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Assessment of Quality of Transportaion Sysyem in a Medium Sized City: A Case Study

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***Abstract*—The travel demand of India is keeps on increasing day by day. In order to meet the demand of the existing scenario of road traffic particularly in urban areas it is necessary to evaluate the performance of the existing transportation system of a city. Transport sector has some performance indicators. similarly For the assessment of quality of operations we have to identifying these performance indicators. In the present study the quality assessment will be done for the city of Alappuzha based on the service level benchmarking procedure given by ministry of urban development in the year 2010. Here a total number of ten performance indicators have been taken and finally a "performance report card will be derived.**

Keywords— Transport system, Performance indicators

INTRODUCTION

The challenges of the urban transport sector in India are growing rapidly, and government agencies at various levels are taking steps to address the gaps in service delivery. One of the important steps towards this is introduction of appropriate systems for information management, performance monitoring, and benchmarking. It provides a common minimum framework for monitoring and reporting on service level benchmarks and also the guidelines on how to operationalize this framework in a phased manner.

A. Objectives

The main aim of the study is to quantify asses the quality of urban transportation of Alappuzha city. It also aims to suggest measures to improve performance in urban public transport sector of Alappuzha

I. LITERATURE REVIEW

The process of benchmarking is in the initiation stage in India. In 2009 the Ministry of Urban Development New Delhi has published the guidelines [MoUD, Government of India] for the benchmarking of public transport. They have provided a database for service level benchmarking of cities [http://www.utbenchmark.in/]. All cities covered by the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) have been advised to benchmark their level of services for various parameters specified by the ministry. The exercise aims to generate information that will be useful in making urban transportation systems effective.

Detailed indicators have been developed to assess the level of service (LOS). Jasti Chaitanya [2011] published the first paper on the Benchmarking process suggested by MoUD, reviewed thoroughly and identified the problems in the direct application of these guidelines to the medium sized cities. .

II. METHODOLOGY

Methodology serving all the objectives of the study has been shown in Figure 1.

A. A Review of Conventional Qualityb assessment procedure suggested by MoUD

MoUD had released the SLB's in December 2009 for the first time in India and later modified the same in December 2010. The concept of benchmarking is completely concentrated upon the Developed cities rather that Developing cities and the present process was not at all suitable to evaluate the performance of medium or small sized city. So it's clear that the SLB's are not tailor made for all the cities and needs to be altered for each and every city individually. So here is an attempt made to minimize the effort by making more flexible and easily adaptable e SLB's by altering the key performance indicators.

B. Identifying problems of direct application of Conventional SLB's to medium sized cities

Service Level Benchmarking is biased towards metro cities and may not be a right approach for medium-sized cities for the performance monitoring. Drawbacks of the conventional benchmarking process have been listed as below in the Table No.1.

TABLE I. Problems of direct application of conventional SLB procedure suggested by MoUD

No	Segment	Problems
1	Public transportation system	Almost absent in most of the Indian cities
2	Pedestrian facilities	Pedestrian delay judged based on signal phase which exists very rarely
3	Non motorized vehicles	Almost absent in most of the Indian cities
4	Usage of ITS	Almost absent in most of the Indian cities
5	Intermediate public transport	Not at all considered, being predominate mode of travel in all Indian cities
6	Parking space	Strictly encourages on street paid parking
7	Financial sustainability of public transport by bus	Most of the cities don't have a public transportation facility; hence it has to be made flexible for consideration
8	Delay at intersection	Not at all considered
9	Pavement condition	Not at all considered

Fig.1. Chart showing methodology of present study

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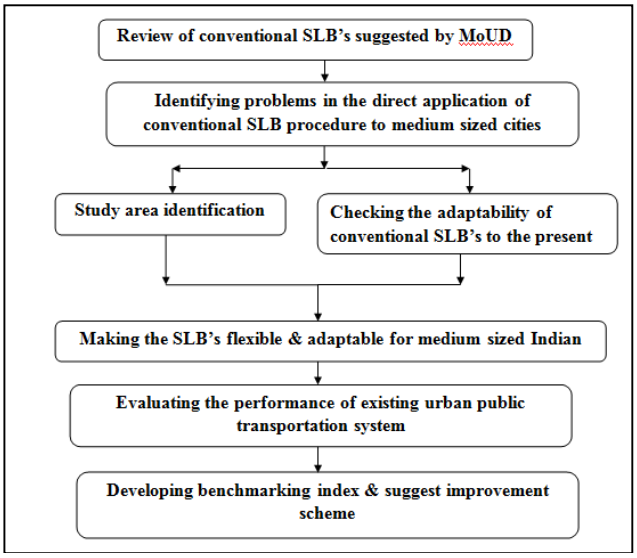

C. *Study area identification*

The study area is Alappuzha town, which is the sixth largest town in Kerala with an urban population of 174,164. Alappuzh town was formed in 1906. The town area was further extended in 1943. At present the town covers an area of 46.77 km^2. The city is accessible by air, rail, road and water. The presence of a lot of backwaters and canals makes water transport a popular means of transport. Alappuzha town accounts for nearly 50.72 % of the urban population of the district. Alappuzha town occupies nearly 20% of the area of the Ambalappuzha taluk and has got 46.5% of taluk population. Population density per sq. Km in Alappuzha town is 3735 persons. Map of Alappuzha city is shown in the following figure 2.

Fig.2. Map of Alappuzha city.

D. *Checking the Adaptability of Conventional SLB's to the Present Study Area*

The adaptability of conventional SLB's to the present study area of Alappuzha has to be verified and it found as inadaptable since the KPI's like ITS, NMV were too high for the medium sized cities to benchmark the Urban Transportation System. So the conventional SLB's cannot be adapted directly and necessary alterations need to be done.

E. *Making the SLB's Flexible & Adaptable for Medium sized Indian Cities*

It's a tedious thing to make an SLB for each and every city individually so keeping all Indian medium sized cities in view a standard SLB framework had been developed by adding and removing few KPI's to the conventional SLB. The added KPI's are Delay at Intersections, Intermediate Public Transport and Pavement Condition. Similarly the KPI's like Financial Sustainability of Public Transport by bus, NMV & ITS were removed.

F. *Evaluating the performance of existing urban public transportation system*

The evaluation of the new KPI's has been shown from Table III, where as the unaltered KPI's evaluation was done based on the conventional techniques suggested by MoUD.

III. DATA COLLECTION AND DATA ANALYSIS.

Apart from the primary data such as link volumes, speed & delay etc. One needs to have the secondary data also such as accidents; bus route permits, pollution details etc. Data collection for benchmarking is shown in the table II below.

TABLE II. Data collection methods adopted in the study

Data	Type	Source
Public transportation & IPT facilities	Secondary	District transport Officials (DTO), Alappuzha
Pedestrian, travel speed, intersection performances, parking & pavement condition	Primary	By conducting trail runs & surveys
Accident data	Secondary	SP Office , Alappuzha
Air pollution level	Secondary	District Pollution Controll board
Land use details	Secondary	District town planning department
Benchmarking index	Primary	Expert survey

The benchmarking will be done with the modified SLB procedure as the study area taken for benchmarking is a medium sized city like Alappuzha, for which the conventional SLB cannot be applied directly. The modified SLB's have been developed with such an intention that they should be applicable to all the medium sized Indian cities where as the combination of both must make the process of benchmarking more suitable for all the metro cities in India. With the same intention maximum effort has been made to integrate all the segments which make a significant impact on urban transportation.

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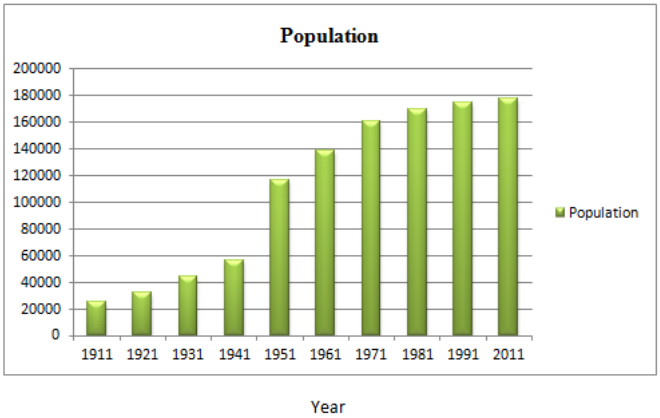

Fig.3. Graph showing population growth trend over the decades

B. Data Analysis

The data collected and the calculation of level of service are explained in the table 2. The overall Score Achieved by the Alappuzha city is 2.4 which indicate its satisfactory performance in the Urban Transportation. The improvisation strategy has to be developed by using the performance report card (shown in table3) in which the present and targeted OLOS will be presented, so that each and every sector will be developed up to the desirable extent.

TABLE III. Data analysis and calculation of LOS for each KPI

No	KPI of SLB	Quantification of KPI	Formulation	Result (LOS)
1	Public Transportion facilities	Public Transportation facilities		
	Presence of Organized Public Transport System	A = Total number of buses operating on road in the city = 154 B = Total number of buses under the ownership of STU/SPV = 127	(A/B) * 100= 82.47 %	LOS_1 =1
	Availability of public transport	A = No of Buses/ train coaches available in a city on any day = 150 B = Total Population of the city = 177079	A/B =0.85	LOS_2 =1
	Service Coverage of Public Transport in the city	A = Total length in road kms of the corridors on which public transport systems ply in the city = 39.113 km B = Area of the urban limits of the city = 23.44 km^2	A/B = 1.66	LOS_3 =1
	Average waiting time for Public Transport	Average waiting time of each route identified and frequency distribution table prepared.	Median waiting time = 2 minute	LOS_4 =1
	Level of Comfort in Public Transport	Average Passenger comfort-Load factor for all routes determined	Passenger per seat = 2.7	LOS_5 =4
	Percentage of fleet as per Urban bus specification	A = Total Number of Buses in the City = 154 B = Total number of buses as per the Urban Bus specifications in the city = 90	(B/A)* 100 = 59a%	LOS_6 =2
CLOS=LOS_1 + LOS_2+ LOS_3 + LOS_4 + LOS_5 + LOS_6 = 1+1+1+1+4+2 = 10 Overall LOS = 1				
2	Pedestrian Infrastructure Facilities	Pedestrian Infrastructure Facilities		
	Average Speed of Pedestrian at Intersection	Representative Sample Technique in which time taken to cross major leg is measured	Average Speed of pedestrian= 4.16 ft/ sec	LOS_1 =2
	Availability of Street Lighting (LUX)	Calculate LUX level using luxmeter (10 samples / km)	LUX= 5	LOS_2 =3
	Percentage of city covered with Foot	A= Total length of foot path in the city = 0.5 km B= Total length of road network = 53.576 km	(A/B) *100 = 0.99%	LOS_3 =4
	Extent of Coverage of FOB's	A =Number of FOB = 2 B= Total length of road network = 53.576 km	(A/B) *100 = 0.0%	LOS_4 =4
CLOS = LOS1 + LOS2+ LOS3 + LOS4 = 2+3+4+4 = 13 Overall LOS = 4				
3	Availability of NMV facilities	Intermediate public transport facilities		
	Equivalent Bus Unit/1000 population	EBU's has to be developed for all modes of travel	1.25	LOS_1 = 2
	Average speed on all corridors	Average speed of IPT facilities on routes determined	35kmph	LOS_2 =1
	Average waiting time	Average waiting time of IPT facilities on routes determined	2 minutes	LOS_3 =1
CLOS = LOS_1 + LOS_2+ LOS_3 = 2 + 1 +1 =4 Overall LOS = 1				
4	Travel speed along major corridors	Travel speed (motorized and mass transit) along major corridors		
	Travel speed of Personal vehicles	LOS of each corridor determined.Weighted Aggregate of LOS density Computed	$\sum(C_n LOS_n)$ = 3	LOS_1 = 3
	Travel speed of Public Transport	LOS of each corridor determined.Weighted Aggregate of LOS density Computed	$\sum(C_n LOS_n)$ = 2	LOS_2 = 2
CLOS = LOS1 + LOS2 = 3 + 2 = 5 Overall LOS = 3				
5	Availability of parking spaces	Availability of parking spaces		
	Availability of paid public parking spaces under .paid parking	There is no on street paid parking in Alappuzha town	ECS for on street paid parking =0	LOS_1 = 4
	Difference in Maximum and Minimum Parking Fee in the City	A=Maximum parking fee= 150 B = Minimum parking fee = 50	A/B = 3	LOS_2 = 2
CLOS = LOS_1 + LOS_2 = 4+2 = 6 Overall LOS = 3				
6	Safety	Safety		
	Fatality rate per lakh population	A= Total number of fatalities recorded in road accidents within city limits in the given year 2014 = 44 B= Population of the urban agglomeration in 2014 = 177079	(AX100 000)/ B = 25	LOS_1 = 4
	Fatality rate for pedestrian and NMT (%)	A=Total number of NMV & Pedestrian fatalities recorded = 5 B = Total number of fatalities recorded in road accidents within city = 49	(AX100)/B = 10.2	LOS_2 = 1
CLOS = LOS1 + LOS2 = 4+1 = 5 Overall LOS = 3				
7	Pollution	Pollution		
	Annual mean concentration range (µg/m^3)	Obtain the Annual mean concentration range of RSPM SPM, Oxides of Nitrogen,SO_2 from KSPCB	Add LOS corresponding	LOS =8

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			to each pollutant	
RSPM + SPM+ NO_2+SO_2 = 1+1+2+1 = 5 Overall LOS = 1				
8	Financial Sustainability of Public Transport by bus	Financial Sustainability of Public Transport by bus		
	Extent of Non fare Revenue (%)	A = Revenue collections per annum from non-fare related sources = 1145418 B = Total revenue per annum from all sources = 300536472	(AX100)/B = 0.38	LOS_1 = 4
	Staff /bus ratio	A=Total staff of bus operation and maintenance = 241 B =Total number of buses = 57	A/B = 4.2	LOS_2 = 1
	Operating Ratio	A= Cost including depreciation cost, operation & maintenance cost, month = 42710218 B= Total revenue generated from all sources such as Fare Revenue and non fare revenue = 26105321	A / B = 1.636	LOS_3 = 4
CLOS = LOS_1 + LOS_2+ LOS_3 = 4+1+4 = 9 Overall LOS = 3				
9	Integrated landuse-transport system	Integrated landuse-transport system		
	Population density	A= Total city area = 4677 Ha B = Population in the city = 174164	B/A = 37.24	LOS_1 =4
	Mixed land-use on major transit network	A = Total developed area = 2228 Ha B = Total non-residential area = 394 Ha	(B/A) X 100= 17.7%	LOS_2 = 2
	Intensity of development – city wide	A = Floor space Index applicable to most part of the city as per Master Plan/DP	2.3	LOS_3 = 1
	Intensity of development – along transit corridor	A = Floor space Index applicable to most part of the city as per Master Plan/DP=2.3 B=FSI along transit corridors= 3	B/A = 1.3	LOS_4 = 3
	Clear pattern and completeness of the network	Major roads have somewhat clear pattern (gridiron) but incomplete network	2	LOS_5 =2
	Percentage of area under roads	A= Overall developed area of the city = 2228 Ha B= Overall area under road network = 115 Ha	(B/A) X 100= 5.16%	LOS_6 = 4
	Percentage road network with exclusive ROW for transit	Total length of road having exclusive BRT/Metro/LRT/Mono rail = 0 km	0%	LOS_7 = 4
CLOS = LOS_1 + LOS_2+ LOS_3 + LOS_4+ LOS_5+ LOS_6 = 4+2+1+3+2+4+4 = 16 Overall LOS = 3				
10	Riding quality of pavement	Riding quality of pavement		
	Road Quality Index (RQI)	IRI value of major roads in the town was obtained using Roughometer. $RQI = 6.634 - (2.813 \times \sqrt{IRI})$	IRI = 2.7 RQI = 2.01	LOS= 2
Overall LOS = 2				
Performance of Alappuzha city in the urban transportation sector is = (1 + 4 + 1 + 3 + 3 + 3 + 1 + 3 +3 + 2)/10 = 24 / 10 = 2.4				

TABLE V. Urban Transportation Performance Report card for Alappuzha city

No	SLB (modified)	OLOS	Action plan to achieve target
1	Public Transort facilities	1	Organized public transport has to be started along the routes connecting tour destinations in the city. Number of KSRTC buses operating within the city has to be increased by 15. Three new JNNUR low floor ac city bus services and inland water transport has to be encouraged. (Figure 4)
2	Pedestrian Infrastructure facilities	4	Installation of foot overbridge at District hospital junction. Provision of foot path of atleast 5 ft width from YMCA to Punnappra on NH 544. Major intersections have to be signalized with an exclusive pedestrian phase.(District Hospital junction, SD college junction, kaichoondi junction, valanjavazhy junction, Outpost)
3	IPT Facilities	1	Increasing the frequency in non peak times and making it available in all routes which could not be covered by public transport, by offering some tax relaxations and making the route permit free.
4	Level of usage of intelligent transport system	4	Surveillance cameras have to be fixed at all major junctions within next 2 years. All junctions have to be signalized within 2 years and synchronized within next 3 years after signal installation.
5	Travel speed along major corridors	3	Utmost care has to be taken such that the improvisation of PT and IPT facilities must not make any negative impact on private transport.
6	Availability of Parking Spaces	3	Off street parking has to be encouraged rather than on street parking. Multi level parking need to be introduced near Maatha jetty and finishing point
7	Road Safety	3	Black spots (kalarcode junction ,kaichoondi junction, thondankulangara , outpost) within the city need to be identified and geometrically improved within next 5 years Road Safety Audit (RSA) has to be carried out throughout city and road markings and signages have to be improved within next 2 years. Adequate sight distance should be ensured at out post junction and

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			shavakkottappalam junction .
8	Pollution levels	1	Pollution level has to be kept low by reducing the concentration of SPM. The urban activities affect the water quality in the canals of the city, especially the vadakkanal. It will affect tourism operations. Strict enforcement has to be imposed on the inland water transport and canal side shops regarding the sewage disposal.
9	Land Use Transport Integration	3	Town planning department has to be made as one of the approver for all the traffic and transportation studies.
10	Financial sustainability of public transport by bus	3	KSRTC services should focus on the comfort and travel time saving of the passengers. 3 New services should be started along Punnamada Aspinbal road and Beach- YMCA through Zhakkariya Bazhaar. Tourist only bus services within the city is another proposal.
11	Riding quality	2	Regular maintenance of pavement must be made prior and after the monsoon within next 1 year,

IV. CONCLUSION

There are few drawbacks in the SLB's proposed by MoUD such as Pedestrian Facilities, NMV, ITS etc which cannot be considered for Benchmarking of Medium Sized Cities.. MoUD had not considered the aspects such as IPT, Delay at Intersections and Pavement Condition etc. which were the Key parameters in rating the Urban Transportation System. Modified SLB's used in this study have been counter acting the drawbacks of conventional SLB's and also making the concept of SLB more flexible and adaptable for Medium sized Indian Cities. The Alappuzha city is performing very poor in the segments such as Pedestrian Infrastructure facilities, Availability of Parking facilities, Level of usage of Integrated Transport System, Land Use Transport Integration, financial sustainability of public transportation and Travel speed along major corridors

Similarly Alappuzha city is performing Good in the Segments such as, Pollution Levels, organized public transport and IPT facilities. The process of SLB has to be made mandatory in all CMP's and CTTS's as it determines how effectively and efficiently the present Transportation system is performing in the existing situation and in which sectors its lagging behind, so that it can be improved easily with the future targeted LOS Urban network need considerable improvements in Road design and available road infrastructure, traffic management and in other such reasons which significantly contribute to road safety. The public transport of the city is financial sustainable but needs considerable improvements. Level of air pollution in the city is low. But the pedestrian facilities are poor.

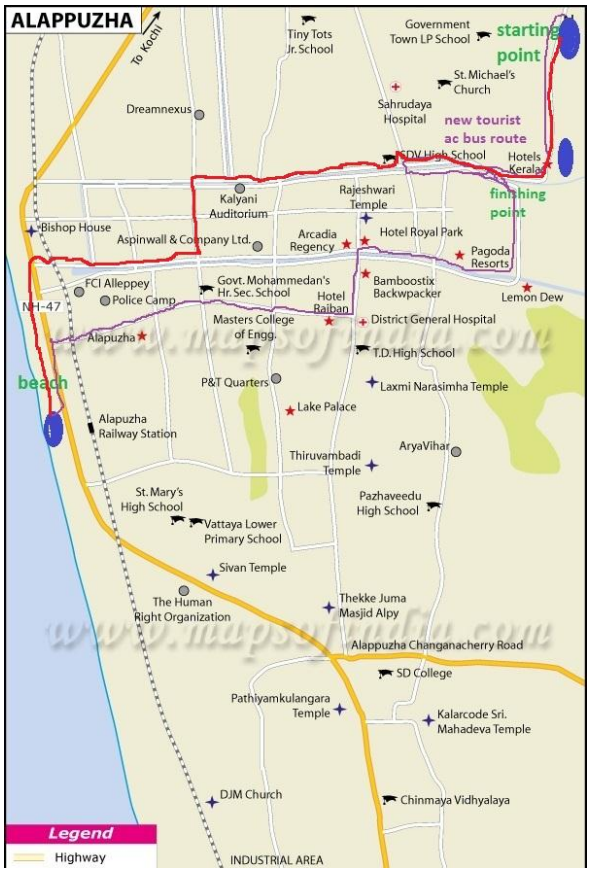

Figure 4: Proposed bus route

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