SMART CITY SCIENCE MANAGEMENT

UDC 656

Dulguun B., Ganchimeg J. Improving public transport network planning in Ulaanbaatar

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Abstract. *Public transportation is an integral part of Ulaanbaatar city transportation system and is designed to provide the full needs of citizen transportation needs.The preference for urban public transport reduces the use of individual car transport, which is linked to the environmental pillar of sustainability. For the customers, the level of the provided service is very important.*

In order to we need to study new ways to improve urban plan transportation services investment or management decisions harmonize demand for the growing capital of the population.

So, In this paper we are determine the factors affecting the operation of public transport of Ulaanbaatar have been studied and recommendations for further improved network planning

Keywords: *Public transportation network, demand, loading*

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Introduction

Today, there is an urgent need to create a public transport system by planning, upgrading and improving urban transportation services with urban planning and demographics and increasing the quality and accessibility of public transportation.

So, it is time to research the current situation of urban public transport services and to develop a dynamic growth trend and to develop strategic solutions, implementing measures and network planning models.

It is important to socioeconomic importance of improving network planning based on passenger demand to develop public transport services as the basis for future urban planning in Mongolia.

This study contributes to the research evidence-base within the UB context by addressing the gap in knowledge relating to the pre-travel information-seeking behaviours of everyday public transport users, which takes account of preferred information sources and use of technology for seeking information as well as journey planning stages.

Our research was based on passenger planning theory, system approach, economic analysis, mathematical statistical methods, regression and correlational analysis. Within the theoretical and research work has been carried out in urban traffic management, demand, supply, network and passenger traffic.

1.Public transportation Planning models, their stages and roles.

The traditional approach or "Four stages" is widely used in transportation planning in international practice. Each stage of the "Four stages" methodology has a specific purpose and describes the key roles of each stage:

- *First stage*. Trip Generation

Total load size of public transportation. Total passenger traffic between Ulaanbaatar and its districts is determined. The main data for this calculation are: the number of people, the number of households in the household, the number of household vehicles, the number of land use units (how many factories, businesses, shops, etc.) and the drivers and drivers of traffic.

- Second stage. Trip Distribution

The direction of distribution of the total traffic curve is calculated from which city to city, district to district.

After the Traffic Analysis Zone (TAZ) is issued, the "Traffic Factor" determines which area of the traffic will be intensified from the zone to which the traffic is intense.

- Third stage. Mode choice

The movement is made by all types of vehicles (by car, by bus, taxi).

Based on the type of transportation of the population in the capital city, the capacity of the public transport vehicle, the interval, the length of the passenger, the rotation time, and the number of buses.

• Fourth stage. **Trip assignment**

Along the road network, how many movements are created and the traffic load will be allocated to each road and route.

The "Traffic Distribution Modeling" is a computer modeling and allocates traffic to the preceding stages on the road network, and what traffic is the traffic on which traffic is measured, traffic conditions, classification, public transport schedules, prices, traffic alerts, etc. do it.

The design of the public transportation service system will make comparisons of traffic load and general traffic load conditions when planning urban and transport plans. Adjust your modeling at this stage.

2. Demand of public transportation services in Ulaanbaatar

Ulaanbaatar has been center of the country's culture, science, business, economy, and administration. The country's total population 3.2 million in 2020, Ulaanbaatar has 1.49 million residents, which represents 46.1 percent of the country's total population. /Figure 1/.

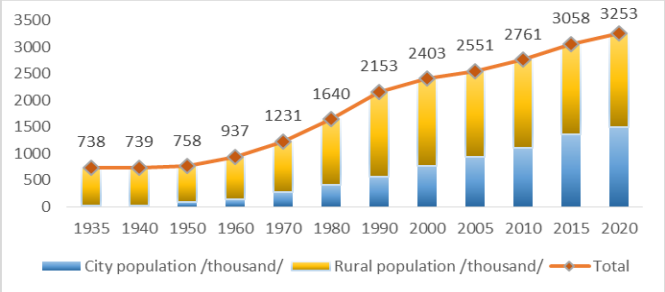

Fig.1. The population of Mongolia

By 2030, according to the Master plan of Ulaanbaatar city, it is expected that the population of the capital city will reach to 1.72 million Ulaanbaatar is becoming larger, and the concentration of Ulaanbaatar population is becoming higher.

The last 30 years, Mongolia has experienced intensive urbanization and the population of Ulaanbaatar city population has increased by 2.5 times and public transport passengers decreased by 2 times.

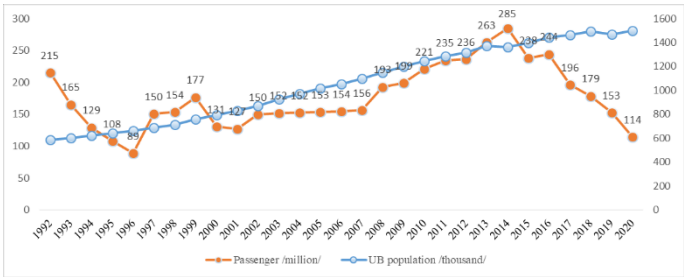

Fig.2. The passenger amount of public transportation within the Ulaanbaatar city /thousand person/, city population /million person/

There are 918 buses, trolleybuses in 98 routes, and over 400-500 million passengers per day in Ulaanbaatar city.

Public transportation is an integral part of our integrated transportation system and is designed to provide the full range of transportation needs.

In July 29, 2015, public transportation field have been introduced to the bus information system, bus management system and e-ticketing system.

In total, 21 companies and 1,257 buses were installed in the bus station, bus card reader equipment and CCTV. In order to reduce the overlapping of city traffic, traffic congestion, and reduction of overlap in public transportation services, in August 15, 2015 there was implemented new public transport network and the financing to bus providers difference between the revenue and expenditure of public transportation is provided by the budget.

The pattern of public transport movement in certain area can represent the pattern of optimum corridor. The best planned routes should follow this pattern to make the movement more

The overview of the number of passengers and the number of passengers traveling by public transport is shown in Figures using the ARCGIS program for each busstop.

According to the survey, the city center is overcrowded and the public transport route overlapped. /figure 5/

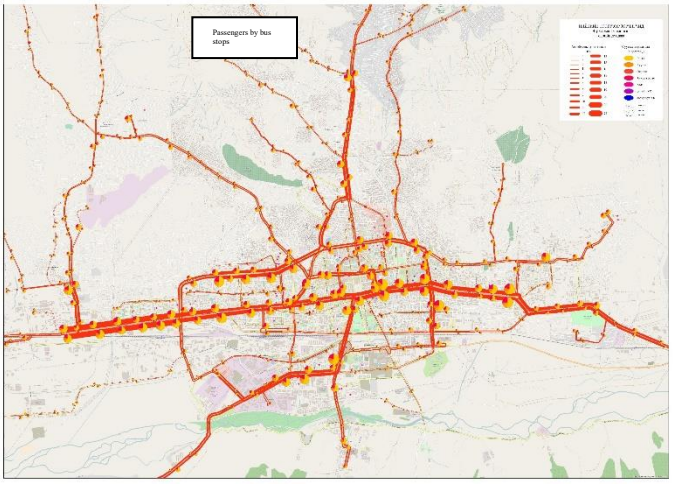

Fig.5. Comparison study of passengers and routes overlapping

This section presents the results of the maximum number unit of passenger patterns calculated from all April and May's data, workdays and weekend data, /Figure 6/ as well as the results of the unit traffic pattern groupings. /Figure 7,8/

39,260,786 lines of passenger card readings from the public transport TBOX system in April and May 2017 were calculated by large data analysis of passenger traffic flow. This analysis was performed in accordance with the methodology shown in the Ulaanbaatar Public Transport Authority's big data analysis of the Ulaanbaatar Public Transportation Project, which was implemented within the framework of the Ulaanbaatar Large and Open Data Project. This method calculates passenger traffic only from passenger card seating readings

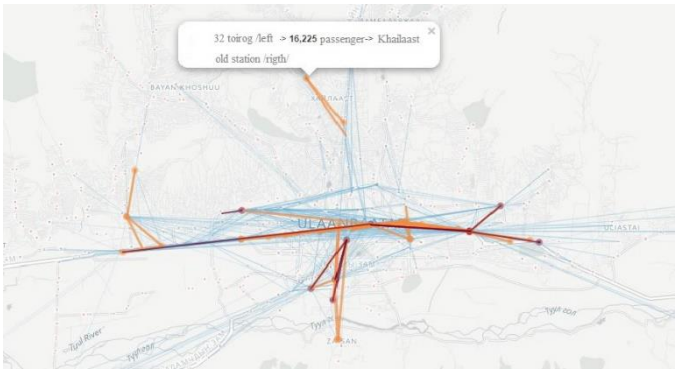

Fig.6. Unit movement patterns of passenger flow

Figure 6 shows 1000 patterns of data containing the maximum number of unit movements, the first 10 being reddish brown and the next 10 being orange. The end of the unit traffic pattern (traffic destination or end bus station) represented by a circle.

The public transport route should also be planned to be consistent with the pattern of existing movement so that the number of transfer between modes could be minimised. Figure 6 shows the existing public transport demand movement within Ulaanbaatar city

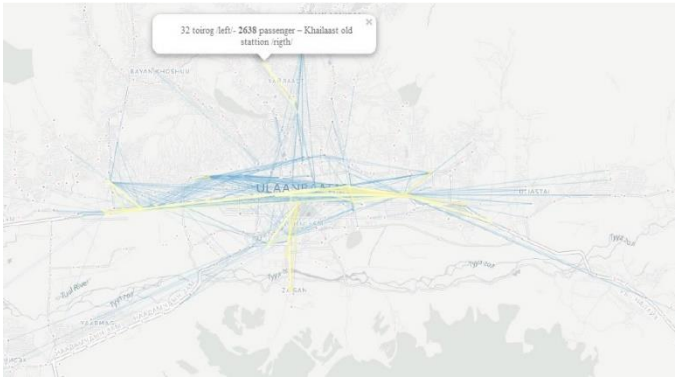

Fig.8. Unit movement patterns grouping /All days/

In Figure 8, the rhombus symbolizes the starting bus stop, the direction and length of the group in the corresponding colored line, and the end of the line in the form of a circle. This endpoint can be any coordinate point. In other words, it indicates which bus station is where the traffic is. For example, in this picture, 121,758 Group III passengers travel from Duukhee Shopping Center to Green Lake Street. This figure grouped the unit traffic from the 10 bus stops where the most units start.

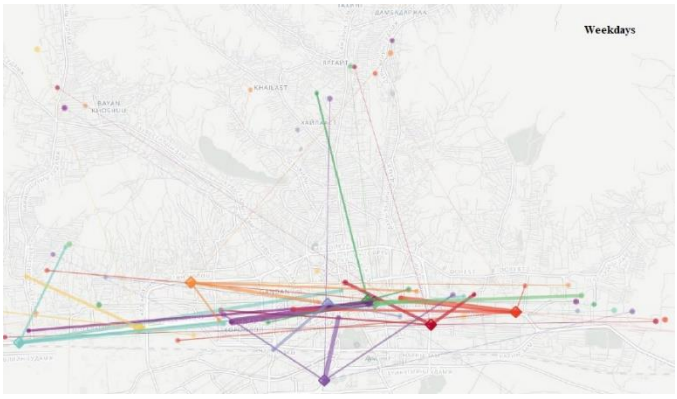

Fig.7. Unit movement patterns grouping /workday/

Figure 6 shows the weekend unit movement grouping. Over the weekend, there were no more centralized traffic patterns, and new group traffic centers appeared in other areas, such as the 3rd and 4th districts and Khar Khorin.

Fig.8. Unit movement patterns grouping /weekend/

Based on the data of the first quarter, the public passenger dynamics survey was carried out:

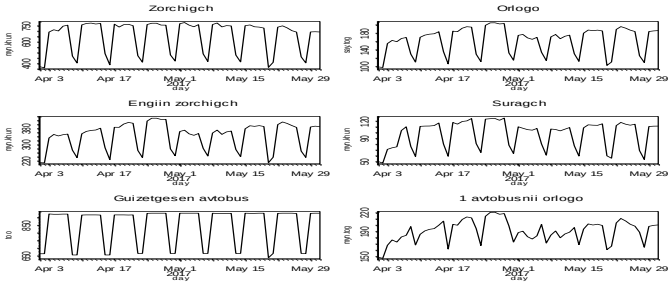

Fig.9. Dynamic Urban public transport

- In the general picture, there is an impact on planetary public transport data and some interesting findings have been made. For example:
- The impact of planetary on one bus per day, but there seems to be a random factor affecting the general trend;
- At the beginning of the month the bus line revenue is low and it increases to the end of the month;

• It is evident that seasonal characteristics of student and student style in total passenger structures are seasonal;

• The survey results show that no public service plans are planned for passenger traffic and passenger travel patterns. For example, starting from 5 months planning to change;

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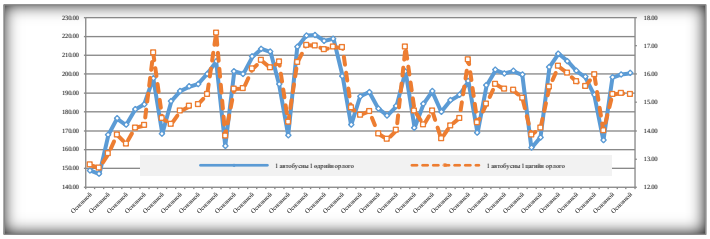

Figure 10. Relationship of the revenue of per hours and per days

Chart 1.

Correspondence correlation

Indicator	*Revenue per hours /per buses/*	*Revenue per hours /per hours/*
Revenue per hours /per hours/	1.00	
Revenue per hours /per buses/	0.87	1.00

One-day revenue per bus is dependent on one-hour passenger buses, which can be modeled with linear formulas, but one-hour revenue is not stable.

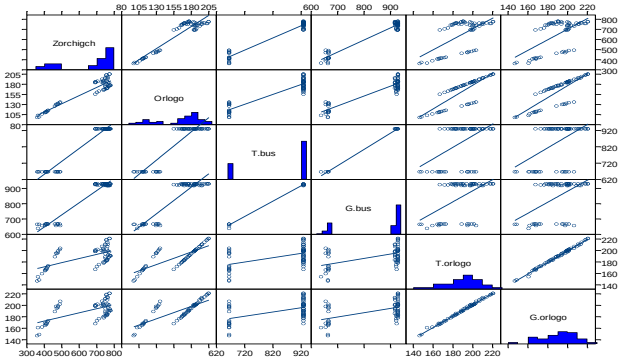

Figure 11. Matrix mapping parameters

From this point it is concluded that the number of passengers on a bus is independent of the average daily income of a bus, which indicates that the passenger structure of the bus is different. In other words, the passenger structure of each route depends on the environment.

Studies show that 1 hour bus revenue is non-constant, reflecting the customer's dependence on the type of day. In other words, it represents the difference between peak commodity start-up and overtime and the difference in income between days and less.

One day bus performance does not depend on day's earnings, indicating the bus load needs to be adjusted. In other words, depending on the specific day of the day, planning is flexible.

Although the number of passengers in the public transport service is affected, the survey found that the impact of the planet has been observed.

3. Supply of public transport services in Ulaanbaatar

Since 1990, the private sector has been shifting to the new socioeconomic system and the share of the economy has been growing, which has also contributed to the public transport sector and the number and quality of such services are increasing year by year.

There are 1213 vehicles in 20 public transport operators is registered in the capital city, with per day working 918 busses and trolleybuses.

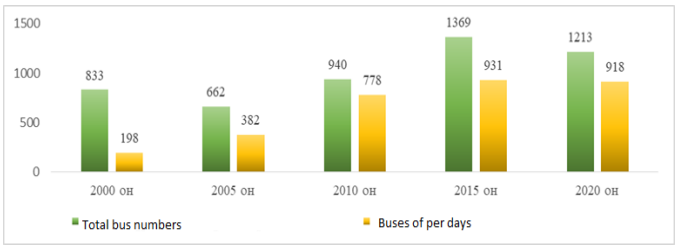

Fig.12. Number of public transportation buses and trolleybuses Within the UB city

The 134 routes in public transport services, which has main route-84, feeder and express routes-33, suburban routes-14, camp routes-3

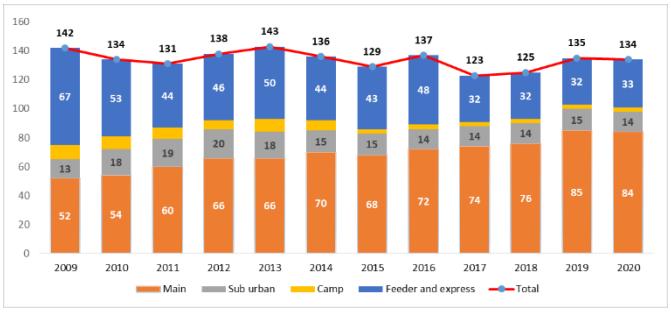

Fig 13. The total number of urban transportation routes

The total length of route public transport 4163 km, the longest route is 145 km, the shortest is 10 km, the time to spend on 30 minutes from 3 hours.

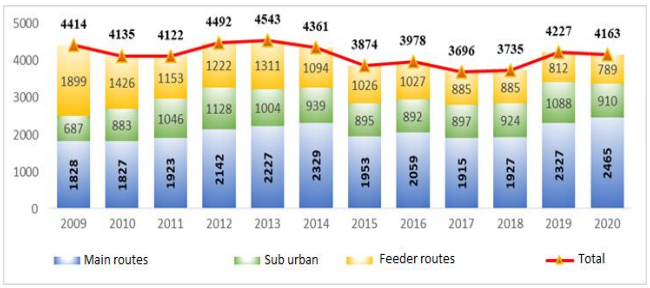

Fig 14. The total length of urban transportation routes

According to the survey, the length of large-capacity bus routes in the city has increased by 636.5 km or 1.3 times since 2009.

The public transport waiting time which is 12 minutes in bus, articulated bus waiting time is 7 , waiting period of trolleybus is 15, bus waiting time for sub urban areas 47 less than 29 minutes.

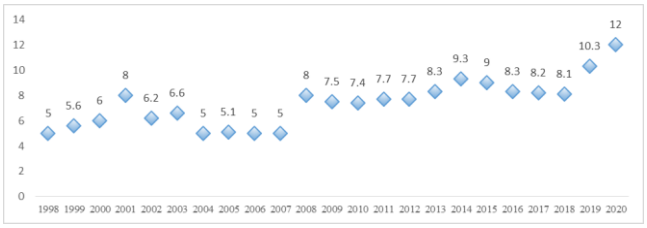

Fig.15. Waiting time /bus.minut/

As part of the study, we used ARC gis software to map public transport overlaps shown picture 15.

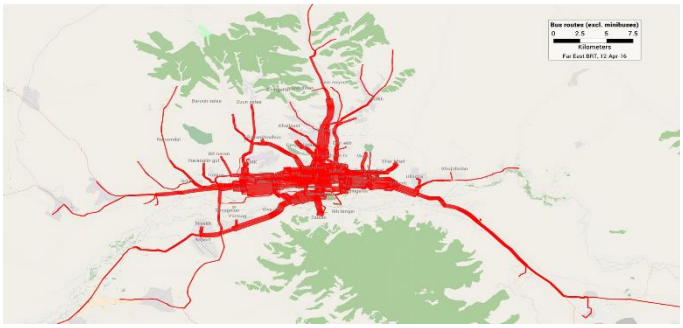

Fig.16. Overlapping of public transportation routes

The public transportation network in Ulaanbaatar is shaped by the city's urban distribution and road network In other words, it is located in the central city of the passenger traffic absorption center, where the center of the passenger traffic is located around the outskirts of the city.

Due to the geographical location and urban planning, production, service and road network of Ulaanbaatar city, demand for people travel to the center of the city, the overlap of public transportation services on key streets, such as Enkhtaivan avenue, Ikh toiruu and Chinggis avenue. was great.

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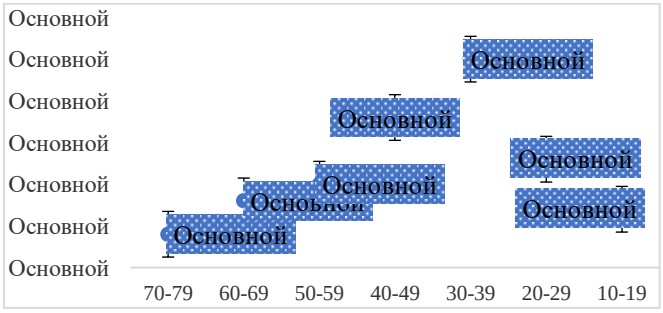

Fig.17. Number of bus station

From this point on, 47.06 percent of the total traffic on the route is too many or more than 40 stations and on the parking lot. This suggests that the general requirement is that the minimum spending time for one trip to go to any city in the public transport route system is minimal.

Approximately 20 percent of the total route is over 40 kilometers long, which is a very delicate solution. In other words, the number of passengers on a passenger journey has been reduced, but on the other hand, it does not meet the requirement of maintaining the full load of the entire network. It shows the routes that can not be recovered costs.

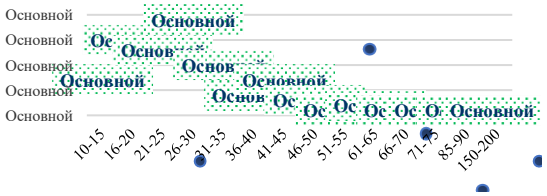

Figure 18. Length of Routes

The city's public transport network planning and intercept speeds were estimated by the average of 07-23 o'clock, with the lowest speed or 6-10 km speeds in the central part of the periphery and low-edges of the Gatsuurt road , Jargalant, the road from Red Stone and the Bayankhoshuu. On the edge of the periphery and summer camp, the speed is 100 km or more.

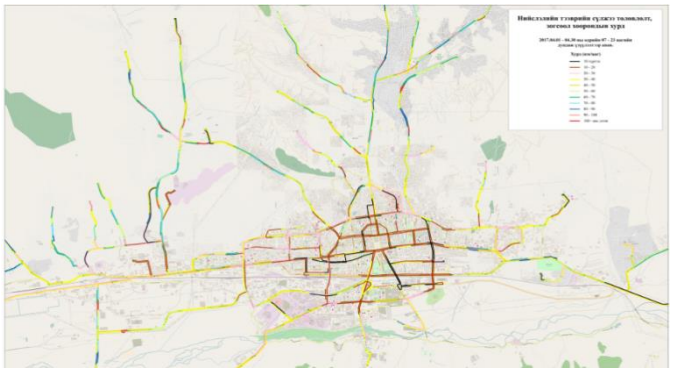

Figure 19. Network planning and Speed between bus stops

In order to study the reasons for public transport speed, the area of the capital city was divided into zones. For example, in the Central Region, traffic lights, traffic congestion, traffic

congestion, and remote departure points are considered as an interval over time and expectations.

We studied the interval between 1037 bus stations of the 98 transport routes of Ulaanbaatar and resulted in the results of the first quarter of 2017. The interval is 10-11 minutes between 8-11 minutes between the Enkhtaivan Avenue and Ikh Zarung and the University Street Entrance, and for the remote city of some of the city's 5 Short-Distance Road Trails.

Intervals such as traffic lights, traffic congestion overlaps, time lapse of bus interval, intervals during the intervals, high expectations, and the number of vehicles passing by that road are relatively small, the roads are straightforward and the barrier is low.

In determining the output of public transport services, we compared the number of companies and routes approved by the Metropolitan Transportation Authority to the mapping using the ARCGIS software.

A detailed survey of the 89 vehicles in 20 public transport services in the capital city was carried out in each direction. These include:

- *Maximum:* Ch:3 - 30 buses.
- *Minimus:* HO:4 - 1 buses.

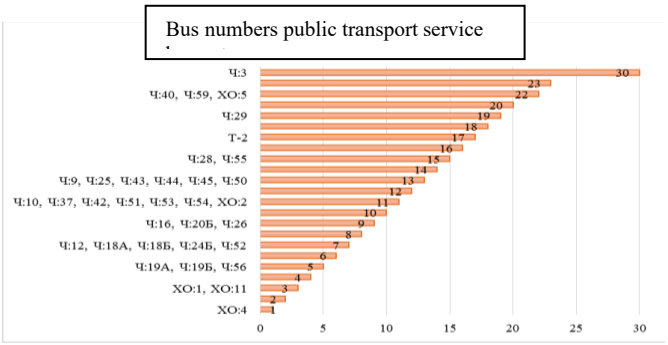

Figure 20. Bus numbers per route

The factors affecting the number of vehicles in the low-traffic range are low population densities and longer turnarounds. In the case of high-traffic routes, the population density is high, the turnaround time is short and the number of traffic routes with high passenger traffic is high.

It is recommended that the public transportation of Ulaanbaatar be modeled as follows.

1. Use the traditional approach or "Four stages" to perform network planning.
2. Detailed study and planning of Ulaanbaatar transportation distract and divide. Establish traffic zones (Traffic Analysis Zone).
3. Determine the statistical and socioeconomic characteristics of the population of Ulaanbaatar in the Traffic Zone
4. Characteristics of the transportation system of the Capital city of Ulaanbaatar is defined by regionary traffic zone (TAZ).
5. Conduct public transport service surveys and define the general demand for transportation in the capital city of Ulaanbaatar
6. Improve public transportation services in the capital city of Ulaanbaatar and identify major zones that cause traffic congestion
7. Make mathematical modeling of public transportation planning and policy in the capital city of Ulaanbaatar
8. Establishing alternative model planning. Develop a planning application for alternative urban planning, policy-making, and policy alternatives for Ulaanbaatar.
9. To make proposals and recommendations describing ways to introduce urban planning, transportation planning policies and strategies appropriate to the Capital City of Ulaanbaatar

In doing so, a thorough study of the experience of a foreigner will be carried out and a detailed analysis will be made.

Acknowledgement

The authors would like to express their gratitude to Transportation department of the Ulaanbaatar capital city for their assistance, advice and resources rendered during the undertakings of this research project.

Conclusion:

The following conclusions are made based on the study of factors influencing the public transport service network planning.

1.Re-planning of public transportation network to increase traffic congestion and traffic congestion, negatively affecting the travel time and usage speed of public transport services,

and to reduce the overlap, improve service quality, increase accessibility, and introduce registration and electronic payment system and new technology. The following results can be achieved if the implementation is implemented.

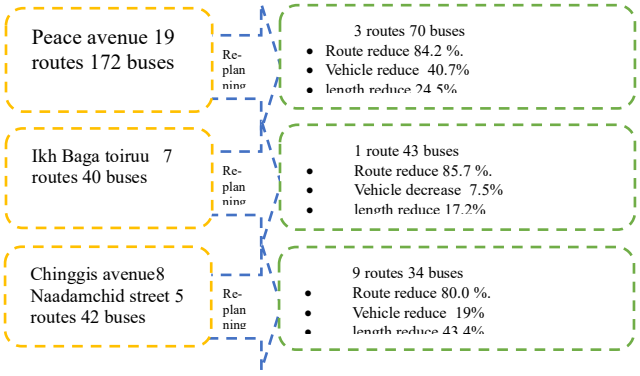

Figure 21. Re-planning public transportation service

2. Integrate routes of public transport services.

18 routes decreasing to 9, reducing 142/102 output by 30%, Expenditure decreased by 40%, Increased subsidence

3. Reduce overlaps in the sub urban routes. Change the six urban areas

4. Modify marine passenger traffic. Modify 10 low passenger routes

5. Change the interval between public transport stops

54.7% of the total parking spaces intervals run 0.5-3.5 minutes, reducing the amount of public transportation and reducing costs by redesigning routes.

6. Reduce the impact of weekends and weekdays on public transport

It is important to consider the impact of the planet on public transport data. For example:

• Pay attention to the impact of planetary on 1 day bus revenue;

• Organize renovations as early as possible at the beginning of the bus line to the end of the month;

• The flexibility of planning for the student and student style in total passenger structure is seasonal;

• alter public service planning based on passenger traffic and passenger travel patterns;

7. Public transport services should be conducted by 9 indicators using the Traffic Analysis Zone (TAZ)

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