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Efficiency and Effectiveness Measurement of Public Transportation of Kathmandu Valley using Data Envelopment Analysis

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Abstract
In most of the urban cities, traffic management has been a major problem. For proper management of traffic, number of vehicles should be minimized and mass transit system should be introduced. For that public transportation service must be made systematic and fully facilitated. Efficiency and Effectiveness measurement of operational performance of public transportation will help in improving the condition of public transportation system. Main objective of the study is to find the operational performance (efficiencies and effectiveness) of each bus in different routes of Tarkeshwor Yatayat and Sajha Yatayat. DEAP, a DOS based program developed by The Department of Econometrics, University of New England, Armidale, NSW 2351, Australia was used for calculation of technical. Due to data and resources constraints only two public transportation company viz; Tarkeshwor Yatayat and Sajha Yatayat were selected for the research purpose. In case of Sajha Yatayat, Lagankhel to Budhanilkantha route was found to have consistently high performance and in case of Tarkeshwor Yatayat, Goldhunga to RNAC has consistently high performance.

Keywords
Decision making units (DMU), Frontier, Vehicle Km per day (efficiency measure), Average passengers per day (Effectiveness measure), Variable Return Scale (VRS)

1. Introduction

1.1 Background

For social and economic growth of a country, transportation infrastructure plays a vital role. Due to the provision of door-to-door services, flexibility of operation, comparatively lower cost and reliability, road transportation is widely used rather than other modes of transportation. Being a developing country, all people are not able to afford the private vehicle. So, public vehicles have become an important mode of transportation to the general public in metropolitan and urban cities in Nepal. In addition to that, for management of traffic congestion it is important for public to rely on public transport rather than the private vehicles. AS per record of Piloting Sustainable Urban Transport Index (SUTI) in Kathmandu Valley, (2017) out of 10,42,856 vehicles registered in Bagmati Zone, 11784 are buses, 11,967 are mini bus and 20,778 micros which are public transportation vehicles. But there are 1,39,981 cars and 8,17,473 motorcycle registered for personal use. This shows that number of private vehicles are more than that of public vehicles.

Nepal Transport Service launched its longest bus route from Kathmandu to Amlekhganj in July 1959, and by September of the same year, it expanded its urban public transportation services to Patan. With a fleet of 11 buses serving over 10,000 daily passengers, the company thrived until financial difficulties forced it to close in 1966. Concurrently, the cooperative Sajha Yatayat began mass transit services in Nepal in 1961/62, covering Kathmandu Valley and inter-district routes. Despite providing effective public transport services for years, both Sajha Yatayat and trolley buses faced challenges after 1990, including poor management, political interference, and the entry of private operators. The privatization of public transport led to more operators but a decline in service quality due to syndicate systems and a lack of government oversight

In Nepal, public transportation is vital for urban mobility. However, many public bus operators in Kathmandu face management and facility challenges. To address these issues, it's crucial to optimize public transportation efficiently and effectively. Efficiency means reducing operational costs while meeting travel demand, including cost efficiency, labor, and vehicle utilization. Effectiveness involves providing affordable and accessible bus services. Assessing the efficiency of Decision-Making Units (DMU) in the public transportation system is essential, and Data Envelopment Analysis (DEA) is a valuable tool for this purpose. This research aims to measure the efficiency and effectiveness of selected public transportation in Kathmandu Valley, using Data Envelopment Analysis (DEA).

1.2 Objectives of Study

The objectives of the study can be listed as follows:

- Measure efficiency and effectiveness of public transportation using DEAP
- Find relationship of input and output variables and identify most influencing factors responsible for efficiency and effectiveness of public transportation.

2. Literature Review

For better management and quality of service, public vehicle company should increasingly be concerned about evaluating their efficiency and effectiveness. Efficiency is measured using key indicators such as ridership, service quality, and cost-effectiveness. Traditionally, methods like regression, stochastic frontier analysis (SFA), and Data Envelopment Analysis (DEA) were used for this purpose. Regression establishes relationships between variables, while SFA deals with data containing noise and inefficiencies. DEA, the chosen method here, assigns efficiency scores to Decision-Making Units (DMUs) to measure relative efficiency, primarily focusing on technical efficiency rather than functional relationships between variables.

Yong Lao and Lin Liu evaluated the performance of bus routes operated by Monterey-Salinas Transit (MST) using DEA and GIS considering both the operations and operational environment. GIS was used to create demographic profiles within the service corridor of each bus line and then DEA was used for operational efficiency and spatial effectiveness scores. [1]

Georgios Georgiadis, Ioannis Politis, and Panagiotis Papaioannou assessed Thessaloniki's public transport network, comparing efficiency and effectiveness. They found that efficiency outperformed effectiveness, with traffic conditions and population density being most influencing factor. To enhance bus line performance, they suggested using buses with fewer seats for greater efficiency. The research highlighted the need for customized models, aligned with strategic objectives, as there's no universal performance estimation model. It recommended using an output-oriented DEA approach to improve services and an input-oriented framework for resource allocation and adopting new techniques. [2]

Pragya Shrestha had evaluated the operational performance of Sajha Yatayat in terms of efficiency using DEAP. The author had used trips per day, running speed, diesel in liter etc. as input variables and amount collected and number of passengers as the output variables. The relation between the input variables and the output variables were also presented with graphical representation.. [3]

(Duwadi, 2019) in research "Passengers Satisfaction and Operational Performance Analysis of Public Transportation Service in Lamachour Chhorepatan Route of Pokhara " had investigated the passengers' satisfaction and operational performance of the Lamachour Chhorepatan route public transportation. The operational performance has been evaluated as productive efficiency using Excel based DEA Solver based on BCC output method. Travel time, waiting time, running speed, stops, average passengers were considered as the variables. The result showed only number of efficient DMUs and inefficient DMUs but don't show the percentage of inefficiency and relative efficiency. [4]

(Bhattarai, February, 2017), in a "Study on Efficiency and Satisfaction level of Public Transportation within Kathmandu Inner Ring Road" study had evaluated the efficiency and satisfaction level of public transportation. The variables average travel time, waiting time, running speed, and average passenger patronage in the study area were accessed by using the moving observer method. Later, these parameters were used for analysis of public transportation efficiency using the Excel-based DEA and DOS-based DEAP model. Satisfaction level of the various modes of public transportation has been assessed with questionnaire survey. SPSS had been used to check the statistical significance of questionnaire. In this study very limited number of input and output variables which has impact in effectiveness and efficiencies were considered. The important variables like number of trips, revenue, capital investments etc., were lacking which can affect the efficiencies. [5]

3. Methodology

3.1 Study area

There are lots of public transportation companies running public vehicles in various routes within Kathmandu Valley. But only Sajha Yatayat and Trakeshwor Yatayat were selected. Sajha Yatayat is running 67 diesel buses in 7 different routes with government and some public shares. Tarkeshwor Yatayat is a private company which has 15 buses registered but only 13 are operating in 5 different routes.

3.2 Data Collection

Secondary data were collected from the offices of respective service providers. Being a quite systematic service provider, Sajha Yatyat had all the required data but Tarkeshwor Yatyat had no system of collecting data on daily basis. So, one day data were collected for individual vehicles by moving observer method. The variables collected for study purpose are shown in (Table 1)

Table 1: Data collected for analysis

Input Variables	Output Variables
Average travel time per round trip (hours), Average number of operators per day, Other employee involved per day, Average number of buses per day, Energy Consumption (Cost), Capital investment	Vehicle Km per day, Average passengers per day, Revenue

All the required data were collected from daily income sheets and daily registration sheet of the organizations which are shown in table 4 and table 5. To define input variable (other manpower involved), all other manpower involving in organization including conductor were summed up and divided by number of vehicles to distribute their contribution equally among each vehicles. Capital investment cost is taken as daily depreciation value of the vehicle. 20 percent of depreciation rate is used as per income tax act, 2058. Average number of operator represents the driver operating vehicle for whole day. Sajha Yatayat has altogether 72 (67 diesel and 5 electric) buses running through the following routes (Table 2) inside the Kathmandu valley.

Tarkeshwor Yatayat has altogether 15 buses registered but only 13 were running at the time of data collection through the following routes (Table 3) inside Kathmandu valley. The

Table 2: Routes of Sajha Yatayat

SN	Route	No of buses
1	Airport to Thankot	12
2	Lagankhel to Budanilkantha	15
3	Lagankhel to New Buspark	13
4	Lamatar to Ratnapark	5
5	Lele to Ratnapark	6
6	Nagdhunga to Narayanthan	16
7	Patandhoka to Dhanchindhoka	5

vehicles start to operate from Tarkeshwor Municipality; outside of ring road and later enter inside ring road

Table 3: Routes of Tarkeshwor Yatyat

Sn	Bus number	No. of buses
1	Sangla To RNAC	1
2	Kavresthali to RNAC	8
3	Paiyutar to RNAC	2
4	Goldhunga to RNAC	2

The table 4 and 5 show summarized data acquired for comparison of each routes which are enlisted below:

3.3 DEA Model

For measurement of efficiency and effectiveness of public vehicles, Data Envelopment Analysis (DEA) method was used. DEA is a linear program used which finds relative efficiencies of different peer units called as decision making units (DMUs). DEA gives an empirical piece-wise linear relation between inputs and outputs and calculate relative efficiency. The relative efficiency is calculated by comparing the program estimated production results and real time production results.

DEA models can be distinguished as input-oriented and output-oriented model. In this research, we focus on maximizing the attraction of passengers towards towards public vehicles. So, output-oriented Banker Charnes and Cooper (BCC) model was used. BCC is a variable return scale (VRS) model an upgraded version of constant rate of scale (CRS) [6]. In CRS model, if input and output variables get altered by same scale factor then efficiency will not change but in VRS model[6], efficiency will change by alteration. Also BCC model gives pure relative efficiency and effectiveness of compared variables.

BCC model can be expressed as follows:

$$Maxu,v.\,\theta_k = \frac{\sum_{m=1}^{M} u_m y_{mk}}{\sum_{n=1}^{N} v_n x_{nk}} \quad \text{(eq-1)}$$

Subject to

$$\frac{\sum_{m=1}^{M} u_m y_{mj}}{\sum_{n=1}^{N} v_n x_{nj}} \leq \forall j \quad \text{(eq-2)}$$

$$\sum_{n=1}^{N} V_n X_{nk} = 1 \quad \text{(eq-3)}$$

$$u_m, V_n, y_{mj}, X_{nj} > 0 \quad \forall m,n,j \quad \text{(eq-4)}$$

where, j refers to (DMU), j=1,...,J n refers to input, n=1,...,N m refers to output, m=1,...,M xnj is nth input for the jth DMU ymj ise mth output for the jth DMU um,vn are Non-negative constraints for mth output and nth input θ:Efficiency/Effectiveness ratio of DMUs

BCC model (Eq. 2) maximizes the ratio of weighted outputs to weighted inputs. The weights u_m and v_n are the decision variables. u_m and v_n are altered till u_m and v_n becomes maximum for the targeted DMU [6], keeping weights of remaining DMUs constant. The value of, θ, in (1) is referred to as the efficiency/effectiveness score, where $0 \leq \theta \leq 1$. value of θ is 1 refers to efficient DMU. The weights calculated are the decision variables where as values of collected inputs and outputs are real-time values. Equation 3 shows that DEA model is Variable Returns to Scale (VRS). Constraints (Eq. 4) ensures non-negativity of calculated weights.

DEA can be performed by various programs like DEAP, Malmquist DEA, Excel based DEA solver, etc. Data Envelopment Analysis Program (DEAP) is a DOS based computer program used for efficiency and effectiveness measurement which follows DEA, used for the estimate of efficiency and effectiveness measures. The software provides a user-friendly interface for inputting data and generating DEA results

3.4 Regression

In order to find the most important variables responsible for efficiency and effectiveness, partial least regression (PLS) was performed using PYTHON programming language based on the collected data. PLS result showed level of multicollinearity between different variables. Positive multicollinearity shows that if one variables increases so does other variables. Also, importance factor for each variables was calculated based on observed data. The importance factor shows level of influence of input variables over output variables . Linear regression was performed which gives us an equation model between dependent (output) variable and independent(input) variables. The equation model gives the relation to find how the output can be maximized and efficiency and effectiveness can be increased.

4. Results and Discussions

The efficiency and effectiveness score of each vehicle in each route of Sajha Yatayat are tabulated in tables 6 to table 13

Table 6 shows that bus number 8767-7 and 8769-7 are operating more efficiently and the bus 8770-7 is effectively running.

Table 7 shows that bus number 5659-4, 5661-4 and 5663-4 are operating efficiently and the bus 5661-4 and 5663-4 are effectively running.

Since there were only two vehicles used for comparison in Lamatar to Ratnapark route (table 8) , 8752-7 was efficient and effective.

AS per the result obtained in Lagankhel to New Buspark route (table 9) shows almost all vehicles have similar efficiency except vehicle 5653-4. Vehicle 5648-4 is both efficient and

Table 4: Summarized daily data of Sajha Yatayat

Sn	Bus routes	Vehicle km per day	Average number of passengers per day	Revenue	Average travel time (Hr)	Average number of operators	Other employees	Average number of buses per day	Energy consumption	Capital investment
1	Airport to thankot	1,087.71	2,360	50,964.79	74.63	7.00	9.30	7.00	39,754.84	15,342.47
2	Lagankhel to Budhanilkantha	1,856.63	6,463	136,753	133.76	13.00	17.27	13.00	83,847.09	28,493.15
3	Lagankhel to New Buspark	1,514.71	5,398	111,326	125.73	12.00	15.94	12.00	74,971.63	26,301.37
4	Lamatar to Ratnapark	260.27	859.00	14,399	25.90	2.00	2.66	2.00	10,333.39	4,383.56
5	Nagdhunga to Budhanilkantha	2,079.80	5,761.00	125,051.92	144.18	14.00	18.60	14.00	88,806.63	35,068.49
6	Ratnapark to Godawari	1,177.92	3,543	73,330	77.45	7.00	9.30	7.00	44,094.35	15,342.47

Table 5: Summarized daily data of Tarkeshwor Yatayat

Sn	Bus number	Vehicle km per day	Average number of passengers per day	Revenue	Average travel time (Hr)	Average number of operators	Other employees	Average number of buses per day	Energy consumption	Capital investment
1	Sangla To RNAC	135.53	469.00	10,430.00	8.50	1.00	1.40	1	5,130.00	5,260.27
2	Kavresthali to RNAC	978.89	3,588.00	79,790.00	69.87	8.00	11.20	8.00	38,095.00	42,082.08
3	Paiyutar to RNAC	216.60	1,341.00	28,240.00	25.17	2.00	2.80	2.00	8,705.00	10,520.55
4	Goldhunga to RNAC	212.40	824.00	18,080.00	10.00	2.00	2.80	2.00	8,150.00	10,520.55

Table 6: Effectiveness and Efficiency of Airport to Thankot route

Sn	Bus number	Efficiency score	Effectiveness score
1	8765-7	0.99	0.874
2	8766-7	0.92	0.804
3	8767-7	1.00	0.997
4	8768-7	0.98	0.965
5	8769-7	1.00	0.766
6	8770-7	1.00	1
7	8771-7	1.00	0.542

effective and vehicle 5664-4 has least effectiveness.

When comparison was made for 10 vehicles in Nagdhunga to Budhanilkantha route (table 10) 5643-4 has the lowest efficiency and 8762-7 has least effectiveness score as shown in table 4.6. Vehicle 8763-7 is found to be both efficient and effective.

Comparison along Ratnapark to Godawari route (table 11) shows that bus 5643-4 has the lowest efficiency and effectiveness score.

When efficiency and effectiveness of different vehicles were measured using weekly data, then relative efficiency and

Table 7: Effectiveness and Efficiency of Lagankhel to Budhanilkantha route

Sn	Bus number	Efficiency score	Effectiveness score
1	3622-5	0.938	0.886
2	5654-4	0.99	0.961
3	5655-4	0.993	0.816
4	5656-4	0.987	0.95
5	5657-4	0.963	0.977
6	5658-4	0.912	0.93
7	5659-4	1.00	0.975
8	5660-4	0.913	0.809
9	5661-4	1.00	1
10	5662-4	0.938	0.884
11	5663-4	0.934	1
12	5665-4	0.939	0.95
13	5667-4	0.911	0.829

Table 8: Effectiveness and Efficiency of Lamatar to Ratnapark route

Sn	Bus number	Efficiency score	Effectiveness score
1	8752-7	1	1
2	8753-7	0.98	0.872

effectiveness were found to be almost similar. There were only few vehicles having efficiency and effectiveness below 0.6 and

Table 9: Effectiveness and Efficiency of Lagankhel to New Buspark route

Sn	Bus number	Efficiency score	Effectiveness score
1	5642-4	0.99	0.916
2	5645-4	0.98	0.926
3	5646-4	0.988	0.745
4	5647-4	0.983	0.898
5	5648-4	1.00	1.00
6	5649-4	1.00	0.942
7	5650-4	1.00	0.942
8	5651-4	1.00	0.855
9	5652-4	1.00	0.908
10	5653-4	0.896	0.863
11	5664-4	0.938	0.831
12	5666-4	1.00	0.964

Table 10: Effectiveness and Efficiency of Nagdhunga to Budhanilkantha route

Sn	Bus number	Efficiency score	Effectiveness score
1	2217-3	0.992	0.881
2	2218-3	1.00	0.892
3	2219-3	0.994	0.944
4	2220-3	0.973	0.755
5	2221-3	0.889	0.845
6	2223-3	1.00	1.00
7	2224-3	0.896	0.75
8	2227-3	1.00	1
9	2227-3	1.00	0.777
10	2228-3	0.98	0.797
11	5638-4	0.98	0.691
12	5639-4	0.921	0.704
13	5640-4	1.00	0.514
14	5641-4	1.00	0.801

Table 11: Effectiveness and Efficiency of Ratnapark to Godawari route

Sn	Bus number	Efficiency score	Effectiveness score
1	5643-4	0.886	0.815
2	5644-4	0.989	0.933
3	8760-7	1.00	0.952
4	8761-7	0.99	0.956
5	8762-7	0.945	0.686
6	8763-7	1.00	1
7	8764-7	1.00	0.907

Table 12: Effectiveness and Efficiency of all routes of Sajha Yatayat

Sn	Bus route	Efficiency	Effectiveness
1	Airport to Thankot	1.00	0.693
2	Lagankhel to Budhanilkantha	1.00	1
3	Lagankhel to New Buspark	0.920	0.906
4	Lamatar to Ratnapark	0.86	0.91
5	Nagdhunga to Budhanilkantha	0.91	0.891
6	Ratnapark to Godawari	1.00	1.00

almost all vehicles were found to be efficient and effective.

Efficiency and effectiveness score of individual buses of Tarkeshwor Yatyat obtained from DEAP are as shown in table 13 to 16 , since route Sangla to RNAC had single bus running in that route efficiency and effectiveness were not calculated. Efficiency and effectiveness measurement of different routes are presented in table 21 to 24

Table 13: Effectiveness and Efficiency Goldhunga to RNAC route

Sn	Bus number	Efficiency score	Effectiveness score
1	7894	1.00	0.768
2	8284	1.00	1

The result of efficiency and effectiveness comparision of Goldhunga to RNAC route is as shown in table 13 which shows that vehicle number 8284 has greater efficiency than 7894 but efficiency is same for both.

Table 14: Effectiveness and Efficiency of Payiutar to RNAC route

Sn	Bus number	Efficiency score	Effectiveness score
1	7415	1.00	0.949
2	8290	1.00	1

Table 14, (Payiutar to RNAC route), shows vehicle 8290 has greater efficiency and effectiveness than 7415

Table 15: Effectiveness and Efficiency of Kavresthali to RNAC route

Sn	Bus number	Efficiency score	Effectiveness score
1	8289	1.00	1.00
2	8236	0.95	0.741
3	8285	0.905	0.992
4	8286	1.00	1
5	8238	0.99	0.989
6	8287	1.00	0.922
7	8288	1.00	0.78
8	7414	0.97	0.869

Table 15 shows effectiveness and efficiency of Kavresthali to RNAC route. It was found that efficiency is almost same for all vehicles but only 8286 and 8289 has both effectiveness score and efficiency score as 1 and vehicle 8236 has least effectiveness.

Table 16: Effectiveness and Efficiency of all routes of Tarkeshwor Yatayat

Sn	Bus routes	Efficiency score	Effectiveness score
1	Sangla To RNAC	0.91	1.00
2	Kavresthali to RNAC	0.89	0.95
3	Paiyutar to RNAC	1.00	1.00
4	Goldhunga to RNAC	0.97	0.89

When 4 routes of Tarkeshwor yatayat (table 16) were compared, Paiyutar to RNAC route is found to efficient and effective than other. Kavresthali to RNAC route has least efficiency score.

The result of multicollinearity obtained from partial least square regression (PLS) found out that there is positive relation between variables revenue and average number of passengers per day and they change with the same scale. So only one of these variables can be used for preparation of linear regression model. In addition to that, average number

	Vehicle _km	Average_ number_of passengers per day	Revenue	Average_travel_time	Average_number_of_operators	Other_employees	Average_number_of_buses_per_day	Energy_consumption	Capital_investment
Vehicle _km	1.000000	-0.000605	0.099431	0.243920	NaN	-0.109488	NaN	0.173366	-0.105359
Average_ number_of passengers per day	-0.000605	1.000000	0.932246	0.225148	NaN	0.257293	NaN	0.276923	0.229806
Revenue	0.099431	0.932246	1.000000	0.177668	NaN	0.337572	NaN	0.295213	0.319296
Average_travel_time	0.243920	0.225148	0.177668	1.000000	NaN	-0.462591	NaN	0.252288	-0.484774
Average_number_of_operators	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Other_employees	-0.109488	0.257293	0.337572	-0.462591	NaN	1.000000	NaN	-0.393942	0.991318
Average_number_of_buses_per_day	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Energy_consumption	0.173366	0.276923	0.295213	0.252288	NaN	-0.393942	NaN	1.000000	-0.421008
Capital_investment	-0.105359	0.229806	0.319296	-0.484774	NaN	0.991318	NaN	-0.421008	1.000000

Figure 1: Multicollinearity of different variables by PLS

of operators and average number of buses per day have no collinear relation with other variables as shown in Figure 1.

The importance factor of different input variables were calculated and linear regression was used for calibration of model using dependent and independent variables with high importance factor. The equation thus formed is shown in equation 5 and 6

$$\begin{aligned}\text{Revenue} = {} & 164.608 \times \text{Average Travel Time (ATT)} \\ & + 8685.94 \times \text{Other Employees} \\ & + 0.591 \times \text{Energy Consumption} \\ & + 0.910 \times \text{Capital Investment } -10362.84\end{aligned} \quad \text{(eq-5)}$$

$$\begin{aligned}\text{Vehicle km} = {} & 2.173 \times \text{Average Travel Time (ATT)} \\ & + 0.004 \times \text{Energy Consumption} \\ & + 0.002 \times \text{Capital Investment} + 71.485\end{aligned} \quad \text{(eq-6)}$$

The equation model was then validated with actual data. The percentage error between the calculated value and observed value were below **15%**. Hence the model is acceptable.

4.1 Discussion

From the above results, it was found out that Lagankhel to Budhanilkantha route exhibit consistently high performance in terms of both efficiency and effectiveness, indicating well-managed and effective service delivery. This can draw a conclusion that there are highest number of consumers. All the vehicles are providing better revenue as compared to others. However, other routes, like Airport to Thankot, shows variations in performance among different buses, suggesting opportunities for improvement in resource utilization and service quality. Tarkeshwor Yatyat is running few buses running for different routes. But Kavresthali to RNAC route has altogether 8 buses. Despite having almost similar efficiency score, effectiveness score are different. The reason behind that is, number of vendors varies within hours and bus getting maximum vendors will have highest effectiveness. The result of Sajha yatayat showed that the vehicles with longer span route have almost all vehicles running efficiently than the shorter span routes. In case of Tarkeshwor Yatayat, routes were of shorter span so all vehicles are not operating at the same time. Once the trip is completed, they have to wait for 1 to 2 hours in queue. So, generally each bus is meant to complete 5 to 6 trips. So, they are found to have similar efficiency.

5. Conclusion

In this research study, operational performance of Sajha Yatayat and Tarkeshwor Yatyat have been measured. Based on the analysis of efficiency and effectiveness scores, it can be concluded that the performance of buses on different routes varies significantly. Overall findings from this analysis provide valuable insights into public transportation system's performance, which can be used by transportation authorities and service providers to make data-driven decisions aimed at improving the efficiency and effectiveness of services they offer.

For increasing efficiency and effectiveness, revenue, average travel time and average number of passengers must be increased keeping the inputs constant. Efficiency and effectiveness score is high when the consumers are higher which may raise question to the costumer's satisfaction which is not considered in this study.

Here, operational performance between individual vehicles and individual routes were done. Further, it can be extended to make comparison between different public vehicle companies so that business module of highly efficient and effective vehicle can be implemented for all. The research can be a module for increasing quality and quantity of public vehicles which will be helpful for attracting people to public vehicles rather than private vehicles.

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