Network Expansions in Kerala State Rtc

P. Parthiban[1], Vincy Verghese[2*]

[1] *PG Scholar Transportation Engineering&Department of Civil Engineering&APJAbdul Kalam technological University, Jyothi Engineering College, Cheruthuruthy,Thrissur, Kerala, India*
[2] *Assistant Professor &Department of Civil Engineering&APJAbdul Kalam technological University Jyothi Engineering College, Cheruthuruthy,Thrissur, Kerala, India*

*Corresponding author E-Mail ID: vincyverghese@jecc.ac.in,

Doi: https://doi.org/10.34256/irjmtcon40

ABSTRACT

The cornerstone of any great public transport organization is its expanding network of operations catering the passengers' demand of all classes of people. Kerala State Road Transport Corporation is in the process of bringing inefficiency within the area of operations in the state and the expansion of its networks is an integral part of achieving it. The network expansion occurs with the introduction of new routes that can coordinate with the existing ones, thereby meeting the passenger demand of the state. The project attempts to recognize the new routes, feasible for the operations of Kerala State Road Transport Corporation. The project extension will be based on the current operational routes of Kerala State Road Transport Corporation and the distinguished potential routes. The project will consist of distinguishing the high-density private routes thereby analysing the nature of commuting in respect of age group, time and purpose of travel. The existing operational concerns will be addressed thereby identifying the routes of operation. Based on the demand assessment, bus operations and the conceivable revenue generations will be articulated.

Keywords: Kerala State Road Transport Corporation, Passenger demand and Routes.

1. INTRODUCTION

Transportation is the movement of humans and goods from one location to another location. It is important because it enables trade between people, which is essential for the development of civilizations. In the 21st century there is huge importance given to management, logistics and networking and this is mainly done so that the overall efficiency of each sector gets improved. If the logistics and networking is working to its maximum efficiency, then the transportation cost and other overheads will get minimized and thus, a more fast and swift world is made. Empowering ideal utilization of existing and proposed Public Transport will be a successful method for accomplishing the ideal modular offer between various modes. Among all the public transportation frameworks, transports are the most mainstream and most normally utilized ones as a result of their inborn adaptability, versatility to changing employment and residential patterns, and low capital expenses. Except for higher income group people, all others prefer bus transportation for the mode of transport. Accordingly, numerous specialists concentrated on improving transport transportation frameworks by diminishing the expense of activities, limiting holding up times, improving the quality of service, etc.

PUBLIC TRANSPORTATION IN KERALA

Passenger Bus Transport nationalization process is only partial in Kerala. The share of KSRTC fleet in the State's total stage carriages is only about one-third as mentioned. But Kerala State Road Transport Corporationhas dominance in the districts of Trivandrum, Quilon, Alleppy, Wayanad and Kottayam. In the Districts of Palghat, Kozhikode, Malappuram, Cannanore (Kannur) and Kasargode, private bus operators are dominant. However, in the long distance routes, i.e., route lengths of about 150 KM and more Kerala State Road Transport Corporation has a fair monopoly in the State, with their Fast Passenger and Express Services, which have a higher fare structure than the Ordinary services.

Because of poor financial performance and the general dissatisfaction at the quality of the services of Kerala State Road Transport Corporation, the extension of nationalization to more routes in the States in the near future appears to be difficult. Generally the public also do not view this proposition favorably, presumably because of the lower quality of service rendered by the Kerala State Road Transport Corporation compared to others.

OBJECTIVE

Efficient transportation and transportation scheduling is a huge challenge due to the various constraints of passenger demand, time, distanceandcost. There for e it is very important to find out ways of optimizing and possible to suggesting a more suitable route which is optimized in both cost and catering the passenger demand of all class of people. So project will befocussingonthebusnetwork of the Kerala State Road Transport Corporation by adding a new link/path to the existing route that would be profitable.

Identifying the high-density private bus routes operation thereby analysing the nature of commuting in respect of age group, time and purpose of travel. The existing operational of Kerala State Road Transport Corporation concerns will be addressed thereby identifying the routes of operation. Based on the demand assessment, bus operations and the possible revenue generations will be articulated by introducing of new routes.

NEED OF THE STUDY

- To bring in efficiency within the area of operations in the state and the expansion of its bus networks.

- As per the passenger demand on private bus operational route comparing with the KSRTC routes.

- To increase the revenue generation with the introduction of new routes.

- KSRTC bus services offered are Fast Passengers, Super-Fast, Super Deluxe, Town to Town, Ordinary buses, etc.,

- KSRTC are operating more number of buses to connecting different district, taluk and villages.

- Due to constraint of the time and in nature of multiple variables, parameters and different routes available, Thrissur depot is taken, in that nearly 78 buses are operating with different routes.

Sometimes, non-availability of adequate secondary data, pertaining to the research topic leads to limitations.

The operational route is from Thrissur to Palakkad, Town to Town services.The collection abstract for 3 months database from January to March 2019.

Duty numbers 23, 24, 25, 26, 27 and 54 are these services and runs daily in the route.

And they by analysing the Private routes of operational route considering the nature of commuting in respect of age group, time and purpose of travel.

LITERATURE REVIEW

The public transportation operation planning process includes four basic components performed usually in sequence. These are network design, route evaluation, vehicle scheduling and timetable preparation has been described. Usually each of these phases is treated as a separate problem in itself and the output of one component is the input for the next component.

A. Network Design and Route Evaluation:

Olivia Sainz (2010), developed a bi-level optimization model for locating bus stops to minimize the social cost of the overall transport system. The work takes into account possible changes in demand due to different bus stop locations considering congestion on buses, interaction with private traffic, operational variables (fleet, frequency, operator budgets) and the socio-demographic characteristics of each zone in the urban area. Finally, the technique is applied to a real case and a sensitivity analysis is performed to check how the different variables analysed influence the solution provided by the model.

B. Vehicle Scheduling:

Yuanqing Wang(2008), studied the headway optimization and scheduling combination of BRT vehiclesin order to improve BRT operation quality, The result of the numerical case shows that: the optimization results can save 69.92% cost. The sensitivity analysis shows that, under higher traffic volume or lower speed, the travel cost can be reduced through reasonable scheduling combination. The method has been proved scientifically and is feasible.

C. Timetable Preparation:

Ching-Hui Tang (2008), developed a demand scheduling model for setting a timetable incorporating the stochastic disturbance of daily passenger demand that occurs in actual operations. There are five types of arcs: service arcs, alternative service arcs, alternative travel-time service arcs, holding arcs, and cycle arcs. A service arc, or an alternative service arc, or an alternative travel-time service arc represents a planned bus trip. To bridge each planned bus trip and its real-time adjustment results for all m travel-time scenarios, we add the multiplier u to each service, alternative service, and alternative travel-time service arc, for each scenario.

D. Framework of Transit Planning:

Ceder and Wilson (1986), described the bus network design problem, summarized the different approaches that had been proposed for its solution and proposed a new approach incorporating some of the positive aspects of prior work. The proposed approach is intended to be easier to implement and less demanding in terms of both data requirements and analytical sophistication than previous methods.

E. Optimization in a Transit Network:

Bookbinder and Desilets (1992), proposed transfer optimization in a transit network to minimize the overall inconvenience to passengers. Bus trips are scheduled to depart from their terminal so as to minimize some objective function measuring their inconvenience. A mean disutility function is defined here which is used to evaluate the inconvenience under random bus

travel times of a transfer connection. This disutility function g (w) is some function of waiting time, which gives the desirability of a waiting time w, as perceived by the user.

ROUTE MARKING USING ARC GIS

Arc-GIS Network Analyst is a powerful extension that offers network-based analysis, including routing, travel directions, nearest facilities and service area analysis. ArcGIS Network Analyst allows users to dynamically model realistic network conditions, including turn restrictions, speed limits, height restrictions and traffic conditions at different times of the day. Users with the Network Analyst extension can. With the help of the Arc-GIS we can find out the following things.

- Find efficient travelroutes

- Determine which facility or vehicle isclosest.

- Generate traveldirections.

- Find a service area around asite

A. Study Area:

The study area selected is the Thrissur Kerala State RTC depot in the central zone and Palakkad Kerala State RTC depot in the central zone. Thrissur Bus Station is situated in Veliyannur in the heart of the Thrissur City, India. Palakkad Kerala State RTC Melamuri Pudur Kottayi Rd, Pudupalli Theruvu, Nurani, Palakkad. The bus station is very near to the Thrissur Railway Station. The bus station runs long distance, inter-state and city services. It is a particularly important station because of its strategic location on the major NH 544. It is also the centre most station is the state thus having easiest access in the state to all the major cities in Kerala and South India. There is an online reservation counter at Thrissur bus station.

Thrissur KSRTC bus station is of very importance in the sense that it is the centre between the south and north zones. But unfortunately, the depot is having very poor infrastructure and inadequate space for allocating the large number of buses passing through the station. The two routes from Thrissur to Palakkad is shown in fig 1.

Route 1 : Thrissur to Palakkad via Alathur

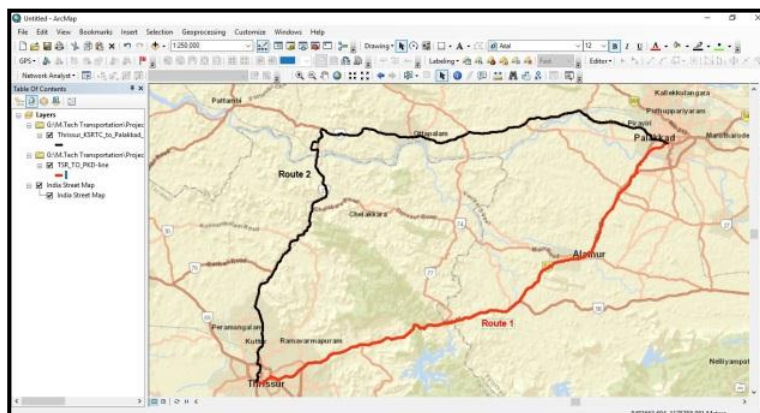Route 2 : Thrissur to Palakkad via Ottapalam

Fig1: Thrissur KSRTC Depot to Palakkad KSRTC Depot

The Fig.1 demonstrates that the bus route of Thrissur to Palakkad, red shading line demonstrating that route 1 via Alathur and black shading line demonstrating route 2 via Ottapalam.

B. Location Identification:

This technique is used to find a location for a new retail outlet. It helps to find out what exists at a particular location as shown in fig. 2. A location can be described inmanyways, using, for instance, name of place, postcode, or geographic reference such as longitude or latitude orX/Y.
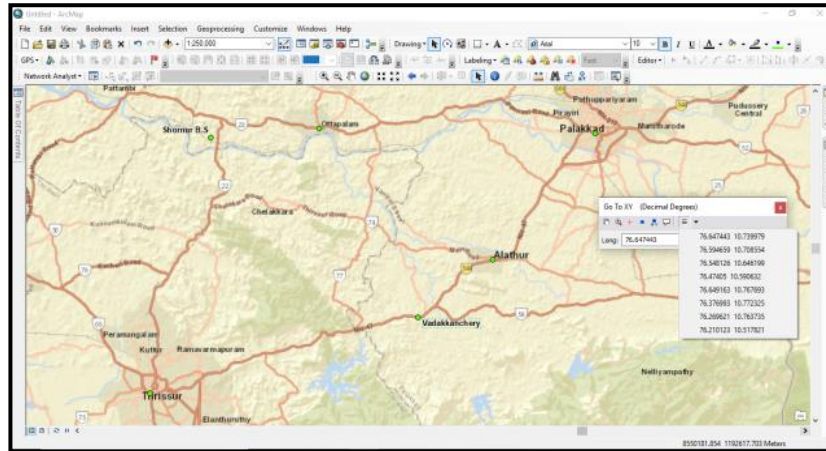

Fig 2: Identifying Locations using coordinates

The fig. 2 shows that ARC GIS softwareadding the coordinates of as longitude or latitude, to find out the bus stop it's a location identifying methodology.

DATA COLLECTION

People travel from an origin to a destination, and may take one or more public or private transport services to get there; some walking and waiting will be required to complete the journey due to non-frequency of fleet operation.

The Origin and Destination is selected as Thrissur to Palakkad. It is a major route in the state connecting two major district headquarters of Thrissur and Palakkad.

This Origin and Destination has two route forms a major portion of the NH 544 Salem - Kochi Highway and inner state highway of SH 22 and SH 23.

KSRTC has Town to Town (TT) buses exclusively operating between these two destinations.

- Private bus route from Thrissur to Palakkad via Shornur – Ottapalam
- Kerala State RTC from Thrissur to Palakkad via Vadakkenchery – Alathur

A. Private Bus Route:

The existing routes cater to the present passenger travel demand in general; an OD matrix for existing bus routes was prepared for Thrissur to Palakkad via Shornur – Ottapalam considering state, private bus routes. Each cell in Table 1 represents the number of bus routes and their origin and destination zones. The passenger OD flows are usually estimated by on-board surveys in the transit industry. However, using on-board surveys to estimate OD flows is time consuming and labor intensive, and can suffer from response bias. The number of passenger and their origin and destination stops.

Table 1:OD Matrix of Private Bus Passenger

OD	1	2	3	4	5	6	7	8	9	10
1	0		3	1	3					2
2	1	0		1		2				3
3	2	2	0				2			3
4	1	2		0	6	2	2	3	2	1
5		1			0			2		3
6	1		1			0	2	1	1	2
7	2				1		0	4		4
8				3			12	0	3	3
9			2				1	4	0	5
10				2	2		2	0	1	0

B. Kerala State RTC Bus Route:

The collection details of the three months are tabulated in MS Excel for evaluation of various parameters. And the lowest passenger trip of the schedule number

Table 2. Collection details of January 2019

JANUARY 2019					
Bus No.	Avg. pass / day	Average passenger per trip	EPKM	EPB	Avg. coll. / trip
23	519	65	33.81	18596	2324
24	566	71	33.88	18549	2329
25	595	74	36.92	20080	2533
26	489	61	33.84	18379	2318
27	601	75	36.36	19819	2500

Table 2 shows the average passenger per day and earning per kilometer of each schedule bus with that average collection per trip in the month of January 2019

Table 3. Collection details of February 2019

FEBRUARY 2019					
Bus No.	Avg. pass / day	Average passenger per trip	EPKM	EPB	Avg. coll. / trip
23	479	60	29.19	15769	2007
24	544	68	34.59	18683	2378
25	529	66	33.44	18390	2299
26	511	64	32.63	17946	2243
27	493	62	31.92	17242	2194

Table 3 shows the average passenger per day and earning per kilometer of each schedule bus with that average collection per trip in the month of February 2019

Table4. Collection details of March 2019

MARCH 2019					
Bus No.	Avg. pass / day	Average passenger per trip	EPKM	EPB	Avg. coll. / trip

23	463	58	28.29	15059	1945
24	499	62	32.07	16994	2195
25	491	61	32.94	17192	2230
26	493	62	32.43	17188	2220
27	496	62	33.48	17738	2291

Table 4 shows the average passenger per day and earning per kilometer of each schedule bus with that average collection per trip in the month of March 2019

COMPARISON OF DATA ANALYSIS

The feasibility for implementing new route was checked using road inventory data in terms of right of way (existing and future), number of major junctions and delay, existing volume by capacity (V/C) ratio, etc. The priority of developing these new routes was determined considering ridership, feasibility criteria and presence of similar or alternative transit services like private bus; and scores were assigned for individual aspects considering equal weight for each aspect.

A. Identification of High Travel Demand Routes:

The bus routes along these routes and links were found out using passenger demand at the bus stops by O-D matrix and ETM. Routes with higher number of passenger demand or higher concentration of bus routes were selected for further analysis. However, within a particular route, different links have varying number of bus-routes as most of the bus routes in Thrissur to Palakkad are very much circuitous in nature. Therefore, bus routes which cover more, the entire journey route and connect the respective travel demand zones are considered and shown in Table 5.

Table 5 Comparison between both the routes of EPB

Private Bus Route : Thrissur to Palakkad via Shornur – Ottapalam			KSRTC Route : Thrissur to Palakkad via Vadakkenchery - Alathur		
Sample Number	Average Passengers per Trip	EPB Average per Trip / day Coll.	Bus Number	Average Passengers / Day	EPB Avg. / Trip / day Coll.
1	210	3360	23	61	2230
2	198	3168	24	67	2259
3	227	3632	25	67	2319
4	206	3296	26	62	2059
5	212	3637	27	66	2283
6	182	2912	54	62	2081

The table 5 shows that average passenger per trip vs earning per bus of both KSRTC and private buses in the both routes of Thrissur to Palakkad and by the result the lowest passenger trip of the schedule number are consider for rescheduling to another of private bus route.

SCHEDULING SYSTEM PLANNING PROCESS

In general terms, the public transportation operational process includes the following four basic components performed in sequence.

- Network route design
- Vehicle scheduling

- Setting frequencies and building timetables

A. Network Route Design:

Route Network Design (RND) is the single most important planning step in the urban bus transit planning process. This is because the route structure designed will invariably affect both frequency setting and bus and crew scheduling.
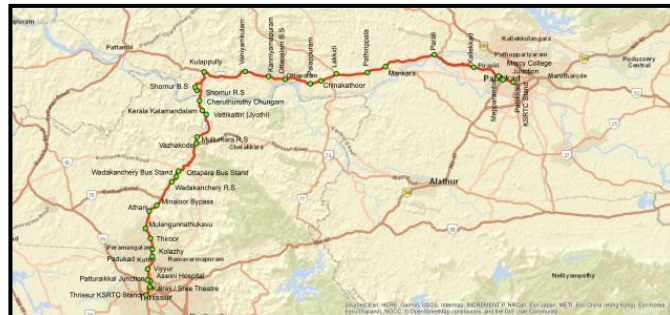

Fig 3: Route design and stop layout of Thrissur to Palakkad via Shornur, Ottapalam

The important components of RND are identified as estimating demand, identification of objective function, constraints, passenger behaviour, and solution technique and computation time. The Route design and stop layout of Thrissur to Palakkad via Shornur, Ottapalam is as shown in fig 3.

B. Vehicle Scheduling:

Scheduling is one of the most important steps in urban transit planning process. Vehicle scheduling or blocking is sequencing series of bus trips into blocks or schedules that can be run by the buses. Each of the blocks is identified by a pull-out or pull-in time. The length of the blocks is restricted by the number of buses, fuel capacity and other operational constraints set forth by the agency.

Bus travel time is an important source of data for time of day partition of the bus route.

$$Total\ Travel\ Time = \frac{Trip\ Length}{Speed\ of\ the\ Vehicle} + (Total\ no.of\ stops\ \times\ Stopping\ delay)$$

Total Travel Time = 180 minutes via Shornur - Ottapalam

Total Travel Time = 120 minutes via Vadakkenchery – Alathur

Table 6: Vehicle scheduling of Thrissur to Palakkad

Trip No. Ti	Origin	Via	Destination	Time K
(1) 05:40:00 AM	TCR	SRR - OTP	PKD	08:40:00 AM 84
(2) 09:00:00 AM	PKD	OTP - SRR	TCR	12:00:00 PM 84
(3) 12:20:00 PM	TCR	Vadakkenchery - Alathur	PKD	02:20:00 PM 68.7 kms
(4) 02:40:00 PM	PKD	Alathur - Vadakkenchery	TCR	04:40:00 PM 68.7 kms

| (5) | TCR | SRR - OTP | PKD | 08:00:00 PM |
| (6) | PKD | OTP - SRR | TCR | 11:20:00 PM |

* TCR-Thrissur, PKD-Palakkad, SRR-Shornur, OTP-Ottapala

Table 6 shows the vehicle scheduling of proposed route Thrissur to Palakkad in that having 6 trips for that total running distance is 462 kms of total travel time 180 minutes via Shornur – Ottapalam and for via Vadakkenchery – Alathur is 120 minutes.

C. Timetable Preparation:

The timetable component of the transit bus system shall be designed to meet the passenger demand associated with the public transportation network. This demand varies according to the time of day, from one season to another and even from one year to another. This demand reflects the business, industrial, cultural, educational, social and recreational transportation needs of the community. It is the purpose of this component to set appropriate timetables for each transit route to meet the variation in the public demand.

Timetable preparation can be done using Microsoft Project software is shown in fig. 4.
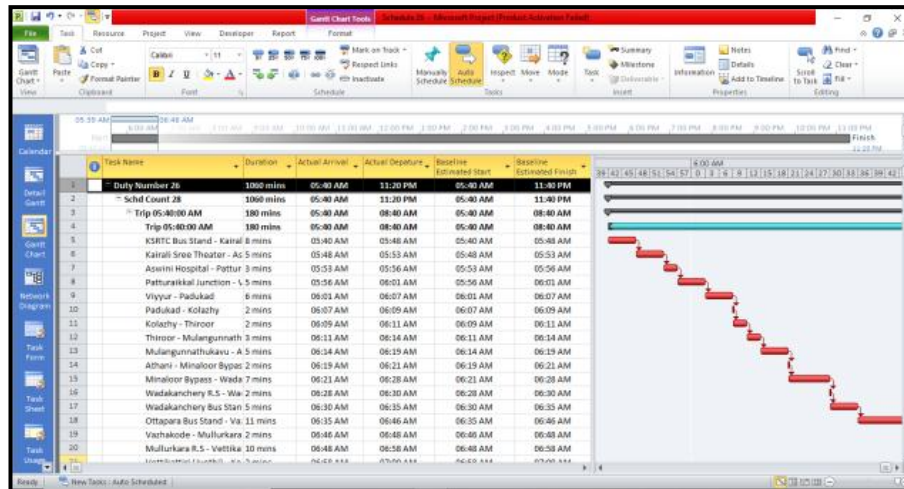

Fig 4. Timetable preparation using Microsoft Project software

Fig.4 shows the timetable and scheduling of each bus stops and trips in a newly proposed route of Thrissur to Palakkad using Microsoft Project software

CONCLUSIONS

In this section the study work that has been carried out the influence of private bus route, scheduling and time table of the proposed route is summarised and conclusions have been drawn. The network expansion of bus routes plays a vital role in the mobility of passengers from one place to another place.

A. General Findings:

The main objective for this study was to develop a network expansion of the routes balancing with the high density of the private route. The operational characteristic of single routes of Kerala state RTC of Thrissur to Palakkad via Vadakakanchery, Alathur and private route of same origin and destination via Shornur, Ottapalam were evaluated.

It was found that the concentration of passengers was mainly on via Shornur, Ottapalam stops which were main high density spots on the entire route in this route passenger are travelling a short distance and the variation of total cost with via Vadakakanchery and Alathur these routes with via Shornur, and Ottapalam was also high.

- The study conducted on the OD matrix and ETM from private and KSRTC bus respectively.

- The total collection EPB Average per Trip in a day of Rs. 2205 via Vadakakanchery, Alathur and Rs. 3334 via Shornur, Ottapalam and EPKM Rs.39.69 and Rs.32.10 respectively.

- Based on the result via Shornur, Ottapalam EPKM has **23.65 %** is increasing.

In the above findings it can be said that the majority of the passengers are travelling from Thrissur to Palakkad via Shornur and Ottapalam it a general observation. Therefore the new proposed route for KSRTC buses via Shornur, Ottapalam is modelled with the latest data it has been proposed to expansion of Kerala state RTC network and will generate profitable revenue collection. The workload of the driver and conductor is found to be, **6** trip of **17 hr 40 minutes - 462 kms** of running distance.

B. Future Study:

- The Study and Analysis of the problems in Network Expansion of bus routes, is an endless process. This study has been performed under uninterrupted free flow traffic condition; following are some scopes for further study are founded.

- To extending the present study may be the development of an information system, Bus Route Information System (BRIS).

- The use of Global Positioning System (GPS) along with GIS to monitor the movement of buses. This would help to identify the traffic congestions, break-downs bus stop waiting time and the like.

- The study can be extended to crew scheduling also.

- Locating the bus stop and its capacity of the passenger is dependent on the demand in the area utilizes.

- Considering the peak and non-peak hour passenger demand and the congestion of traffic will influence in fleet operation, Headway and frequency

- In this way, the study can be extended to there is need of developing headway model for the each bus stop and by also considering the some parameters like clearance time, traffic signals, road conditions and speed limit.

- However, a macro level studymay be taken up for further research.

REFERENCES

1. Lbeas, Á., dell'Olio, L., Alonso, B. and Sainz, O., "Optimizing   bus stop spacing in urban areas", Transportation Research Part E vol. 46, pp. 446–458, 2010.

2. Sun, C., Zhou, W. and Wang, Y., "Scheduling Combination and   Headway Optimization of Bus Rapid Transit", Journal of Transportation   Systems   Engineering   and   Information   Technology, vol. 8(5), pp. 61-67, 2008.

3. Yan, S. and Ching-Hui Tang, "An Integrated Framework For Intercity Bus Scheduling Under Stochastic Bus Travel Times", Transportation Science, vol. 42(3), pp. 318-335, 2008.

4. Barnum, D. T., Tandon, S. and Sue McNeil, S., "Comparing the performance of urban transit bus routes after adjusting for the environment, Using data envelopment analysis", Journal of Transportation Engineering, vol. 134(2), pp. 77-85, 2008.

5. Chakroborty, P. and Dwivedi, T. "Optimal Route Network Design for Transit Systems Using Genetic Algorithms", Engineering Optimization, vol. 34(1), pp. 83–100, 2002.

6. Tao Liua, and Cedera, A. "Integrated Public Transport Timetable Synchronization and Vehicle Scheduling with Demand Assignment: A Bi-objective Bi-level Model Using Deficit Function Approach ", Transportation Research Procedia, vol. 23, pp. 341–361, 2017.

7. Arhin, S., Noel, E., Melissa, F., Anderson, L. and Stinson, R. "Optimization of transit total bus stop time models", Journal of Traffic and Transportation Engineering, vol. 3(2), pp. 146-153, 2016.

8. Anil Kumara, B., Vanjakshi, L. and Shanar Subramanian, C "Day-wise travel time pattern analysis under heterogeneous traffic Conditions", Science Direct, Transportation Research Procedia, vol. 104, pp. 746–754, 2013.

Conflict of Interest

None of the authors have any conflicts of interest to declare.

About the License