eISSN: 2976-1190

Journal of Engineering and Sciences

Vol. 2 Issue 1 November 30, 2023

Journal homepage: ***Journal of Engineering and Sciences (nepjol.info)***

Publisher: Research Management Cell, Pashchimanchal Campus, Lamachour, Pokhara

Comparative Performance Evaluation of Public Transportation Services in Pokhara Valley

Subas Subedi[1], Ramesh Bastola[2], Sandip Duwadi[2]

[1]*Research Student, Department of Civil Engineering, IOE, Pashchimanchal Campus, Tribhuvan University, Nepal*
[2]*Professor and Guide, Department of Civil Engineering, IOE, Pashchimanchal Campus, Tribhuvan University, Nepal*

(Manuscript Received:30/09/2023; Revised:20/11/2023; Accepted: 29/11/2023)

Abstract

This study conducts the performance evaluation of the public transportation system on the Fewa-Begnas route in Pokhara Valley. The performance evaluation of public transportation is conducted from three perspectives (Economic, operational performance of the vehicle, and passenger perception). Passenger perceptions are assessed based on a survey of 9 indicators. The results obtained from the questionnaire survey are analyzed by calculating the index values.

Also, the operational performance of the vehicle is evaluated using 5 indicators (Journey time, Journey speed, running time, Running speed, and transport system capacity index). Also, for evaluation from an economic perspective, the total cost per km that occurred to run a public bus and the total revenue generated per km is calculated.

Keywords: Economic perspective; Key performance indicator; Operational perspective; Passenger's perspective public transportation system

1. Introduction

Public transportation, including buses, minibusses, and micros, is a common means of travel in Nepal, particularly in Pokhara, the country's largest city. The estimated population of Pokhara, Nepal in 2023 is 475,969. This represents a 3.97% annual change from the previous year[1]. Pokhara is known for its natural beauty, cultural diversity, and adventure activities. It also has a vibrant public transportation system with seven main providers: Pokhara Fewa Yatayat, Gandaki Taxi Bebahasi Public Limited, Pokhara Taxi Sewa Pvt. Ltd, Pokhara Yatayat, Mama Yatayat, Begnastal Pokhara Yatayat, and Prithiv Rajmarga bus Bebahasi Samati.

An efficient public transportation system is required for urban areas in developing countries like Nepal to reduce the problems of degrading environment, traffic congestion, and poor level of service[2].

However, the public transportation system in Pokhara faces challenges due to rapid urbanization and population growth. High travel time, overcrowding, lack of cleanliness, and inefficient operations have led to a preference for private vehicles. Further, implementing a new public transport system requires a huge amount of funds, mainly for infrastructure, construction, and maintenance. Hence, before investing in transport, poor economic conditions, limitation of infrastructure facilities, and better utilization of existing infrastructure, there is a continued need to evaluate and compare the performance of public transport systems in urban areas[3]. Nowadays, most providers have their method to know the performance of public transport systems. However, the performance evaluations by the providers do not necessarily reflect the user perspective and cannot be considered adequate[4]. Comparative performance evaluation of public transportation systems can be a significant method of evaluating its performance.

The performance evaluation of a public transport system is more effective if we consider the indicators that affect the public service providers and the users. Therefore, the performance evaluation of public buses is conducted from three perspectives: the economic perspective, the operational perspective of the vehicle, and the passenger's perception of the public vehicle. These three indicators serve as the key performance indicators (KPI) to evaluate the performance of a public bus. Evaluating these three KPIs involves employing 16 micro-performance indicators (KPIs).

This study aims to compare the performance of public buses from two transport companies, Pokhara Yatayat, and Begnastal Pokhara Yatayat, operating along the route from Fewa Lake to Begnas Lake in Pokhara. This route is among the longest routes used by two public transportation service providers within the Pokhara Valley.

*Corresponding author. Tel:,
E-mail address: subassubedi19@gmail.com

1.1 Problem Statement and Objective of the Study

The Fewa-Begnas route, one of the longest in the Pokhara Valley, is a significant public transportation corridor. This route covers key areas of the Pokhara Valley, such as Prithiv Chowk, the International Airport, the industrial area, and Sisuwa, all of which see a high passenger flow. Some segments of this route are also operated by public vehicles that run outside the valley, making it one of the busiest routes in Pokhara. These factors lead to longer travel times and high delay times during the journey, resulting in increased inefficiency in the use of public buses. The lack of data about the cost and revenue generation of public buses hampers new investments in public transportation. The lack of data about passengers' perception of public transportation hinders improving the performance of public buses. As a result, the unreliability of public transportation is on the rise, leading to a surge in private vehicle ownership. Evaluating passengers' perceptions of public transportation is crucial to understanding the current situation and identifying areas for improvement. This assessment not only provides insights into the existing state of public transportation but also aids in suggesting measures for enhancement. Therefore, there is a need for a performance evaluation of the public transportation system. This evaluation would consider factors such as travel time, delay time, passenger satisfaction, and financial viability, aiming to improve the reliability and efficiency of public transportation in the region.

This study concludes the following two objectives:

- To evaluate the index value of micro (KPI).
- To compare the performance of public transportation from three perspectives: economic, passenger, and vehicle operation, using an index value for measurement.

2. Literature Review

Vaidya (2014)[5] evaluated 26 public urban transportation organizations in India using the Analytic Hierarchy Process (AHP) and Data Envelopment Analysis (DEA). The study introduced the Transportation Efficiency Number (TEN) as an overall performance indicator considering 19 criteria grouped into Operations, Finance, and Accident-based categories. The approach aids strategic decision-making and policy formulation.

Jain et al. (2016)[4] evaluated the comparative performance of alternate public transport systems in Indian cities from a user perspective. The study proposed a simple and systematic methodology consisting of four stages and demonstrated its application using bus services in Bhopal city. The results showed that the proposed technique is straightforward, simple, and cost-effective.

Duwadi et al. (2018)[2] investigated passenger satisfaction and operational performance of the public transportation system in Pokhara, Nepal. The study revealed that different bus services excelled in different aspects of service delivery. Both bus services demonstrated effectiveness and efficiency in operational performance based on Data Envelopment Analysis (DEA). The study emphasized the importance of maintaining or improving the current performance level to enhance passenger satisfaction.

Jain et al. (2020)[3] propose a method to evaluate public transportation systems from three perspectives: users, operators, and the city. The study emphasizes the need for comprehensive evaluation to improve existing systems, particularly in resource-limited settings like developing countries. The method was applied in Bhopal, providing valuable insights for decision-making in public transportation management.

Mishra et al. (2020)[6] assess the effectiveness of public transportation in Kathmandu, Nepal, using four key performance indicators (KPIs) and twenty-nine micro indicators. The study identifies areas for improvement, such as passenger discomfort during peak hours, overcrowding, and staff misconduct. It underscores the importance of continuous monitoring and benchmarking to enhance public transportation services.

Kabir et al. (2019)[7] evaluate the performance of the public transportation system in Dhaka city across five categories: service efficiency, system efficiency, cost efficiency, utilization efficiency, and network efficiency. The study reveals that the existing system is not operating efficiently due to issues like traffic congestion. It suggests sustainable solutions like implementing metro rails and bus rapid transit and improving management and infrastructure.

Lin et al. (2021)[8] developed a public transport criteria matrix AHP model to assess the performance of public transport networks. The model considers infrastructure, service, economic benefits, and sustainable development criteria. The study provides valuable insights for optimizing resources and enhancing urban public transportation networks.

Duleba et al. (2021)[9] introduced a grey-AHP methodology to overcome uncertainties in evaluating public transport quality. The model was applied to Amman city in Jordan and effectively enhanced the public transport system's quality. The study suggests focusing on safety, maintenance, driver

training, and increased bus line frequency to improve transport quality.

Tiwari et al. (2023)[10] The study used a method called fuzzy-AHP to determine the importance of factors in public transportation services in Kathmandu. The study found that vehicle safety was the most important factor. This information can be used to improve user satisfaction with public transportation services.

Table 1: Reviews of important performance indicators used in Nepal

S. N.	Performance indicators	Study carried out in Nepal
1.	Cost/Km	Mishra et al. (2020)[6]
2.	Revenue/Km	Mishra et al. (2020)[6]
3.	Journey time	Mishra et al. (2020)[6], Duwadi et al. (2018)[2]
4.	Running time	Mishra et al. (2020)[6], Duwadi et al. (2018)[2]
5.	Journey speed	Mishra et al. (2020)[6], Duwadi et al. (2018)[2]
6.	Running speed	Mishra et al. (2020)[6], Duwadi et al. (2018)[2]
7.	Transport system capacity	Jain et al. (2020)[3]
8.	Safety	Tiwari et al. (2023)[10]
9.	Seat comfort	Mishra et al. (2020)[6]
10.	Comfort in travelling	Tiwari et al. (2023)[10]
11.	Staff behavior	Mishra et al. (2020)[6], Tiwari et al. (2023)[10]
12.	Female friendly	Mishra et al. (2020)[6]
13.	Old friendly	Mishra et al. (2020)[6], Tiwari et al. (2023)[10]
14.	Child friendly	Mishra et al. (2020)[6]
15.	Disable friendly	Mishra et al. (2020)[6], Tiwari et al. (2023)[10]
16.	Vehicle cleanliness	Tiwari et al. (2023)[10]

In Nepal, similar research has been conducted in Kathmandu for different types of public transportation. Also, in Pokhara, a study was done on two public transportation groups that go from Lamachaur to Chhorepatan. They looked at what passengers thought and how well the buses worked for Bindabisini Yatayat and Pokhara Yatayat. Studies about public transportation was done in Pokhara on the Lamachaur-Chhorepatan route considering passenger satisfaction and performance analysis of public transportation but the economic perspective of the study area is not explored. So, this research could fill in this gap by considering what both passengers and the operators think, as well as the economic aspects in this new route by looking at public buses of two different public transportation companies**,** Pokhara Yatayat and Begnastal Pokhara Yatayat, which run from Fewa to Begnas Lake.

3. Methodology

3.1. Study Area

For this research, the road section from Fewa Lake to Begnas Lake was chosen. This section, which is 19.3 km long, runs through the northern part of Pokhara, covering major areas such as Mustang Chowk, Prithiv Chowk, Bus Park, Industrial Area, International Airport, Budi Bazar, Talchowk, and Sesuwa. This road section has a high demand for transportation due to its large catchment area of passengers.

The road section passes by both Fewa and Begnas lakes, which are major tourist attractions in Pokhara. It also includes a segment of the Prithvi Highway and runs through the International Airport. As a result, a diverse range of passengers, from those traveling for recreation to those seeking entertainment, are expected to use this route. Given its importance in gauging user satisfaction levels among a mixed passenger group, and being the longest route in the Pokhara Valley operated by two transport service providers Pokhara Yatayat and Begnastal Pokhara Yatayat, this route section is selected for the study.

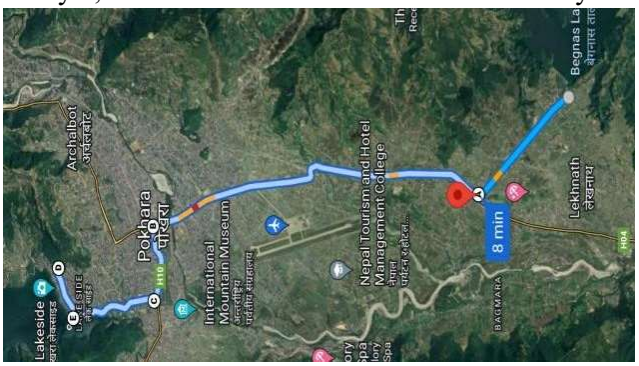

Figure 1: Study Area

The methodology of the study involves a detailed process for the comparative evaluation of public transportation systems operating on a selected route.

This evaluation focuses on various key indicators to assess the effectiveness of public buses based on passenger perception, economic aspects, and operational performance.

3.2 Identification of Key Indicators for Comparative Performance Evaluation

The first stage involves selecting the most appropriate indicators to measure the comparative performance of public transportation on the chosen route. The challenge lies in choosing indicators that align with the study's goals, are easy to understand and measure, are cost-effective in data collection, and can be obtained promptly. To address this, the study compiles a list of essential measurements by examining existing research papers and theses. Usually, the performance indicators that are used in Nepal for the study of public transportation are selected. Selected indicators are shown in Table 1. The identified performance indicators are categorized as follows:

Table 2: Performance indicator from an economic perspective

S.N	Performance indicators
1.	Comparative operational cost of vehicle
2.	Comparative revenue from vehicle

Table 3: Performance indicators from operational performance of bus perspective

S.N	Performance indicators
1.	Comparative journey time
2.	Comparative running time
3.	Comparative journey speed
4.	Comparative running speed
5.	Comparative transport system capacity

Table 4: Performance Indicators from passenger's Perception

S.N	Performance indicators
1.	Comparative Safety
2.	Comparative seat comfort
3.	Comparative comfort in travelling
4.	Comparative staff behavior
5.	Comparative female friendly
6.	Comparative old friendly
7.	Comparative child friendly
8.	Comparative disable friendly
9.	Comparative in vehicle cleanliness

3.3 Data Collection

The main source of data is a primary source. Questionnaires were prepared and asked of the intended groups. The respective heads explain these in detail.

Data collection for the performance indicators from an Economic Perspective:

The operational cost of the vehicle is gathered through a questionnaire given to the head of the public transport service provider. At the same time, the revenue generation data is collected through a questionnaire given to the conductor. The revenue collection data is obtained from the conductor at the end of each journey. Over three days, eighteen sets of data are collected during the AM peak, off-peak, and PM peak periods. This data is collected in both inbound and outbound directions from public transportation service providers.

Data collection for the performance indicators from operational performance Perspective:

Data was collected through an onboard survey. A public vehicle was randomly selected and the same vehicle was used to travel the route. During the journey, the number of passengers getting on or off the bus, the delay time, the time elapsed between two stops, and the total time taken to cover the entire route were all recorded. The trips were made at different times in each direction. Thirty-six sets of data were collected from two bus service providers during the study, covering the morning peak (8 AM – 11 AM), evening peak (3 PM-6 PM), and off-peak (12:00 PM- 3:00 PM) periods.

Data collection for the performance indicators from the passenger's Perspective:

To understand people's perceptions of public transportation, data from 95 respondents were collected to assess satisfaction levels between two bus service providers. A structured questionnaire survey was conducted among passengers on the Fewa-Begnas Route. The questionnaire was distributed to passengers using public transportation services on this route. The required number of respondents for the questionnaire survey is calculated by calculating the sample size.

3.4. Evaluation of micro–Key Performance Indicators

This stage focuses on developing various essential indices to evaluate the condition of the identified key performance indicators. These indices are designed to facilitate the comparative performance assessment of alternative public transport systems while minimizing the data required. The indices are defined as follows:

Table 5: Evaluation of comparative performance evaluation of public buses from economic, operational, and passenger

Performance indicators	Evaluation of performance indicators
Comparative operational cost index (COCI)	It is the ratio of the average cost per km of public transportation system 2 (ACT2) to the average cost per km of public transportation system 1 (ACT1). COCI = ACT2/ACT1
Comparative revenue from vehicle index (CREI)	It is the ratio of the average revenue per km of public transportation system 1 (ART1) to that of public transportation system 2 (ART2). CREI = ART2/ART1
Comparative	It is the ratio of the journey time of pu

journey time index (CJTI)	blic transportation system 1 (AJT2) to t he average journey time of public transp ortation system 2 (AJT1). CREI = ART2/ART1
Comparative running time index (CRTI)	It is the ratio of the running time of pu blic transportation system 1 (ARUT1) to the average running time of public tran sportation system 2 (ARUT2). CRTI = ARUT2/ARU1
Comparative journey spee d index (CJS I)	It is the ratio of the average journey sp eed of public transportation system 1 (A JS1) to the average journey speed of pu blic transportation system 2 (AJS2). CJSI = AJS2/AJS1
Comparative running spee d index (CR SI)	It is the ratio of the average running sp eed of public transportation system 1 (A RS1) to the average running speed of p ublic transportation system 2 (ARS2). CRSI = ARS2/ARS1
Comparative transport syst em capacity index (CTCI)	It is the ratio of the transport system ca pacity index of transport system 1 (TSC I1) to the transport system capacity inde x of transport system 2 (TSCI2). CTCI = TSCI1/$TSCI2$ And, TSCI = TNP/MCP Where TNP = Total number of passenge rs traveled per day in vehicles MCP = Maximum capacity of passenger s traveled per day in vehicles MCP = 2*ANT*TNV*TSC Where ANT = Average number of trips per day per vehicle of public transport system TNV = Total number of vehicles of the public transport system ply on a route TSC = Total seating capacity of a vehic le of the public transport system on that route.
Comparative safety index (CSFI)	This is a ratio comparing user safety rat ings for two different public transport s ystems (System 1 and System 2) during travel and waiting at stops, denoted as SRT1 and SRT2 respectively. CSFI = $SRT1/SRT2$ SRT = $((5 * R5) + (4 * R4) + (3 * R3) + (2 * R2) + (1 * R))$/TNR Where, (R5 to R1) is respondent ratings from 1 (not safe) to 5 (very safe), and TNR is the total number of respondents.
Comparative seat comfort index (CSCI)	This is a ratio comparing user ratings f or seat comfort between two different p ublic transport systems (System 1 and S ystem 2) during travel and waiting at st ops, denoted as SCR1 and SCR2 respect ively. CSCI = $SCR1/SCR2$ SCR = $((5 * R5) + (4 * R4) + (3 * R3) + (2 * R2) + (1 * R))$/TNR R5 to R1 define different levels of seat comfort perception during travel and wai ting at a stop, categorized by respondent ratings from 1 (very uncomfortable) to 5 (very comfortable), TNR representing the total number of respondents.
Comparative comfort inde x (CCOI)	This is a ratio comparing user comfort r atings during traveling for two different public transport systems (System 1 and System 2) during travel and waiting at stops, denoted as CR1 and CR2 respecti vely. CCOI = $CR1/CR2$ CR = $((5 * R5) + (4 * R4) + (3 * R3) + (2 * R2) + (1 * R1))$/TNR R5-R1 defines different levels of comfor t perception during travel and waiting at a stop, categorized by respondent rating s from 1 (very uncomfortable) to 5 (ver y comfortable), and TNR represents the total number of respondents.
Comparative staff behavio r index (CS BI)	This is a ratio comparing user ratings o f the behavior of staff for two different public transport systems (System 1 and System 2), denoted as BSR1 and BSR2 respectively. CSBI = $BSR1/BSR2$ BSR = $((5 * R5) + (4 * R4) + (3 * R3) + (2 * R2) + (1 * R))$/TNR R5 to R1 defines different levels of use r ratings for the behavior of staff, rangi ng from 1 (very poor) to 5 (very good), and TNR represents the total number o f respondents.
Comparative in vehicle cl eanliness ind ex (CVCI)	This is a ratio comparing user ratings o f the cleanliness of two different public transport systems (System 1 and System 2), denoted as CLR1 and CLR2 respecti vely. CVCI = $CLR1/CLR2$ CLR = $((5 * R5) + (4 * R4) + (3 * R3) + (2 * R2) + (1 * R))$/TNR R5 to R1 defines different levels of use r ratings for the behavior of staff, rangi ng from 1 (very poor) to 5 (very good), and TNR represents the total number o f respondents.
Comparative in Female, O ld, Child, Di	This is a ratio comparing user ratings o f the friendliness of two different public transport systems (System 1 and Syste

sable friendly index (CFFI) (COFI) (CCFI) (CDFI)	m 2) towards specific groups, including females, the elderly, children, and disabled individuals. It is denoted as FR1 for System 1 and FR2 for System 2. CFFI, COFI, CCFI, CDFI = $FR1/FR2$ $FR = ((5 * R5) + (4 * R4) + (3 * R3) + (2 * R2) + (1 * R1))/TNR$ R5 to R1 defines various user ratings for a specific aspect, with ratings ranging from 1 (very poor) to 5 (very good), and TNR represents the total number of respondents.

4. Data Analysis

This section of the study evaluates the relative performance of two transportation systems in Pokhara Valley from various perspectives: economic, operational, passenger perception, and service quality.

Table 6: Criteria considered in the study

SN	Index Value	Description of the index value
1.	<1	Public transportation system 1 has better performance than 2
2.	=1	Performance of public transportation system 1 is equal to 2
3.	>1	The performance of public transportation system 1 is inferior than 2

Table 7 : List of details of the occurred costs

S.N	Day	Period of day	Direction	Public transportation system 1	Public transportation system 2
1	Day 1	AM Peak	Inbound	625	890
			Outbound	1575	2445
		Off Peak	Inbound	870	620
			Outbound	845	1250
		PM peak	Inbound	765	2150
			Outbound	1545	520
2	Day 2	AM Peak	Inbound	960	1140
			Outbound	955	1205
		Off Peak	Inbound	1050	1020
			Outbound	950	1325
		PM peak	Inbound	1325	1505
			Outbound	910	655
3	Day 3	AM Peak	Inbound	985	985
			Outbound	1325	955
		Off Peak	Inbound	1460	1240
			Outbound	1350	1275
		PM peak	Inbound	1050	1050
			Outbound	995	1060
Total fare collection of 18 trips (Rs)				19540	21290
Average fare Collection (Rs)				1085.56	1182.78
Total length travelled in per trip (Km)				19.3	19.3
Average revenue per Km (Rs/Km)				**56.25**	**61.28**

The two systems are referred to as Public Transport System 1 as PT1 (representing Pokhara Yatayat) and Public Transport System 2 as PT2 (representing Begnastal Pokhara Yatayat). Here is a summary of the key findings:

4.1 Analysis and Results of performance indicators from an economic perspective

4.1.1 Comparative operational cost of vehicle index (COCI)

Table 8: Cost occurred in cost per km

S. N	Description	Duration	PT1	PT2
1	Salary of driver	per month	3650	3000
2	Allowance of driver	per day	900-1000	800-900
3	Salary of conductor	per month	2150	2000
4	Allowance for conductor	per day	650-700	500-600
5	Food cost for (driver+ conductor)	per day	700	500
6	Cost of dress for driver	per year	2500	2500
7	Average working days per month	per day	25	24
8	Maintenance cost	per month	10,000	12000
9	Mobil Cost	per 3 month	15000	15000
10	Cost on tyres (front)	per year	19000	19000
	(Cost on tyre (back)	per year	20000	20000
11	Government tax	per year	27000	27000
12	Painting Cost	per 3 year	25000	25000
13	Route Permit	per 6 month	1000	1000
14	Fitness test	per 6 month	1000	1000
15	Insurance cost	per year	45000	45000
16	Accident Cost	Not fix		
17	Fuel Cost	per ltr	164.5	164.5
18	KM/Ltr of fuel	km/ltr	5-6	5-6
19	Average round trip per day	Nos	4	4
20	Length of travel in each round trip	Km	38.6	36.8

Table 9: Details of input data for revenue collection

S.N	Description	Unit	PT1	PT2
1	Salary of driver	per km	0.94	0.8
2	Allowance of driver	per km	6.16	5.52
3	Salary of conductor	per km	0.56	0.54
4	Allowance for conductor	per km	4.38	3.57
5	Food cost for (driver + conductor)	per km	4.54	3.24
6	Cost of dress for driver	per km	0.05	0.05
8	Maintenance cost	per km	3	3.1
9	Mobil Cost	per km	1.3	1.35
10	Cost on tires (front) 2 nos	per km	0.82	0.85
	(Cost on tire (back) 4 nos	per km	1.73	1.8
11	Government tax	per km	0.58	0.6
12	Painting Cost	per km	0.18	0.19
13	Route Permit	per km	0.04	0.04
14	Fitness test	per km	0.04	0.04
15	Insurance cost	per km	0.97	1.01
17	Fuel Cost	per km	29.9	29.9
	Total	**per km**	**54.79**	**52.6**

Table 7 presents the total costs incurred over a specific duration, and these costs are then converted into cost per km and displayed in Table 8. From the table, we obtain a Comparative Operational Cost of Vehicle Index (COCI) of 0.96.
This index value of 0.96 (which is less than 1) indicates that the performance of Public Transportation 1 (Pokhara Yatayat) is inferior to that of Begnastal Pokhara Yatayat (as per Table 6). In other words, the total cost incurred while traveling per km is higher for Pokhara Yatayat than for Begnastal Pokhara Yatayat.

4.1.2 Comparative revenue from vehicle index (CREI)

It is the ratio of the average revenue per km of public transportation system 1 (ART1) to the average revenue per km of public transportation system 2 (ART2).
CREI = ART2/ART1
For, revenue generation fare collection during the trip is listed with the help of vehicle staff, and for cost calculation, the total cost occurred is listed with the help of the operator.

So, Comparative revenue from vehicle index (CREI) = 0.92.

This index value of 0.92 (which is less than 1) indicates, the total revenue generation while travelling per km is less for Pokhara Yatayat than for Begnastal Pokhara Yatayat.

4.2 Analysis and results of performance indicators from operational performance of buses

Table 10: Data input for journey time and journey speed

S.N	Day	Period of day	Direction	PT1	PT2
1	Day 1	AM Peak	Inbound	54.78	62.4
			Outbound	70.21	74.8
		Off Peak	Inbound	66.58	64.5
			Outbound	61.13	64.2
		PM peak	Inbound	62.97	80.85
			Outbound	70.42	62.33
2	Day 2	AM Peak	Inbound	66.1	66.61
			Outbound	64.08	67.1
		Off Peak	Inbound	58	60.95
			Outbound	57.92	69.93
		PM peak	Inbound	67.01	70.17
			Outbound	57.93	61.61
3	Day 3	AM Peak	Inbound	62.05	57.83
			Outbound	62.26	65.83
		Off Peak	Inbound	70.9	64.1
			Outbound	62.13	59.57
		PM peak	Inbound	61.35	64.4
			Outbound	64.33	68.75
Total Journey time for 18 trips (min)				1140.2	1185.9
Average journey time for a trip(min)				**63.3**	**65.9**
Average Journey Speed (m/s)				**5.08**	**4.88**

Table 10 shows the average journey time and the journey speed of each public transportation service provider. From the table we get,
Comparative journey time index (CJTI) =1.04
Comparative journey Speed index (CJSI) =1.04
The index value for CJTI and CJSI (>1) indicates Pokhara Yatayat takes less time to reach to destination with a higher journey speed than Begnastal Pokhara Yatayat.

Table 11: Data for running time and running speed

S.N	Day	Period of day	Direction	PT1	PT2
1	Day 1	AM Peak	Inbound	49.51	53.95
			Outbound	57.58	55.8
		Off Peak	Inbound	51.4	55.83
			Outbound	51.71	53.65
		PM peak	Inbound	55.99	57.73
			Outbound	54.29	51.08
2	Day 2	AM Peak	Inbound	59.12	57.97
			Outbound	55.66	57.22
			Inbound	49.88	50.73

		Off Peak	Outbound	51.4	58.33
		PM peak	Inbound	58.66	57.74
			Outbound	51	52.57
3	Day 3	AM Peak	Inbound	52.95	47.62
			Outbound	52.76	54.13
		Off Peak	Inbound	60.17	53.98
			Outbound	54.48	50.56
		PM peak	Inbound	52.18	57.48
			Outbound	64.33	59.33
Total Running time for 18 trips (min)				983.1	985.7
Average Running time for a trip (min)				**54.6**	**54.8**
Average Running speed (m/s)				**5.89**	**5.87**

Table 11 shows the average running time and the average running speed of each public transportation service provider. From the table we get,
Comparative running time index (CRTI) =1.04
Comparative running speed index (CRSI) =1.04
The index value for CRTI and CRSI (>1) indicates Pokhara Yatayat takes less time to reach to destination without considering delay and with higher running speed than Begnastal Pokhara Yatayat.

Table 12: Data for no of passengers traveling per day

S.N	Day	Period of day	Direction	PT1	PT2
1	Day 1	AM Peak	Inbound	23	33
			Outbound	56	85
		Off Peak	Inbound	42	22
			Outbound	30	46
		PM peak	Inbound	25	79
			Outbound	56	19
2	Day 2	AM Peak	Inbound	33	39
			Outbound	37	40
		Off Peak	Inbound	36	33
			Outbound	30	44
		PM peak	Inbound	44	49
			Outbound	29	22
3	Day 3	AM Peak	Inbound	35	35
			Outbound	44	32
		Off Peak	Inbound	47	40
			Outbound	45	41
		PM peak	Inbound	33	35
			Outbound	34	34
Total no of passengers for 3 days				679	728
Total no of passengers for a day				**226**	**243**

Table 12 shows the no. of passengers accessing each public transportation. From the table, we get,
Comparative transport system capacity index (CTCI) = 0.93
The index value 0.93 (<1) indicates that the number of passengers that use Pokhara Yatayat is less than that of no of passengers that use Begnastal Pokhara Yatayat.

4.3 Analysis and results of performance indicator from passenger's perspective

For this data analysis, data on people's perceptions is taken from a questionnaire survey. The Total number of respondents for the survey is 95. 49 responded to Pokhara Yatayat, and 45 responded to Begnastal Pokhara Yatayat.

Sample Size

To calculate the sample size Corchan equation (1963) with a 95% confidence level and precision of 10% is adopted. The sampling method considers the entire population of passengers that travel during the 3 days of the survey.

$$n_o = \frac{z2pq}{e2}$$

$$n = \frac{no}{1+\frac{no-1}{N}} \quad \text{(For finite sample)}$$

Where, n = Size of infinite population
z = Area of normal curve with value 1.96 for 95% confidence level.
p = Estimated proportion of an attribute that is present in the population. (50%)
q = 1-p
N = Total population size of passenger
e = the acceptable sampling error (10%)
Taking the total population of study (N) = 1407
We have n_o = 96.04
And n = 90

4.3.1 Data analysis of comparative safety index (CSFI)

It is the table of safety ratings given by users during travel in a vehicle and waiting at a stop for alternate public transport System 1(SRT1) and safety ratings given by users during travel in a vehicle and waiting at a stop for alternate public transport System 2 (SRT2).

Table 13: Data for passenger's ratings for Safety and Security

S.N	Rating	Public transportation system 1	Public transportation system 2
1	5	0	1
2	4	30	23
3	3	19	22
4	2	0	0
5	1	0	0
	Total	**49**	**46**

From the table, we get,
So, Comparative safety index (CSFI) = 1.05
The index value 1.05 (>1) indicates that passengers feel safer traveling in Pokhara Yatayat than in Begnastal Pokhara Yatayat.

4.3.2 Data analysis for comparative seat comfort index (CSCI)

It is the table of ratings for seat comfort level given by users during travel in a vehicle and waiting at the stop for alternate public transport System 1(SCR1) and Seat comfort rating given by users during travel in a vehicle and waiting at the stop for alternate public transport System 2 (SCR2).

Table 14: Data for passenger's ratings for seat comfort

S.N	Rating	Public transportation system 1	Public transportation system 2
1	5	0	0
2	4	38	17
3	3	11	29
4	2	0	0
5	1	0	0
	Total	**49**	**46**

From the table, we get,
So, Comparative seat comfort index (CSCI) = 1.12
The index value 1.12 (>1) indicates that passengers feel comfortable seats in Pokhara Yatayat than in Begnastal Pokhara Yatayat.

4.3.3 Data analysis for comparative comfort in travelling index (CCOI)

It is the table of comfort rating given by users during travel in vehicle and waiting at stop for alternate public transport System 1(CR1) and comfort rating given by users during travel in vehicle and waiting at stop for alternate public transport System 2 (CR2).

Table 15: Data for passenger's rating for comfort in travelling

S.N	Rating	Public transportation system 1	Public transportation system 2
1	5	0	0
2	4	24	19
3	3	25	27
4	2	0	0
5	1	0	0
	Total	**49**	**46**

From the table, we get,
So, Comparative comfort in travelling (CCOI) = 1.02
The index value 1.02 (>1) indicates that passengers feel more comfortable in travelling in Pokhara Yatayat than in Begnastal Pokhara Yatayat.

4.3.4 Data analysis for comparative staff behavior index (CSBI)

It is the table of the rating given by users to the behavior of staff of alternate public transport System 1(BSR1) and the rating given by users to the behavior of staff of alternate public transport System 2 (BSR2).

Table 16: Data for passenger ratings for staff behavior

S.N	Rating	Public transportation system 1	Public transportation system 2
1	5	0	0
2	4	27	17
3	3	20	28
4	2	2	1
5	1	0	0
	Total	**49**	**46**

From the table, we get,
So, Comparative staff behavior index (CSBI) = 1.05
The index value 1.05 (>1) indicates that passengers feel the behavior of staff in Pokhara Yatayat is better than in Begnastal Pokhara Yatayat.

4.3.5 Data analysis of comparative in Female, Old, Child, Disable friendly index (CFFI) (COFI) (CCFI) (CDFI)

It is the table of ratings given by users to the friendliness of alternate public transport System 1(FR1) and rating given by users to the cleanliness of alternate public transport System 2 (FR2) about females, old, children, and disabled.

Table 17: Data for passenger's ratings for female friendliness

S.N	Rating	Public transportation system 1	Public transportation system 2
1	5	0	0
2	4	18	14
3	3	28	30
4	2	3	2
5	1	0	0
	Total	**49**	**46**

From the table, we get,
Comparative in female friendliness index (CFFI) =1.02
The index value 1.02 (>1) indicates that passengers feel that Pokhara Yatayat is more female-friendly than Begnastal Pokhara Yatayat.

Table 18: Data for passenger's ratings for old friendliness

S.N	Rating	Public transportation system 1	Public transportation system 2
1	5	0	0
2	4	32	29
3	3	17	17
4	2	0	0
5	1	0	0
	Total	**49**	**46**

From the table, we get,
Comparative in old friendliness index (COFI) =1.003
The index value 1.003 (>1) indicates that passengers feel that Pokhara Yatayat is more old-friendly than Begnastal Pokhara Yatayat.

Table 19: Data for passenger's ratings for child friendliness

S.N	Rating	Public transportation system 1	Public transportation system 2
1	5	0	0
2	4	16	8
3	3	33	36
4	2	0	2
5	1	0	0
	Total	**49**	**46**

From the table, we get,
Comparative in child friendliness index (CCFI) =1.09
The index value 1.09 (>1) indicates that passengers feel that Pokhara Yatayat is more child-friendly than Begnastal Pokhara Yatayat.

Table 20: Data for passenger's ratings for Disable friendliness

S.N	Rating	Public transportation system 1	Public transportation system 2
1	5	0	0
2	4	16	8
3	3	33	36
4	2	0	2
5	1	0	0
	Total	**49**	**46**

From the table, we get,
Comparative in disable friendliness index (CDFI) =1.08
The index value 1.08 (>1) indicates that passengers feel that Pokhara Yatayat is more disable-friendly than Begnastal Pokhara Yatayat.

4.3.6 Data analysis for comparative vehicle cleanliness index (CVCI)

It is the table of ratings given by users to the cleanliness of alternate public transport System 1(CLR1) and the rating given by users to the cleanliness of alternate public transport System 2 (CLR2).

Table 21: Data for passenger's rating for vehicle cleanliness

S.N	Rating	Public transportation system 1	Public transportation system 2
1	5	0	0
2	4	30	28
3	3	19	16
4	2	0	2
5	1	0	0
	Total	**49**	**46**

From the table, we get the comparative vehicle cleanliness index (COFI) =1.01
The index value 1.01 (>1) indicates that passengers feel that Pokhara Yatayat is cleaner than Begnastal Pokhara Yatayat.

Table 22: Result of comparative performance of Pokhara Yatayat w.r.t Begnastal Pokhara Yatayat bus service

S.N	Key performance indicator	Index value	Remarks
1.	Comparative operational cost of vehicle index (COCI)	0.96	The inferior performance of Pokhara Yatayat
2.	Comparative revenue from vehicle index (CREI)	0.92	The inferior performance of Pokhara Yatayat
3.	Comparative journey time index (CJTI)	1.04	Better performance of Pokhara Yatayat
4.	Comparative running time index (CRTI)	1.003	Better performance of Pokhara Yatayat
5.	Comparative journey speed index (CJSI)	1.04	Better performance of Pokhara Yatayat
6.	Comparative running speed index (CRSI)	1.003	Better performance of Pokhara Yatayat
7.	Comparative transport system capacity index (CTCI)	0.93	Inferior performance of Pokhara Yatayat
8.	Comparative Safety Index (CSFI)	1.05	Better performance of Pokhara Yatayat
9.	Comparative seat comfort index (CSCI)	1.12	Better performance of Pokhara Yatayat
10.	Comparative comfort index (CCOI)	1.02	Better performance of Pokhara Yatayat
11.	Comparative staff behavior index (CSBI)	1.05	Better performance of Pokhara Yatayat
12.	Comparative female-friendly index (CFFI)	1.02	Better performance of Pokhara Yatayat
13.	Comparative Old Friendly Index (COFI)	1.003	Better performance of Pokhara Yatayat
14.	Comparative child-friendly index (CCFI)	1.09	Better performance of Pokhara Yatayat
15.	Comparative disable friendly index (CDFI)	1.08	Better performance of Pokhara Yatayat
16.	Comparative in vehicle cleanliness index CVCI)	1.01	Better performance of Pokhara Yatayat

5. Conclusion

In conclusion, the analysis of various performance indicators has provided valuable insights into the relative performance of two public transportation systems in Pokhara Valley: Pokhara Yatayat (System 1) and Begnastal Pokhara Yatayat (System 2). These indicators encompass economic, operational, and passenger perception aspects.

Economic Perspective

The comparative operational cost index (COCI) and comparative revenue from Vehicle Index (CREI) are

less than one, so Pokhara Yatayat's revenue generation performance is inferior to that of begnastal Pokhara Yatayat, while its operational cost is higher along this route.

Operational Performance

From the index value, we can see that the journey time, journey speed, running time, and running speed of Pokhara Yatayat are better than those of Begnastal Pokhara Yatayat while traveling on this route. The number of passengers using the public bus is less for Pokhara Yatayat than for Begnastal Pokhara Yatayat.

Passenger's Perception

Various indices were analyzed from the passenger's perspective, including safety, seat comfort, overall comfort while travelling inside the bus, staff behavior, and friendliness towards different passenger groups, i.e., female, old, child, and disabled. In all perspectives, passengers rated Pokhara Yatayat better than begnastal Pokhara Yatayat along this route. In summary, Begnastal Yatayat performs better economically, while Pokhara Yatayat performs better operationally and from the passenger's perspective.

Recommendations:

Based on the analysis, here are the recommendations:

Economic Improvement: Since Pokhara Yatayat (System 1) has higher operational costs and generates less revenue compared to Begnastal Pokhara Yatayat (System 2), it is recommended to review and optimize the operational strategies of Pokhara Yatayat to improve its economic performance.

Operational Adjustments: Despite having better journey time, speed, and running time, Pokhara Yatayat has fewer passengers than Begnastal Pokhara Yatayat. It is suggested that the reasons behind the lower passenger count be investigated and that necessary adjustments be made to enhance the operational performance.

Passenger Satisfaction: Pokhara Yatayat has received better ratings from passengers in terms of safety, comfort, staff behavior, and friendliness. To improve passenger satisfaction, it is advised to maintain high standards and possibly implement similar practices in Begnastal Pokhara Yatayat.

In conclusion, each system has its strengths and areas for improvement. By learning from each other, both systems can enhance their performance and provide better service to the passengers.

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