International Journal on Engineering Technology (InJET)

www.kec.edu.np/kec-journal/
Volume 2, issue no. 1, Dec 2024, Page 218-226
Received Date: Aug 25, 2024
Accepted Date: Oct 23, 2024
ISSN: 3021-940X (Print)
DOI: https://doi.org/10.3126/injet.v2i1.72578

Assessing User Contentment in Long-Distance Public Transport: An Analytical Approach Utilizing Principal Component and Regression Analysis

Niroj Gautam [1], Thusitha Chandani Shahi [2, *], Sudip Pokhrel [3]

[1]*Nepal Engineering College, Pokhara University, Duwakot, Bhaktapur, Nepal, nirojgautam2006uet@gmail.com*
[2]*Nepal Engineering College, Pokhara University, Duwakot, Bhaktapur, Nepal, thusithacs@nec.edu.np*
[3]*Nepal Engineering College, Pokhara University, Duwakott, Bhaktapur, Nepal, sudipp@nec.edu.np*

Abstract

This study assesses the performance of long-route public transport services, considering passenger contentment as a key metric through the application of a passenger satisfaction approach. A self-rating questionnaire with a 5-point Likert scale was used to rate 16 different variables. The variables were selected after a literature review and consulting with relevant stakeholders. Data collected from com passengers were analyzed to determine the passengers' comfort and satisfaction using Principal Components Analysis (PCA) and Regression Analysis. Variables with higher-than-average scores indicate that passengers are satisfied with that variable.16 variables with strong correlation among each other were collapsed into different component using PCA. Furthermore, the components extracted from PCA along with two extra variables that are age and sex were regressed to find the mean passenger satisfaction score. This research fills the gap by specifically targeting long-distance public transport in Nepal, an area that has not been extensively studied. It explores the perceptions of passengers regarding the facilities provided by long-route public transport services and identifies the major factors contributing to passenger satisfaction. Previous studies have often emphasized factors such as service quality, comfort, and safety in urban bus services, but there is a notable lack of research addressing the unique challenges and passenger experiences associated with long-distance bus travel. This study can offer theoretical assistance in devising relevant strategies to enhance the satisfaction level of public commuters.

Keywords: Passenger Satisfaction, Public Transportation, Principal Component Analysis, Long route, Variable.

1. Introduction

Public transport is a system that operates at regular schedules on fixed routes and is used by the general public. Mobility plays a crucial role in our daily lives and is essential for everyone. It is a well-known fact that it is a fundamental aspect of human existence. In fulfilling the need for mobility, public transport has become one of the most widely used modes of transportation. The services and facilities provided by public transportation are crucial due to their impact on the mindset and behavior of travelers.

It is believed that utilizing public transit can help to ease traffic, lower emissions, and decrease energy use. The daily use of public transportation holds a significant place in the lives of numerous people. Research study in the past indicate that high-quality public transit services can result in heightening the general satisfaction with the travel experience (Kawabata et al.2020). Understanding the essential and adequate external components that contribute to high travel gratification is crucial for ensuring a pleasant journey if using public transportation. People are more likely to use public transportation as their means of mobility when they are satisfied with the quality of those services. To determine how well they are serving their customers' demand; public transportation management organizations and businesses must gauge how satisfied passengers are with the goods and services provided by the sector (Zhang et al. 2019).

**Corresponding Author*

Throughout the world, public transit is widely used to provide movement. However, due to the lack of adequate public transportation systems, extensive population growth, and spikes in motorization, there is a growing trend of using personal vehicles for commuting in many cities. These are causing difficulties such as traffic congestion, a flawed public transportation, pedestrian discomfort, automobile conflict, and toxic air quality. In the context of Nepal, the amenities and services provided by various bus companies are poor and not very different from one another. Due to financial circumstances, most of people cannot afford private vehicles and are forced to take public transportation. The current public transportation system lacks dependability and reliability in a wide range of areas, which include vehicle availability, frequency of service, and availability during off-peak hours. Operators of public transportation are more focused on accommodating the maximum number of passengers than on adhering to a schedule to generate more profit. Transport operators' timetables appear to be ineffective, which causes unnatural traffic congestion. Again, for long route transportation, facilities for people disabilities are adequate than for people in general.

We don't have a clear picture of the satisfaction levels of long-route public commuters in Nepal. To the best of the author's knowledge, long-distance public transportation has never been a particularly popular topic for study in Nepal and in other developing countries. Researchers are unwilling to continue their work in this field because it is difficult to collect primary data via questionnaires. Passengers from whom the researcher wants to collect information are less willing to interact with researchers as passengers are tired from long-distance travel and in a hurry to reach their destination, they are often unwilling to speak with researchers. The only option to collect data is to travel with the passengers, distribute the questionnaire on the bus, and gather information directly. It is very time consuming and hectic task.

The main goal of this research was to analyze passengers' perceptions of the facilities provided by long-route public transport services and to identify the significant factors contributing to passenger satisfaction in the context of Nepal. The study's findings not only highlight the situation in Nepal but also serve as a valuable benchmark for other developing countries with comparable public transportation infrastructures. This study was limited to long-route public buses and did not include microbuses, minibuses, or short-route buses.

2. Literature Review

The discussion surrounding the selection between personal and public transportation is becoming more focused on the non-quantitative characteristics of transportation. Studies in the field of transportation have shown that the intangible qualities of public transportation can have an impact on a person's well-being and the mode of transportation they choose (Litman ,2008).

According to Noor et al. (2014), In Kota Kinabalu City, Malaysia, the factors that contribute to satisfaction with public bus services were found to be comfort, accessibility, and safety. The study discovered a slight variation in satisfaction between those who used minibuses and those who used buses. Bus users expressed that the most important elements affecting their level of satisfaction were overcrowding and safety concerns during nighttime. Service comfort encompasses the provision of attractive service features, such as the availability of seating and personal space referred to as passenger density), uninterrupted travel experiences, air conditioning, and the state of waiting areas (Litman,2008).

According to public transportation researchers, service comfort is one of the most crucial elements when deciding on a mode of transportation. Further studies on customer satisfaction in public transportation revealed that service comfort was among the top four contributing factors that had a strong positive correlation with overall satisfaction (Budiono,2009).

Consumers must take quality into account when determining how satisfied they are with a good or service. It speaks to all of the elements and aspects that make up a good or service and determines how well they can satisfy both explicit and subliminal demands. In the near term, a product's or service's characteristics establish its quality, which in turn meets the needs of the consumer. (Budiono,2009). Five essential factors, including the visible ones such the setting, tools, and staff members' appearance, can be used to assess a

service's quality. Reliability, or the capacity to provide promised services with accuracy and regularity, is still another crucial element. Respondency, or the readiness to help clients and offer timely service, is also essential. The term "assurance" relates to an employee's knowledge, demeanor, and capacity to inspire confidence and trust. Using quality assessment factors, Nwachukwu (2014) conducted a study to ascertain the degree of customer satisfaction with the intra-city public transportation service in Abuja, Nigeria. The main goal of this study was to determine the variables that affect the city's public transportation system's quality and to weigh each one's relative importance. Several statistical methods, including descriptive statistics, correlation analysis, principal component analysis, and regression analysis, were used in the data analysis.

The satisfaction of customers with public transportation services in eight European cities (Stockholm, Barcelona, Copenhagen, Geneva, Helsinki, Vienna, Berlin, Manchester, and Oslo) was compared by Fellesson and Friman (2012) in a transnational study using principal component analysis. According to the study's findings, there are four general factors that affect customer satisfaction: the quality of the transportation system, which includes elements like traffic supply, reliability, and information; the design of the buses and bus stops, which should be pleasant for passengers; the staff's skills, knowledge, attitudes; and safety worries, including both the risk of accidents and the physical safety of the buses and bus stops.

According to the findings of a research project at Cosenza, Italy public's transportation system, it was concluded that variable of service planning has a significant impact on total customer satisfaction. Planning for services considers factors including dependability, regularity, information delivery, promotion, hiring, and complaint handling. It is anticipated that by improving these aspects of the service, customer satisfaction will rise, and more people will choose to use public transportation, thereby reducing traffic, air and noise pollution, and energy consumption. The study emphasizes how crucial it is to consider service quality factors throughout the planning and management of public transportation networks (Eboli and Mazzulla 2007).

Bist (2018) used Principal Component Analysis and Regression Analysis to compare customers' satisfaction with public transport across four different transportation modes: large buses, small buses, microbuses, and tempos. Bist (2018) concluded that the contributions of comfort and affordability have more significant impact on satisfaction with the services provided by transportation companies. These factors need to be improved to get higher overall satisfaction with the corresponding mode of transport. Along with other enhancements, improving the quality variables of public transportation is essential for delivering a higher level of passenger satisfaction.

3. Methodology

This study was completed in four phases. The identification of problems, setting of objectives, and literature review were completed in the first phase. In the second phase, the study area was selected, and questionnaires were developed. After that, data collection and analysis were conducted, and the results of the analysis were compiled in the final phase.

3.1. Study Area

Kathmandu-Surkhet, 536 km and Kathmandu-Dhangadi,594 km. Surkhet and Dhangadi are two major cities in Western Nepal. Surkhet is the capital of Karnali Province, while Dhangadi is a significant hub city in Sudurpaschim Province. Eleven bus companies are operating bus services in these two routes. Moreover, most rural and urban areas are linked to these cities; therefore, a diverse set of people can be approached to gain a representative sample in these routes. Data collection was conducted on both day and night buses, encompassing travel during weekdays as well as weekends.

3.2. Sample Size for Respondent

The study population for this study was the total number of people traveling from Kathmandu to Surkhet and Kathmandu to Dhangadhi per day. Questionnaire was distributed among passengers travelling on these

two long-distance routes. It was exceedingly challenging to determine the precise number of persons that use public transportation each day. As a result, sample size was calculated using an infinite population as sample population. One who uses bus service is the sampling unit. To determine the necessary sample size for an infinite population, the following formula was used.

$$SS = P(1-P)\left(\frac{Z}{E}\right)^2 = 0.5\,(1-0.5)(1.96/0.075)^2 \quad \text{(Equation 1)}$$

where,

SS = Sample Size,

P= percentage of passengers using public transportation. To assess the degree of accuracy for a sample, it is assumed that the worst-case situation is 50%.

Z = Z-value (e.g. 1.96 at the 95 percent confidence level),

E = Margin of Error, or a measure of the variation within the data that is 7.5 percent.

We got 171 nos as sample size. A convenience sampling technique was adopted for sample collection. Those people who were comfortable with a questionnaire and who clearly understood the purpose of the research were only included in the study.

3.3. Questionnaire Survey

Questionnaire survey was designed for public bus users to determine the current satisfaction level. A total of 181 participants were asked to rate their satisfaction with 16 service aspects related to public transportation using a five-level Likert scale, with 1 being "Poor" and 5 being "Excellent". Survey comprised of 117 males and 67 females. During the data collection process, respondents were asked for their opinions on 16 factors related to the effectiveness of their experience with public transportation. Questionnaire was formulated in such a way that passengers could easily comprehend and rate them. 16 variables with variable code included in questionnaire survey is mentioned in Table 1. All variables were normalized to ensure comparability and to mitigate the effects of differing scales. We employed Z-score normalization, transforming each variable to have mean of 0 and standard deviation of 1. This preprocessing step was crucial for the subsequent Principal Component Analysis (PCA), allowing for a more accurate representation of the underlying factors influencing passenger satisfaction. By normalizing the data, we enhanced the reliability of our findings and interpretations.

Table 1. Variable and variable code for questionnaire survey

Variable Code	Variable Description
X1	Opening of Window
X2	Height of back rest
X3	Width of armrest
X4	Height of service door
X5	Width of service door
X6	Passenger seats width
X7	Window lock system
X8	Height of Seat base from floor
X9	Enough no of Emergency Door X10
X10	Bus is well maintained Cleanness of Bus
X11	Targeted group are seating in Ladies Elder and Disable persons seat
X12	Frequency of bus service
X13	Gangway Width
X14	Spacing between two seats X15

X15	Inner height of bus
X16	Facilities inside bus are in good condition like TV Sound

4. Result

An average value of 3 indicates that the participants are neither satisfied nor unsatisfied (neutral). In comparison to mean values above 3 which indicate respondent's satisfaction and below 3 which show respondent's dissatisfaction. Age of respondent ranged from 17 to 65 years with average age of 32 years. Most respondent answered bus body parameters to be either fair or unsatisfactory. Few percentages only found it to be satisfied or very satisfied.

Three variables did not meet the desire for customer satisfaction with public bus service. The variable, width of armrest (X3) having mean value of 2.87 (mean <3.0), standard deviation 1.25 and variance 0.44, 16.02 percent extremely unsatisfied, 23.20 percent unsatisfied, 33.15 percent neither satisfied nor dissatisfied, 13.26 percent satisfied and 14.36 percent extremely satisfied. Another variable, Height of Seat base from floor (X8) mean 2.97 (mean <3.0), standard deviation 1.31 and a variance 0.44, yielded 14.36 percent extremely unsatisfied, 27.26 percent unsatisfied, 20.99 percent neither satisfied nor dissatisfied, 20.44 percent satisfied and 16.57 percent extremely satisfied. The third variable, Facilities inside bus like TV, Sound system, (x16) are in good condition having mean of 2.57 (mean <3.0), standard deviation 1.052 and a variance 0.41, 17.68 percent extremely unsatisfied, 28.18 percent unsatisfied,38.67 percent neither satisfied nor dissatisfied, 10.50 percent satisfied and 4.97 percent extremely satisfied.

Table 2. Frequency Distribution Table Representing Public SatisfactionCod

Variable S5		**S4**	**S3**	**S2**	**S1**	**Mean**	**SD**
X1	19	71	31	43	17	3.18	1.181
X2	49	39	33	42	18	3.33	1.35
X3	26	24	60	42	29	2.87	1.25
X4	35	38	43	42	23	3.11	1.308
X5	55	37	34	25	30	3.34	1.45
X6	30	48	40	34	29	3.09	1.323
X7	28	46	44	42	21	3.1	1.249
X8	30	37	38	50	26	2.97	1.311
X9	33	38	47	38	25	3.09	1.301
X10	42	40	44	36	19	3.28	1.301
X11	39	43	52	38	9	3.36	1.174
X12	32	56	31	33	29	3.16	1.347
X13	34	39	64	29	15	3.27	1.178
X14	31	56	31	43	20	3.19	1.279
X15	34	44	42	34	27	3.13	1.327
X16	9	19	70	51	32	2.57	1.052

4.1. Principal Component Analysis

To determine the degree of their correlations, the 16 variables were transformed into an inter-correlation matrix. Strong inter-correlations between the variables were evident from the correlation matrix's observations, which explained why some variables had a lot of redundancy. The 16 variables of public bus transportation services were condensed into some orthogonal factors using PCA to exclude the effects of these strong inter-correlations and to include the contributions of the redundant (weakly correlated) variables.

Kaiser Meyer Olkin (KMO) and Bartlett's test were used to determine whether the analysis was appropriate

for collecting variables. KMO quantifies the observed correlation coefficients' value, and it should be more than 0.5. From the Table 2, we can observe that KMO value for the data is 0.78 which is more than 0.5. The significance level was 0.000 which indicate that KMO value is significant at 5 percent level of significance.

Table 3. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.718	
Bartlett's Test of Sphericity and Approximate Chi-Square	409.096	
	df	120
	Sig.	0

In PCA method, given components with eigenvalues greater than 1 and having factor loading more than 0.50 are retained and this is most commonly used method. This is popularly known as eigenvalue-one criterion. In our context, the data set incorporates these 6 components can account for 58.46 percent of the variance. The results of the study are shown in Table 4, which simplified the 16 variables into just 6 components. This was done using a method called varimax rotation.

Table 4. Eigenvalues of ComponentsComponent Initial Eigenvalue

Component	**Initial Eigenvalue**		
	Total	**% of Variance**	**Cumulative %**
1	3.351	20.942	20.942
2	1.403	8.767	29.709
3	1.286	8.038	37.748
4	1.195	7.47	45.218
5	1.082	6.761	51.979
6	1.037	6.481	58.46

Eigenvalue of component 1 is 3.351 which explain 20.942 percent of the total variance. Loading values for component 1 is greater than 0.5 for X1 (Passenger seats width), and X2 (Height of backrest). These variables describe Seating conveniences in buses which is primary factor for passenger satisfaction. Therefore, component 1 is identified as "Seating convenience." Loading values for component 2 are X5 (0.757), X6 (0.624), X7 (0.609), and X8 (0.553) respectively. It explains service quality related with the dimension of door, windows and emergency door. Component 2 is then identified as "Window and door dimensions." Eigenvalue of this component is 1.403 and explain 8.767 percent of the total variance. Loading values for component 3 are X9 (0.752) and X10 (0.645), having eigenvalue of 1.286 which is 8.038 percent of the total variance. It is related with the dimension of gangway and internal height. It is, therefore, identified as an "Internal walking space."

Loading values for component 4 are X11 (0.791) and X12 (0.636), having eigenvalue of 1.195, and is 7.470 percent of the variance. It depicts service quality related with the height of seat and spacing between seats. It is, therefore, identified as a "Seating arrangement." Loading values for component 5 are X13 (0.802) and X14 (0.557), having eigenvalue of 1.082, and is 6.761 percent of the total variance. It expresses service quality-related extra facilities like TV, sound system and cleanness of bus. It is, therefore, identified as "Sanitation and recreation facilities of bus". Loading values for component 6 is X15 (0.788), having eigenvalue of 1.037, and is 6.481 percent of the total variance. It is identified as the "frequency of bus services".

Table 5 shows the correlation between the identified factors which is very low, highest being 0.216 which is correlation between "Seating conveniences" and "Seating arrangement". It means, all six factors which were identified are independent to each other and they are measuring the unrelated scopes. The independence of the six components –suggests that they assess unrelated characteristics. The outcomes offer statistical support for the cited variables that affected user satisfaction long- distance buses.

Table 5. Component Transformation Matrix

Component	1	2	3	4	5	6
1	0.6	0.593	0.31	0.382	0.216	0.027
2	-0.32	-0.31	0.858	0.196	0.153	0.056
3	0.255	-0.221	-0.033	-0.452	0.69	0.453
4	0.617	-0.697	-0.035	0.237	-0.141	-0.238
5	-0.304	-0.101	-0.388	0.637	0.568	-0.135
6	-0.009	-0.092	-0.121	0.386	-0.335	0.846

4.2 Normality Test

Before running the regression statistics, we checked whether dependent variables are auto correlated or normally distributed and free from multi-collinearity or not. For that, Q-Q plot and K-S test was done.

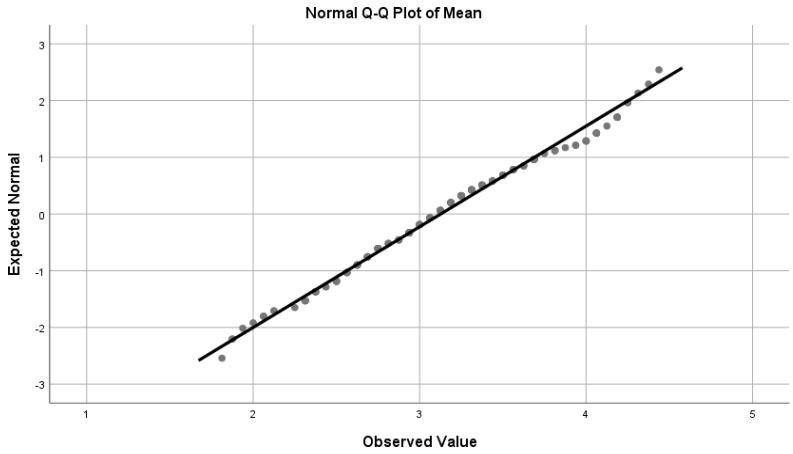

Figure 1. Q-Q Plot of the dependent variable

From Q-Q plot, we can see that the provided data followed the normal distribution and it to assure the normality of the dependent variable, K-S test was run based on statistical inference. Hypothesis was assumed for testing the normality of the data, such that:

H0: Mean Value follows Normal Distribution.
HA: Mean Value do not follow Normal Distribution.

From Table 6, P-value of the K-S test was 0.062, which was greater than 0.05. Thus, it failed to reject the null hypothesis showing that the customer satisfaction was a dependent variable which followed normal distribution and the data set did not significantly deviate and could be fitted in regression analysis.

Table 6. Tests of Normality of the dependent variable

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Mean	0.065	181	0.062	0.987	181	0.102

4.3. Regression Analysis

To find the overall satisfaction level due to above mentioned factors, regression analysis was done. Two additional factors, Age and Gender, were included as independent variables to examine whether they contributed any differences in satisfaction levels. Mean customer satisfaction index here is considered as a dependent variable. The slope of the regression line was significantly greater than zero, indicating that

overall satisfaction tends to increase as these eight factors increase.

Table 7. Model Summary of Regression Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.881[a]	0.776	0.761	0.0714

The R-squared value, which is defined as coefficient of determinations reflects how closely the trend line's estimated values represent the true data. R-square value for this study was 0.776, this signifies that 77.6 percent of the variation of dependent variable (Mean satisfaction score) was explained by the variation of the independent variables. This implied that 77.6 percent of the data fits the regression model.

To figure the effect of the factor's satisfaction of passengers, regression analysis was done with eight factors taken as the independent variable and the mean satisfaction index as a dependent variable. Results showed that age and gender did not show significance role in mean satisfaction score.

Table 8. Regression Analysis for Passenger satisfaction

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	3.137	0.017		185.865	0
Seating convenience	0.338	0.005	0.6	63.406	0
Window and door dimensions	0.286	0.005	0.507	53.408	0
Internal walking space	0.182	0.005	0.323	34.101	0
Seating arrangement	0.239	0.005	0.425	44.628	0
Sanitation and recreation facilities	0.154	0.005	0.274	28.926	0
Frequency of bus services	0.042	0.005	0.074	7.791	0
Age	-0.001	0	-0.011	-1.171	0.243
Gender	0.011	0.011	0.01	0.998	0.319

a. Dependent Variable: Mean Satisfaction Score

Mean Satisfaction Score =3.137+0.338(Seating convenience) +0.286(Window and door dimensions) +0.182(Internal walking space) +.239(Seating arrangement) +0.154(Sanitation and recreation facilities) +0.042 (Frequency of bus services).

According to the aforementioned equation, it can be deduced that overall satisfaction tends to rise as the six underlying factors increase because the slope of the regression line is much greater than zero. The equation also demonstrates that when all 16 service quality indicators are at zero, the overall satisfaction of public bus transportation services will be 3.137 percent. The underlying feature "Seating convenience" has the biggest impact on passengers' overall satisfaction with public bus transportation services with standardized regression coefficient beta (β=0.338). It is followed by "Window and door dimensions" (β=0.286), "Seating arrangement" (β =0.239), "Internal walking space" (β = 0.182), "Sanitation and recreation facilities" (β=0.154), "Frequency of bus services" (β=0.042). Age and Gender do not have significant effect.

The results from the regression equation for the mean satisfaction score in long-distance public transportation are crucial as they provide a quantitative framework for understanding passenger satisfaction, highlighting key factors such as seating convenience and sanitation that significantly impact overall contentment. This aligns with existing literature emphasizing the importance of comfort and cleanliness in enhancing user experiences, thereby validating previous findings while offering a prioritized approach for transport operators to allocate resources effectively. Furthermore, the established mean satisfaction score serves as a benchmark for comparing different public transportation systems, facilitating the identification

of best practices and areas needing improvement. This model not only lays the groundwork for future research by allowing scholars to explore additional variables or different contexts but also encourages longitudinal studies to assess the impact of implemented changes over time, ultimately contributing to the development of more effective and user-centered public transportation services.

5. Conclusion

This study was conducted in the context of Nepal related to the satisfaction issues of public transport services for long route buses. Data collected from 181 respondents were analyzed to determine passenger comfort and satisfaction using Principal Component Analysis (PCA) and Regression Analysis. 13 variables scored above the average value of 3, indicating that respondents were satisfied with these 13 variables and dissatisfied with the remaining 3 variables. 16 variables with strong correlation among each other were collapsed into six different components using PCA. These 6 components explain 58.46 percent of total variance. 6 components along with 2 extra variable that is age and gender were regress to find the mean passenger satisfaction score. Equation for mean passenger satisfaction was derived using Regression Analysis and the analysis concluded that age and gender do not play significant role in mean satisfaction score of long route public transport services.

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