

# Comparison of Travel Time Reliability of Different Bus Service Providers: A Case Study of Airport to Narayan Gopal Chowk Route, Kathmandu

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## Abstract

The diminishing preference for the public transportation system in the Kathmandu Valley has been a longstanding issue, attributed to factors such as uncontrolled urbanization, increased motorization, inadequate transit infrastructure, and diminished reliability. The issue of less reliability of public transport in Kathmandu has drawn significant interest of public authorities, policy makers, planners and researchers. The lack of reliability in the public transportation system may compel commuters to choose personal vehicles, primarily motorcycles and cars. The increase in these smaller vehicles, sharing routes with larger ones, not only leads to an increase in congestion but also diminishes overall reliability. Hence, it becomes imperative to maintain the public transport system at an optimal level of reliability. Thus, this research focuses on the performance of public transport, particularly buses, employing measures of travel time reliability. Planning time and planning time index are used as a measure of the travel time reliability. This study includes a comparative analysis of the travel time reliability among different bus service providers operating on the case study route. On board technique was adopted to collect the data. Among the different public service providers operating in the area, four bus service providers Mahanagar Yatayat, Mahasagar Yatayat, Mayur Yatayat and Khwopa Yatayat were selected for this study. The comparison of travel time reliability among various bus service providers was conducted using an Analysis of Variance (ANOVA) test and post-hoc test.

*Keywords:* Travel time reliability, planning time, planning time index

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## 1. Introduction

Public transport refers to a collective passenger transportation service encompassing various modes such as tempos, buses, micro buses, trolley buses, and trains available to any individual and following fixed routes. The public transportation system in the Kathmandu valley operates through multiple operators, lacking a well-defined time schedule, interconnectivity, designated bus stations and standardized fare structures. Consequently, the public perceives public transport as an unreliable mode of transportation.

The Kathmandu Valley features 27 bus lines within the valley and around 166 city routes, inclusive of bus, microbus and tempo services, primarily along the ring road (Manadhar, 2023). According to statistics from the Department of Transport Management (DOTM, 2018) reveal that only 2.5% of registered vehicles in the Kathmandu valley belong to the public transport category, with 78.5% of those vehicles being two-wheelers. The majority, accounting for 97.5% of the total registered transportation fleet, consists of private, government, and diplomat-owned automobiles (DOTM, 2018).

The definition of travel time reliability, as outlined by the Florida Department of Transportation (2011), pertains to the percentage of travel time that does not exceed the anticipated travel time with an acceptable additional unexpected time. Iida (1999) has approached the concept from a probabilistic perspective, defining it as the probability of a commuter successfully reaching at their destination within a designated time frame. The United States Federal Highway Administration (FHWA) characterizes travel time reliability as the

consistency or predictability in travel times, measured across different times of the day or from day-to-day. Essentially, travel time reliability measures the extent of unexpected delays. The FHWA recommends a straight forward measure of travel time reliability using the 90<sup>th</sup> or 95<sup>th</sup> percentile travel times, namely planning time for specific routes or trips, indicating the severity of delays on peak travel days.

## **2. Literature Review**

Numerous studies have explored the reliability of travel time in public bus transportation. Mishra et al. (2020) conducted a study related to operational evaluation of public transportation in Kathmandu, Nepal, specifically focusing on the Kalanki-Kalimati-Tripureshwor-Bhotahity section, covering a distance of 6700 m in forward and 6200 m backward in backward direction. The research utilized economic indicators such as the benefit-cost ratio and rate of return as performance indicators, while service indicators included running time, journey time, running speed, journey speed, running index, passenger waiting index, bus punctuality and accessibility index. The chosen modes of public transport for analysis were Sajha Yatayat, private buses and microbuses. The authors conducted a scheduled questionnaire survey with 94 respondents, revealing that 21.27% expressed dissatisfaction with Sajha Yatayat, buses, and microbuses. Their conclusion was that among the three chosen modes of public transport on the study route namely Sajha Yatayat, buses and microbuses, Sajha Yatayat has superior performance with the performance order being in a decreasing sequence from Sajha Yatayat to buses and then microbuses. Gautam and Marsani (2020) mentioned that the economic significance of travel time in Nepal, particularly in Kathmandu Valley, is underestimated. Their study specifically concentrated on assessing the importance of travel time and the associated reliability for commuters in the Kathmandu Valley. Before gathering data through the stated preference method, a perception survey was conducted. The researchers utilized a Multinomial Logit model for the data to estimate the value of travel time.

Aryal et al. (2022) illustrated that passenger satisfaction with service providers is lacking, leading to decreasing demand. Thus, the collective literature indicates the necessity for enhanced reliability of public transport in Nepal.

Karki and Shahi (2019) evaluated the quality of public transport services by using various indicators, including waiting time, walking distances, frequency during peak and off-peak hours, route changes, fares, and staff behavior. According to their data analysis, the service quality was found to be poor for peak hour service frequency and service reliability, whereas cleanliness, information provision, and waiting time exhibited an average service quality. The researchers recommended enhancing the service reliability of public transport as a crucial measure to boost passenger satisfaction.

Sen et al. (2019) had carried out a study to determine the 95% travel time reliability of various public transportation modes along a specific route in the Kolkata city in India. The state government bus, private bus and minibus in-vehicle journey time reliability were estimated and then results were compared to metro railway. Their findings indicate that journey time reliability falls between 45 to 65 percent behind of the metro railway's reliability for all bus kinds. In order to provide valuable information on the bus reliability, characteristics such as planning time and planning time index were also calculated. The relationship between reliability and other important traffic measures like waiting time delays and congestion delays has also been investigated.

Ashwini et al. (2023) conducted research on analyzing travel time reliability of a bus route in a limited data set scenario taking a case study of "Tumakuru city, India" to analyze 95% travel time reliability. According to the "National Urban Transport Policy" of the Government of India, service level benchmarks for urban transport include headway, waiting time, speed, and journey time, which are the reliability factors evaluated for public transportation services. According to their findings, the public transport system faced an unexpected delay time of about 30% of the average travel time and more than twice as much free-flow travel time needs to be scheduled at peak hours and worst situation.

Studies in context of Nepal have predominantly addressed the reliability of public transport services in terms of service reliability rather than focusing on the reliability of travel time. The global discourse has

increasingly highlighted the significance of travel time reliability. Consequently, this study places a specific emphasis on the travel time reliability of public bus transport, aiming to contribute in literature gap by investigating travel time reliability of bus services on the selected case study route in Kathmandu. The Federal Highway Administration has recommended 90<sup>th</sup> or 95<sup>th</sup> percentile travel time reliability, namely planning time. Most research papers conducted on travel time reliability have used 95<sup>th</sup> percentile travel time reliability. Hence, this study uses planning time based on 95<sup>th</sup> percentile travel time reliability as a measure of travel time reliability.

### 3. Methodology

Different key parameters such as 95% travel time (planning time), free-flow travel time, planning time index were determined from the collected data. To compare travel time reliability among different bus service providers One Way Analysis of Variance (ANOVA) test was performed in SPSS (Statistical Package for the Social Sciences).

#### 3.1 Study Area

Airport to Narayan Gopal Chowk Route as shown in Figure 1, is one of the busiest public transport routes in Kathmandu, with multiple bus service providers operating along the way. Therefore, Airport to Narayan Gopal Chowk Route of 5.6 Kilometer (km) was selected as the study route in this research. Among the different public bus service providers operating in the area, four bus service providers Mahanagar Yatayat, Mahasagar Yatayat, Mayur Yatayat and Khwopa Yatayat were selected for this study based on higher operating frequency on this route.

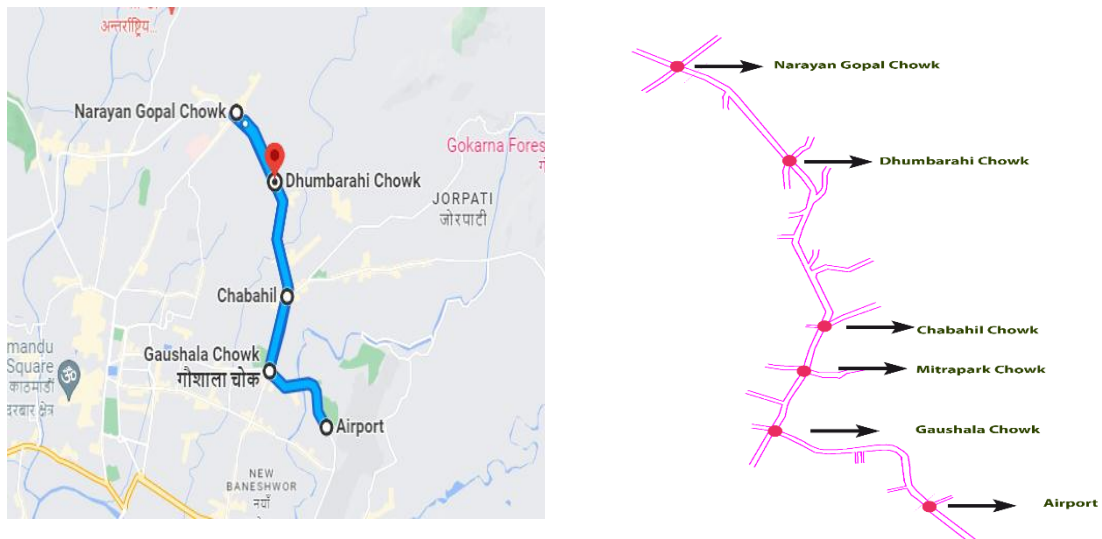


Figure 1. Overview and Layout of Study Area

#### 3.2 Data Collection

On board technique was adopted to collect the data. In this method, surveyors rode on selected bus service providers along the study route, utilizing a stopwatch to record travel times. Time of the beginning of the journey in hour, minute and second at the origin was noted. The end time was noted down at the destination in hour, minute and second. The same process was followed in the reverse direction too. From this, the travel time taken by the buses of Mahanagar Yatayat, Mahasagar Yatayat, Mayur Yatayat and Khwopa Yatayat of Airport to Narayan Gopal Chowk Road were obtained. The data were collected from 8:30-11:30 AM for six days during morning peak hour in July ,2023 for comparison of travel time reliability. The planning time was calculated for 95% travel time reliability as a 95 percentile for a group of seven data. The measurement of free flow travel time involved observing the duration taken by chosen bus service providers on the Airport to Narayan Gopal Chowk route at 6 am in the morning. The study did not include public holidays and Saturdays.

### 3.4 Data Extraction

The data obtained were input on spreadsheet for further processing. The data were classified per 30 min interval of departure time i.e., 8:30-9:00 AM till 11:00-11:30 AM for each bus service providers. For calculating 95% travel time reliability, seven data of same departure time interval for each bus service provider were grouped together. The planning time was calculated for 95% travel time reliability as a 95 percentile for a group of seven data. Thus, forty-one set of data obtained from 287 data records were used for finding out planning time and planning time index. The free flow travel time was calculated as average of seven number of data incorporating all bus service providers and was found to be 26.37 minute.

### 3.5 Comparison of Travel Time Reliability

The travel time reliability of different bus service providers is compared with respect to planning time and planning time index, another measure of travel time reliability. The planning time index is the ratio of planning time to free-flow travel time as given in Equation 1. Planning time index indicates the planning time at any time of the day with respect to free flow traffic condition. The higher the value of planning time and planning time index, the less reliable is the mode of transport and vice versa.

$$PTI=PT/FFTT \quad \text{(Equation 1)}$$

Where,

PTI: Planning Time Index

PT: Planning Time

FFTT: Free -Flow Travel Time

## 4. Result and Discussion

### 4.1 Planning Time of the Bus Service Providers

The descriptive statistical analysis value of planning time of four bus service providers i.e., Mahasagar Yatayat, Mahanagar Yatayat, Mayur Yatayat and Khwopa Yatayat are summarized in the Table 1.

Table 1. Planning Time of Bus Service Providers

Bus Service Providers	Mean Planning Time (Min)	Standard Deviation (Min)
Mahasagar Yatayat	34.408	4.502
Mahanagar Yatayat	37.920	4.615
Mayur Yatayat	37.751	6.056
Khwopa Yatayat	32.759	4.264

The descriptive statistics values shows that Mahasagar Yatayat has mean planning time of 34.408 minutes with standard deviation 4.502 minutes, Mahanagar Yatayat has mean planning time of 37.920 minutes with standard deviation 4.615 minutes, Mayur Yatayat has mean planning time of 37.751 minutes with standard deviation 6.056 minutes and Khwopa Yatayat has mean planning time of 32.759 minutes with standard deviation 4.264 minutes. The descriptive statistics values shows that Mahanagar Yatayat has maximum mean planning time of 37.920 minutes with standard deviation 4.615 minutes and Khwopa Yatayat has minimum mean planning time of 32.759 minutes with standard deviation 4.264 minutes.

### 4.2 Planning Time Index of the Bus Service Providers

The free-flow travel of public bus transport was found to be 26.37 minute. The descriptive statistics for the planning time index reveal values of 1.305, 1.439, 1.432, and 1.243 for four bus service providers, namely Mahasagar Yatayat, Mahanagar Yatayat, Mayur Yatayat, and Khwopa Yatayat, respectively, as indicated in Figure 2 respectively.

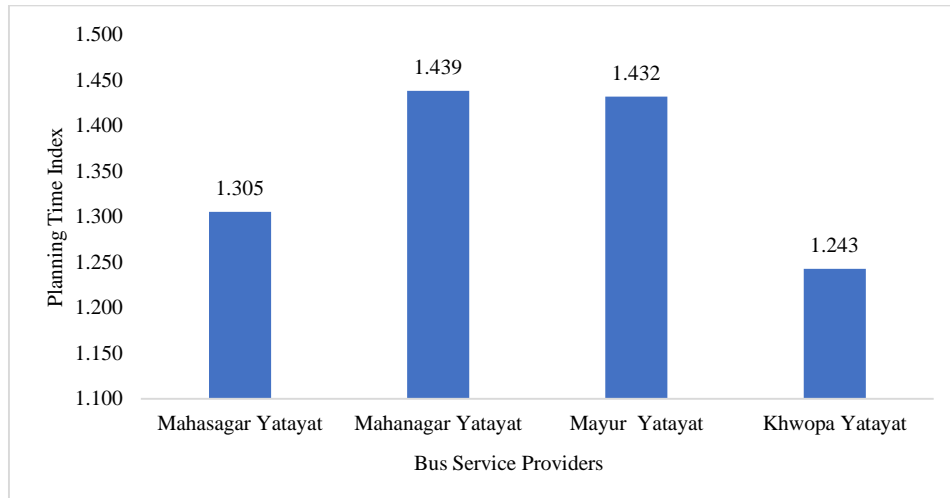


Figure 2. Planning Time Index of Bus Service Providers

The descriptive statistics shows that the planning time of Mahasagar Yatayat is 30.5% more than the free-flow travel time. Likewise, planning time of Mahanagar Yatayat is 43.9% more than the free-flow travel time. Also, the planning time of Mayur Yatayat and Khwopa Yatayat are 43.2% and 24.3% more than the free-flow travel time. This shows Khwopa Yatayat needs minimum of 24.3% more planning time than the free-flow travel time whereas Mahanagar Yatayat requires the maximum of 43.9% more travel time than free-flow travel time.

### 4.3 Comparison of Travel Time Reliability

The travel time reliability of four bus service providers of selected bus route was compared with respect to planning time. The planning time of Mahasagar Yatayat, Mahanagar Yatayat, Mayur Yatayat and Khwopa Yatayat was compared by conducting ANOVA testing using SPSS software to check if there is significant difference between the travel time reliability of different bus service providers.

Table 2. ANOVA Result for Comparison of Travel Time Reliability of the Four Bus Service Providers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	194.502	3	64.834		
Within Groups	867.799	36	24.106	2.690	0.061
Total	1062.301	39			

The significant value obtained from ANOVA test as shown in Table 2 is 0.061, which is more than the significance level of 0.05. This suggests that there is no statistically significant difference in the planning time of four bus service providers at a 5% level of significance. The route is same for all bus service providers and the delays faced by each bus service providers are of same type for the same route. So, analysis of variance test, shows no significant difference on travel time reliability. Therefore, it can be concluded that there is no significant difference in travel time reliability among different bus service providers at a 5% level of significance.

But the result shows that at 10% level of significance, there is significant difference between travel time reliability of different bus service providers. The results of the post hoc test indicate a significant difference in the mean planning time between Mahanagar Yatayat and Khwopa Yatayat, with a significant value of 0.024 and a mean difference of 5.160 minutes. There is significant difference between mean value of Mayur Yatayat and Khwopa Yatayat ( $p=0.029<0.1$ ) with mean difference of 4.991 minutes. While there is no notable difference between mean value of planning time of Mahasagar Yatayat with Mahanagar Yatayat, Mayur Yatayat and Khwopa Yatayat. The result of ANOVA and post hoc analysis concluded that Khwopa Yatayat has the highest travel time reliability, while Mahanagar Yatayat exhibits the least travel time reliability among the studied four bus service providers at 10% level of significance. The result of post hoc test is presented in Table 3.

Table 3. Post Hoc Test Result

Multiple Comparisons				
Dependent Variable:		Planning time		
(I)Bus Service Providers	(J)Bus Service Providers	Mean Difference (I-J)	Std. Error	p-value
Mahasagar Yatayat	Mahanagar Yatayat	-3.512	2.196	0.118
	Mayur Yatayat	-3.343	2.196	0.137
	Khwopa Yatayat	1.648	2.196	0.458
Mahanagar Yatayat	Mahasagar Yatayat	3.512	2.196	0.118
	Mayur Yatayat	0.168	2.196	0.939
	Khwopa Yatayat	5.160	2.196	0.024
Mayur Yatayat	Mahasagar Yatayat	3.343	2.196	0.137
	Mahanagar Yatayat	-0.168	2.196	0.939
	Khwopa Yatayat	4.991	2.196	0.029
Khwopa Yatayat	Mahasagar Yatayat	-1.648	2.196	0.458
	Mahanagar Yatayat	-5.160	2.196	0.024
	Mayur Yatayat	-4.991	2.196	0.029

## 5. Conclusion

This study investigates the travel time reliability of four different bus service providers namely Mahasagar Yatayat, Mahanagar Yatayat, Mayur Yatayat and Khwopa Yatayat operational between Airport and Narayan Gopal Chowk route in Kathmandu. The travel time reliability of the service providers was compared in terms of planning time and planning time index. 95% travel time reliability has been considered for calculating planning time. Analysis of Variance (ANOVA) and post hoc test was used to compare the travel time reliability of selected bus service providers.

Based on the test results and analysis, the following conclusion can be drawn:

- Analysis of variance (ANOVA) test, shows no significant difference on travel time reliability at 5% level of significance. The route is same for all bus service providers and the delays faced by each bus service providers are of same type for the same route. Therefore, it can be concluded that there

is no significant difference in travel time reliability among different bus service providers at a 5% level of significance.

- The results of ANOVA and post hoc test shows that the planning time Mahanagar and Khwopa Yatayat, Mayur Yatayat and Khwopa Yatayat are significantly different at 10% level of significance. This shows that Khwopa Yatayat has highest travel time reliability whereas Mahanagar Yatayat has least travel time reliability among the four bus service providers at 10% level of significance.

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