the items have their composite reliability (CR) values between 0.782 and 0.891 there by reaching a threshold value of 0.7 [18]. Similarly, table 3 showed that (AVE) for all the items exceeded a threshold value of 0.50 [18, 29].

Table 1. Socio-demographic features of respondents

Gender	**Count**	**(%)**
Male	515	47.7
Female	565	52.3
Total	1,080	100.0
Age	**Count**	**(%)**
≤ 20	79	7.3
21-40	514	47.6
41-60	352	32.6
Above 60	135	12.5
Total	1,080	100.0
Highest educational qualification	**Count**	**(%)**
Quranic/Islamiyya School	132	12.2
Primary School	234	21.7
Secondary school	408	37.8
Tertiary school	306	28.3
Total	1,080	100.0
Employment status	**Count**	**(%)**
Civil servant	145	13.4
Retired	96	8.9
Self employed	361	33.4
Student	138	12.8
Other specify	340	31.5
Total	1,080	100.0
Marital Status	**Count**	**(%)**
Single	305	28.2
Married	446	41.3
Divorced	181	16.8
Widowed	125	11.6
Separated	23	2.1
Total	1,080	100.0

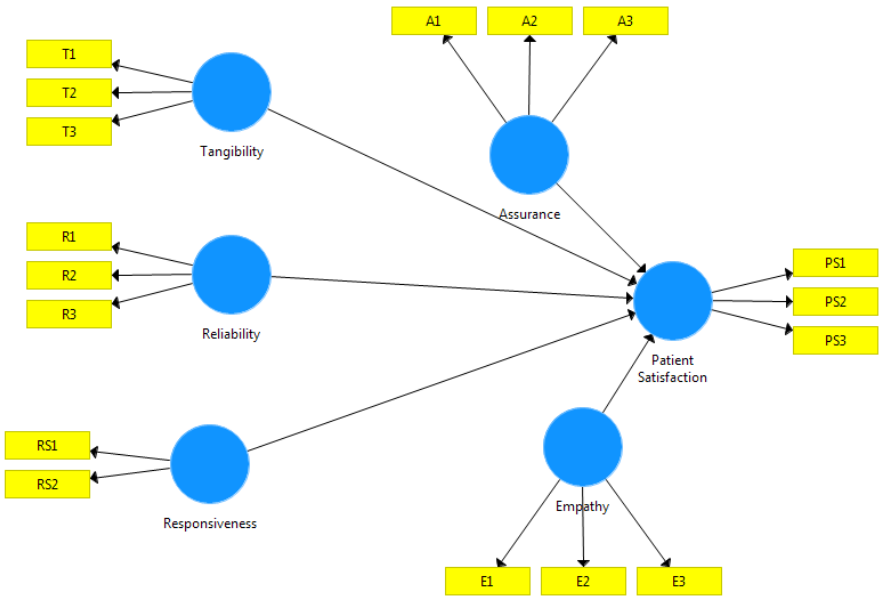

Fig. 2. PLS-algorithm diagram

Table 2. Correlation matrix of the construct variables

Construct variables	1	2	3	4	5	6
Assurance	1					
Empathy	0.101	1				
Patient Satisfaction	0.614	0.667	1			
Reliability	0.394	0.103	0.622	1		
Responsiveness	0.246	0.304	0.346	0.236	1	
Tangibility	0.106	0.489	0.674	0.107	0.310	1

Table 4 presents discriminant validity measures the degree to which a latent variable varies from other latent variables in the same model [28]. In a PLS, the main criteria for assessing discriminant validity is to ensure that a latent variable has larger variance with itself than with other latent variables in a given model [30]. Since correlations in Table 4 show that each latent variable has more variance values with itself than other latent variables, then discriminant validity is established in this study.

Table 3. Reliability and validity of the constructs

Constructs	Variables	Factor loadings	Composite reliability	AVE
	T1	0.737		
Tangibility	T2	0.907	0.817	0.602
	T3	0.662		
	R1	0.749		
Reliability	R2	0.852	0.823	0.609
	R3	0.735		
Responsiveness	RS1	0.918		
	RS2	0.875	0.891	0.804
	A1	0.767		
Assurance	A2	0.838	0.822	0.606
	A3	0.728		
	E1	0.748		
Empathy	E2	0.905	0.834	0.629
	E3	0.713		
	PS1	0.787		
Patient satisfaction	PS2	0.763	0.782	0.546
	PS3	0.662		

Table 4. Discriminant validity

Latent Variable	1	2	3	4	5	6
Assurance	0.779					
Empathy	0.101	0.793				
Patient Satisfaction	0.614	0.667	0.739			
Reliability	0.394	0.103	0.622	0.780		
Responsiveness	0.246	0.304	0.346	0.236	0.897	
Tangibility	0.106	0.489	0.674	0.107	0.310	0.776

The structural model displays the relationship among the latent variables on the proposed model. Having established reliability and validity of the variables on the outer model, then the next stage is to assess structural model (inner model). Five stages were proposed by Hair et al. [31] as the criteria for assessing structural model assessment procedure 1) check whether structural model has collinearity issue or not 2) check the significance of the path coefficient 3) Evaluate the coefficient of determination (R^2) 4) Evaluate the effect size (f^2) 5) Evaluate the predictive relevance (Q^2).

It is already established that there is no problem of multicollinearity in this study (see table 2). In PLS analysis the bootstrapping technique is used for examining the significance of all the path coefficients. It remains the

only tool for investigating the significance of path coefficients [32]. It tries to estimate the sampling distribution of a statistic by re-sampling with replacement from the original sample (Good, 2000). Table 5 showed that the hypothesis one which stated that the tangibility of hospital services has no effect on patients' satisfaction is rejected since significant value < alpha level and concluded that tangibility had a positive effect on patient satisfaction. It also showed that the hypothesis two which stated that reliability of hospital services has no effect on patients' satisfaction is rejected since significant value of 0.000 < 5% alpha level and concluded that the reliability has a positive significant relationship with patient satisfaction. Hypothesis three which stated that the responsiveness of hospital services has no effect on patients' satisfaction is rejected since significant-value of 0.015 <5% alpha level and concluded that responsiveness has a positive significant relationship with patient satisfaction. Hypothesis four which stated that the assurance of hospital services has no effect on patients' satisfaction is rejected since significant-value of 0.048 < 5% alpha level and concluded that assurance is positively and significant related with patient satisfaction and finally hypothesis five stating that the empathy of hospital services is of no statistical effect on patients' satisfaction is rejected since significant -value of 0.018 is < 5% alpha level and concluded that empathy is positively and significantly related with patient satisfaction, hence it is suggested that the service quality dimensions influence patient satisfaction.

Table 5. Path coefficients

Path	Coefficients	T-statistics	P-values
Assurance through Patient Satisfaction	0.159	1.984	0.048
Empathy through Patient Satisfaction	0.312	2.390	0.018
Reliability through Patient Satisfaction	0.625	8.322	0.000
Responsiveness through Patient Satisfaction	0.162	2.449	0.015
Tangibility through Patient Satisfaction	0.568	10.12	0.000

The R^2 shows the extent of variability accounted for by the exogenous variable in its endogenous counterpart [24]. It is an indication that the model variables are good [15] recommended 0.10 as tolerable R^2 coefficients. Also, Chin [24] considered the coefficient values of 0.67, 0.33, and 0.19 in PLS-SEM as significant, moderate and weak correspondingly. Similarly,R^2 coefficients of 0.02 to 0.12, 0.13 to 0.25 are considered as small and moderate while values above 0.26 are regarded as significant [25]. In this study, the R^2 value is obtained as 0.768 and according to Chin [24] recommendation, the model can be considered as significant since its R^2 exceeded 0.67. It therefore mean that about 77% of the variability in patient satisfaction has been accounted for by service quality dimensions.

Table 6. Coefficient of determination (R^2)

Latent construct	R-Square	R-Square adjusted
Enterprise Growth	0.768	0.758

Table 7. F_ Square

Latent Construct	f-square	Effect size
Assurance	0.04	Small
Empathy	0.027	Small
Reliability	0.033	Small
Responsiveness	0.16	Medium
Tangibility	0.36	Large

In determining the effect size, Cohen f^2 Cohen [25] formula given below was used as below:

$$f^2 = \frac{R^2\ included - R^2 excluded}{1 - R^2\ included}$$

Table 7 clearly indicated that the effect sizes were small for assurance, empathy and reliability and only large for tangibility and medium for responsiveness as suggested by Cohen, [25]. Table 8 suggested that the model in this study has a good predictive relevance since Q^2 is 0.365 since it is greater than zero (0) but as suggested by Yahaya et al. [33] predictive relevance of 0.365 in this study can be regarded as medium.

Table 8. Q Square

Latent Variable	SSO	SSE	$Q^2 = 1 - SSE/SSO$
Assurance	366.000	366.000	
Empathy	366.000	366.000	
Patient Satisfaction	366.000	232.582	**0.365**
Reliability	366.000	366.000	
Responsiveness	244.000	244.000	
Tangibility	366.000	366.000	

4 Conclusion

This study investigated the effect of Hospital Service quality on patient satisfaction in Katsina metropolis, Nigeria. The measurement model indicated all the items under each service quality dimension were retained and it therefore validated the constructs of service qualities dimensions. Hypotheses testing results indicated all the five null hypotheses that stated that service qualities do not have significant effect on patient satisfaction were rejected in favor of their alternative hypotheses as all p-values are less than 5% level of significance. The study therefore concludes that there is significant positive relationship between tangibility, reliability, responsiveness, assurance and empathy of hospitals' services and patient satisfaction in Katsina Metropolis. It therefore indicated that the higher the tangibility, reliability, responsiveness, assurance and empathy of hospitals' services the higher satisfaction patients will have from hospitals' services.

Ethical Approval

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

Consent

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

Competing Interests

Authors have declared that no competing interests exist.

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Appendix 1. Service Quality; SA=strongly agree, AG=agree, UD=undecided, DA=disagree, SD=strongly disagree

Dimension	Statement	SA	AG	UD	DA	SD
Tangible	T1=Hospital waiting environment has good space with fine equipments and materials					
	T2= Working staff have attractive appearance					
	T3=Hospital gives access to information about its services					
Reliability	R1=Hospital services are promptly delivered					
	R2=Hospital accomplishes its promises to patients					
	R3=Hospital is reliable and steady in Attending to patients problems					
Responsiveness	RS1=Hospital staffs inform patients when they will get serviced					
	RS2=Hospital staffs willingly attend to patients questions and problems					
Assurance	A1=The behaviour of hospital staffs encourage patients					
	A2=Hospital staffs are capable of resolving patients Problems					
	A3=Hospital services are of good standard.					
Empathy	E1=Hospital staffs are friendly and easy to communicate					
	E2=Hospital has good working hours					
	E3=The approach of the nursing workers is moral					

Appendix 2. Patient Satisfaction; VS=very satisfied, SA=satisfied, NT=Neutral, US=unsatisfied, VU=very unsatisfied

Statement	VS	SA	NT	US	VU
PS1=Please rank your your experience with hospital staffs					
PS2=Please state your overall satisfaction with the hospital service					
PS3=Please rank your satisfaction with the waiting room environment					

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