Service evaluation of urban public transportation in Baghdad City

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Abstract. Public transport performance is an important tool for users and operators. It generally allows them to verify whether the service is provided efficiently and effectively, identify areas where performance improvement may be needed, ensure that the community and users are satisfied; and support decision-making. In this research, the public transport routes located in different areas in Baghdad were studied. Public transport lines are used daily by people because they pass through vital areas and serve all passengers, students, employees, and others for several purposes. Data were taken on different days and at peak hours for four routes. The service level of public transport relied upon Transit Cooperative Research Program (TCRP) Report 100 scales was adopted to determine the level of service for each route. The most important problems faced by each line were identified, and based on these problems, appropriate solutions were proposed as they are important lines that serve a large group of people.

1 Introduction

Evaluation of service quality of public transportation is an important issue, gaining a prerequisite to increasing urban life sustainability [19]. Public transportation performance is a critical key to users and operators. Service is measured to estimate if the service is efficient and effective. Performance measurement clarifies whether the users and community are satisfied; and aids in decision-making, to make the decision about how and when the service could be improved [12]. Public transportation performance is measured by four different views, the first view depends on user satisfaction, and the second view depends on the achievement of the expected goals of public transport such as accessibility to employment and reduction of congestion and air pollution. The third view measures the performance from the service provider view and the fourth view is a combination of the aforementioned views [13, 17].

evaluated the level of service of Hyderabad Metro for improving urban sustainability. The service quality is evaluated using Analytical Hierarchy Process (AHP); the results appear that the level of service can be improved by improved parking spaces and ticket fares.

measured the service quality of para-transit services which is a fixed route operated as a feeder to major public routes. The level of service is estimated based on system attributes from the user view. The results stated that the qualitative attributes are

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the service quality of public routes in Kutahya based on (TCRP) Report 100, various transit attributes were evaluated, and the results indicated the public routes are longer than the shortest path even there is good service coverage. In addition, there are longer waiting times at transfer points which means there is a decrease in the efficiency of public transport.

To estimate the congestion-pricing plan using the delay value and utilized it to determine the hierarchical cumulative prospect (CPV) for all types of trips. The area of Melbourne is selected as the study area; there is an enhancement in the network performance, by using this approach.

Evaluated the performance of Electric Trolley Bus Routes in Greece using the DEA approach; sales and production efficiency were measured, and the results indicated that arterial bus routes have improved performance in the production process, while the feeder bus routes have better sales performance.

Analyze the service quality of the metro station in Shohada Square by VISSIM software. TCRP manual was applied to improve the performance, solutions found are to reduce headway and remove the ticket purchase location.

Monitoring the service quality of public transport in Brazilian city using a multi-criteria model with AHP for assessing the opinion of users and experts. The results indicated that the operational group and infrastructure have the highest weight in assessing the quality.

Al-Sahili & Sadeq, 2003 studied the intercity bus in the Palestinian area, they estimate ridership demand and used it as a basis to predict future demand.

Aim to study the quality of service for the bus in Johor Bahru Sentral in Malaysia. They adopted the procedure of Transit Capacity and Quality of Service Manual (TCQSM), they found bus service lay with class D, the service showed the inconsistency of frequency service and schedule information should be improved.

Used a simple method for benchmarking public transport service using available data, they estimate the number of people who reached a stop based on an acceptable walking distance within the range of headway classes.

Showed that developed LOS range from user perception; they used methodology to estimate LOS for bus service. The method takes into account the variation between geographic and different economic regions. Norhisham et al., 2022 conducted a study to estimate the level of service of the bus system in Penang. The TCQSM procedure adopted to measure service level, the results refer that service quality lay within level D. This indicates there is a need to improve the service to adequate the passenger’s perceptions.

Used the TCQSM procedure for bus service measurements in Dublin, Ireland, the data analysis showed an efficient service for the bus corridor in Dublin. Bunker, 2015 evaluated bus routes in Brisbane, Australia on a weekday, he investigate the correlation between average travel time and occupancy load factor and its effect on the quality of service (QOS). The output concluded that the occupancy load factor has been a better measure to QOS estimation.

Present a paper refers to the importance of user perception in assessment of bus service quality for developing countries and describe the need to setup LOS thresholds from user perception.

The increasing population in Iraq leads to generating a higher number of trips on a road network, which results in big traffic congestion in the city. To decrease congestion and release the current pressure on a road network, public transportation must take the main role, it needs to be studied in-depth to show the problems associated with it and try to improve its services to encourage people to use it. Current research in Iraq does not take into measure public transportation service quality. Despite the presence of public transportation since the 1970s in Iraq, efforts have never been made to evaluate the efficiency of the system in Baghdad city, the capital of Iraq, so this study is the first try. The objective was to locate the weak level of service for public transport and try enhancing it to a good level and improve the overall performance of public transport. This research used performance measurement indicators that are detailed in the Transit Cooperative Research Program (TCRP) manual to assess the performance of the existing condition. The level of service of public routes was found, which is used to measure the efficiency of public transport.
2 Study Area

Large urban cities are featured with high population numbers and large economic activities accompanied by complex public transportation networks. Our study area in this research is Baghdad city. Baghdad is the capital of Iraq and is the largest city in terms of population, and the city has recently witnessed rapid economic and commercial growth. The city is accompanied by a high number of car ownership, which led to an increase in people’s trips so the roads became crowded all the time. Despite a large number of public transport lines in the city, the priority is to use the private vehicle for transportation. This is due to the poor public transport service offered to users. Public transport has many issues like the following:

1. Insufficient existing infrastructure, which is used for both private and public transportation. Especially with a high increase in the number of cars and a high share of private vehicles, which leads to increased demand and increase traffic congestion.
2. Longer travel times spent by public transport to transfer between home and work; this has a negative impact on public transport share and increases health problems.
3. There is no stop location defined, so the user can board or alight anywhere on the route that has a negative impact on travel time. So the duration of the journey in public transport is twice the duration of the journey in private transport, in most cases due to the lack of places designated to stop, and thus the number of stops increases, which reduces the speed of the vehicle and thus increases the journey time.

In this research, we try to measure the level of service for four public transport lines that are shown in Figure 1, and are as follows:

- Bab Al Mu’adham to Aden square
- Hay Al-Adl to Al-Bayaa
- New Baghdad to Mawal
- Bab Al Sharqi to Jadriya

Fig. 1. Selected Public Transport Routes
3 Data collection

The study area is Baghdad city, and a group of important public transport lines in the city was selected. To accomplish the objective of this study, a field survey is a necessary step. Two survey methods were used. The first type is the survey along the route line, which is known as the ridership survey. Here, the demand is calculated at each stopping point, and the speed and time of the trip in each section of the path are calculated. The other survey is the survey at the critical stopping point of the line, which is called the point check survey. The critical stop was defined based on the results of the previous survey. Here in this survey, the stopping point is located and the number of buses that pass each line within an hour is calculated, as well as the time between the passing of one bus and another bus is estimated, and this value is known as the headway time.

4 Methods

The level of service is a complex measure for public transportation that depends on more than one factor that differs from what it is in private transportation, which depends on only one factor. In this study, the service level of public transport relied upon Transit Cooperative Research Program (TCRP) Report 100 scales (TCRP, 2003). There are six levels of service measurement which are shown in Table 1. As all the information required to estimate the service level for each public transport line was collected, then the level of service for each line is obtained. This study is useful to determine the locations of defects in the operation of service and work to improve the service towards better performance.

Table 1. Public Transport Levels of Service [3]

<table>
<thead>
<tr>
<th>Hours of Service</th>
<th>Service Frequency</th>
<th>Service Coverage</th>
<th>Passenger Load</th>
<th>Headway Adherence</th>
<th>the Transit-Auto Travel Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>19-24</td>
<td>A</td>
<td>0.00-0.50</td>
<td>90.0-100.0%</td>
<td>≤ 0.21</td>
</tr>
<tr>
<td>B</td>
<td>17-18</td>
<td>B</td>
<td>0.51-0.75</td>
<td>80.0-89.9%</td>
<td>1-15</td>
</tr>
<tr>
<td>C</td>
<td>14-16</td>
<td>C</td>
<td>0.76-1.00</td>
<td>70.0-79.9%</td>
<td>16-30</td>
</tr>
<tr>
<td>D</td>
<td>12-13</td>
<td>D</td>
<td>1.01-1.25*</td>
<td>60.0-69.9%</td>
<td>31-45</td>
</tr>
<tr>
<td>E</td>
<td>4-11</td>
<td>E</td>
<td>1.26-1.50*</td>
<td>50.0-59.9%</td>
<td>46-60</td>
</tr>
<tr>
<td>F</td>
<td>&lt; 5</td>
<td>F</td>
<td>&gt; 60</td>
<td>&lt; 0.01</td>
<td>&gt; 60</td>
</tr>
</tbody>
</table>

Table E3S Web of Conferences 402, 09019 (2023) https://doi.org/10.1051/e3sconf/202340209019 TransSiberia 2023 4
5 Results

The data collected were organized and classified to obtain public transport line characteristics, all these properties were shown in Table 2.

Table 2. Public Transport Route Characteristics

<table>
<thead>
<tr>
<th>Route name</th>
<th>Code</th>
<th>Travel time (Min.)</th>
<th>Route length (Km)</th>
<th>Headway Min.</th>
<th>Frequency (Bus/hr.)</th>
<th>Dwell time (Sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bab Al Mu'adham/Aden square</td>
<td>PTR1</td>
<td>48</td>
<td>8.0</td>
<td>9</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Hay Al-Adl to Al-Bayaa</td>
<td>PTR2</td>
<td>56</td>
<td>9.7</td>
<td>5</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>New Baghdad-Mawal</td>
<td>PTR3</td>
<td>48</td>
<td>14</td>
<td>4</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>Bab Al Sharqi-Jadiriyah</td>
<td>PTR4</td>
<td>62</td>
<td>9.9</td>
<td>4</td>
<td>15</td>
<td>9</td>
</tr>
</tbody>
</table>

According to these characteristics, the level of service was found for each line and the following Tables from (3 to 6) showed the LOS for each route's attributes.

Table 3. Level of Service of Bab Al Mu'adham to Aden square Route

<table>
<thead>
<tr>
<th>Hours of Service</th>
<th>Route Service Frequency</th>
<th>Route Service Coverage</th>
<th>Route Passenger Load</th>
<th>Route Headway Adherence</th>
<th>Transit-Auto Travel Time</th>
<th>Average LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-13</td>
<td>5-6</td>
<td>80.0-89.9%</td>
<td>0.76-1</td>
<td>0.22-0.3</td>
<td>1-15</td>
<td>C</td>
</tr>
</tbody>
</table>

Table 4. Level of Service of Hay Al-Adl to Al-Bayaa Route

<table>
<thead>
<tr>
<th>Hours of Service</th>
<th>Route Service Frequency</th>
<th>Route Service Coverage</th>
<th>Route Passenger Load</th>
<th>Route Headway Adherence</th>
<th>Transit-Auto Travel Time</th>
<th>Average LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-16</td>
<td>&gt;6</td>
<td>80.0-89.9%</td>
<td>0.51-0.75</td>
<td>0.4-0.52</td>
<td>0</td>
<td>A</td>
</tr>
</tbody>
</table>

Table 5. Level of Service of New Baghdad-Mawal Route

<table>
<thead>
<tr>
<th>Hours of Service</th>
<th>Route Service Frequency</th>
<th>Route Service Coverage</th>
<th>Route Passenger Load</th>
<th>Route Headway Adherence</th>
<th>Transit-Auto Travel Time</th>
<th>Average LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-13</td>
<td>&gt;6</td>
<td>80.0-89.9%</td>
<td>0.76-1</td>
<td>0.22-0.3</td>
<td>1-15</td>
<td>C</td>
</tr>
</tbody>
</table>
6 Discussion

From observing the level of service for PTR1, it can be shown there is a deficiency in hours of service, and this can be increased if there is a need in demand and this requires special study if the service needs improvement. For the passenger load, LOS was (C), all passengers can sit and no need for any standup passenger for the route this is because there are so many buses going to the same stops so there are enough seats for everyone. All other attributes at LOS C which it is adequate. From observing the level of service for PTR2, there is adequate LOS for all attributes except the headway adherence attribute which means there is dispersion in the distribution of headway time. From observing the level of service for PTR3, it can be shown that there is a deficiency in the hour of service. For transit–auto travel time for all routes, it can be seen that all routes use the shortest path so there is a small difference in time between using private cars or buses because they use the same route and go through the same traffic jams. For user comfort attribute, although the passenger load for all routes ranges between LOS B-C, the questionnaire survey stated that in 60% of answers, the users are uncomfortable due to problems associated with vehicle design, lack of amenities, and a high number of stops and the driver did not commit to a specific time to stop. All trips on these routes have high congestion, so all other attributes mentioned by the TCRP manual do not account for the traffic environment level of service. Reliability is the primary factor users take into account when they think to use public transport, this parameter is represented by on-time performance by the TCRP manual, this property could not taken into consideration in our study due to the high number of buses operated during an hour and the manual state to measure this parameter if the headway is longer than 10 minute, so reliability measurement is a key factor to evaluate public transport even if headway is less than 10 minute and this parameter should be taken into account. The major deficiency in service quality of all bus routes is the hour of service had at level D which must be improved by increasing hours of operation.

7 Conclusion

The main points concluded are:

1. TCRP manual track service coverage is the main factor to evaluate public transport service
2. All routes studied in this study showed a reasonable service scale
Reliability is considered the main factor to evaluate service public transport because all these public routes showed high variation in travel time length which affects their service.

There is a need to add other specific indexes to evaluate public transport services because there are important measurement indexes missed by the TCRP manual.

8 Acknowledgements

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