METHODS OF DETERMINING PASSENGER FLOW IN PUBLIC TRANSPORT

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Annotation.

The article analyzes the importance of methods for determining passenger flow in improving the quality of urban public transport services and correctly organizing movement intervals. Various calculation methods have been used to study passenger flow, and these methods have proven effective in determining the number of vehicles on routes, selecting the correct movement intervals, and studying passenger flow. The more vehicles there are on a route and the shorter their movement intervals, the higher the quality of transport services provided to passengers.

The importance of road transport in the socio-economic development of our country and in the transportation of goods and passengers is significant. As the population increases year by year, cities expand, and the need for road transport grows. This naturally leads to safety issues on the roads, congestion in city streets, and problems providing transport services to the population. Public transport is a means that directly influences people's mood by shortening distances. Last year, over 3,000 complaints were submitted to the People's Reception Offices concerning this issue, highlighting numerous shortcomings in the field. According to estimates, only about 22%, or 4.4 million, of the 20 million daily passengers in our country use public transport. This figure is even lower in regions such as Andijan, Kashkadarya, Namangan, Khorezm, Samarkand, Fergana, Bukhara, and Tashkent. Around 1,200 rural district routes are not covered by public transport. The shortage or aging of public transport fleets, with some vehicles past their service life, and the improper organization of movement intervals show that there is much work to be done.

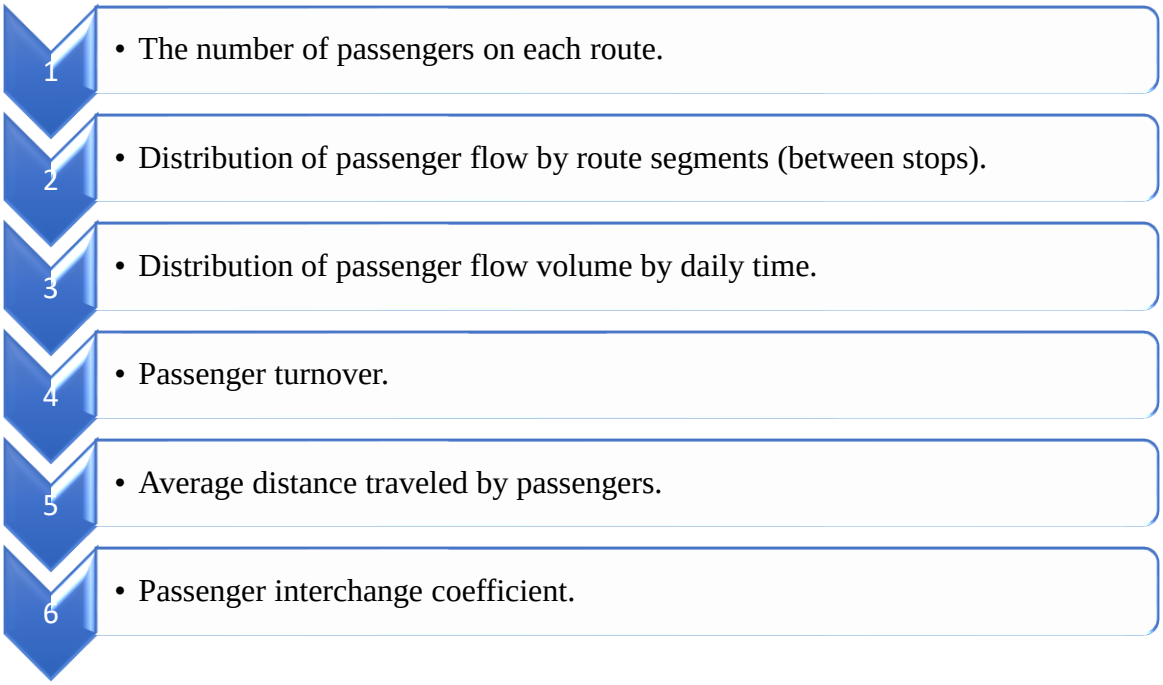
This in turn highlights the need for surveys to identify city public transport routes and gather data to improve the existing transport service system. Studying transport demand provides information on the patterns of passenger transportation needs. Through transport service surveys, it is possible to determine how well the existing system meets the population's transport service needs. Currently, the transition to a market economy is increasing the population's transport mobility. Passenger flow, its volume, and other characteristics depend on the population's transport mobility. Transport mobility refers to the frequency of transport usage over a certain period (usually a year or more). The frequency and timing of transport usage depend on the purpose of transport usage (work, education, recreation, etc.). Research emphasizes the need to optimize these aspects.

Public transport plays a crucial role in our country, particularly buses and minibuses, which are important for serving passengers. The large number of vehicles on city streets, especially during peak hours, leads to traffic congestion, reduced speeds, and, as a result, disrupted schedules. This causes long waiting times for passengers. To solve these problems, it is essential to first analyze passenger flow in public transport. Identifying movement intervals based on passenger flow and effectively organizing transportation is critical. To provide efficient transport services, it is necessary to systematically collect data on passenger flow. The main objectives of data collection are to study passenger movements, which can be divided into two categories: the population's transport needs and the transport demand patterns, indicating that around 70% of the population uses transport to get to work or study.

Passengers transported on a specific route and segment are referred to as passenger flow. To fully meet the population's transport needs and provide high-quality services, passenger flow and its characteristics should be integrated with the following data:

Passenger flow can be represented in the form of graphs, epures, cartograms, cyclograms, or tables. Passenger flow is detailed by the length of the route and the hours of the day. We need to observe the daily variations in passenger flow to identify the two periods with the highest flow, such as the morning hours when people go to and return from work. These periods are known as peak hours.

Pic 1 Information of pasangers flow



Passenger flow can be studied either comprehensively (covering all buses operating within a city, district, or route) or selectively (covering only part of the buses in a city, district, or route). The method chosen depends on the purpose for determining the passenger flow.

There are several widely used methods for studying passenger flow, which include the following:

Survey Method: In this method, special questionnaires are prepared and distributed to the population to study passenger flow. The questionnaire includes questions about how many times and for what purpose people used transport services, which routes they took, and the distance traveled during a given period. The data collected can be used to evaluate the quality of transport services provided to the population, develop future transport network plans, choose the type of transport, and solve issues related to city transport planning.

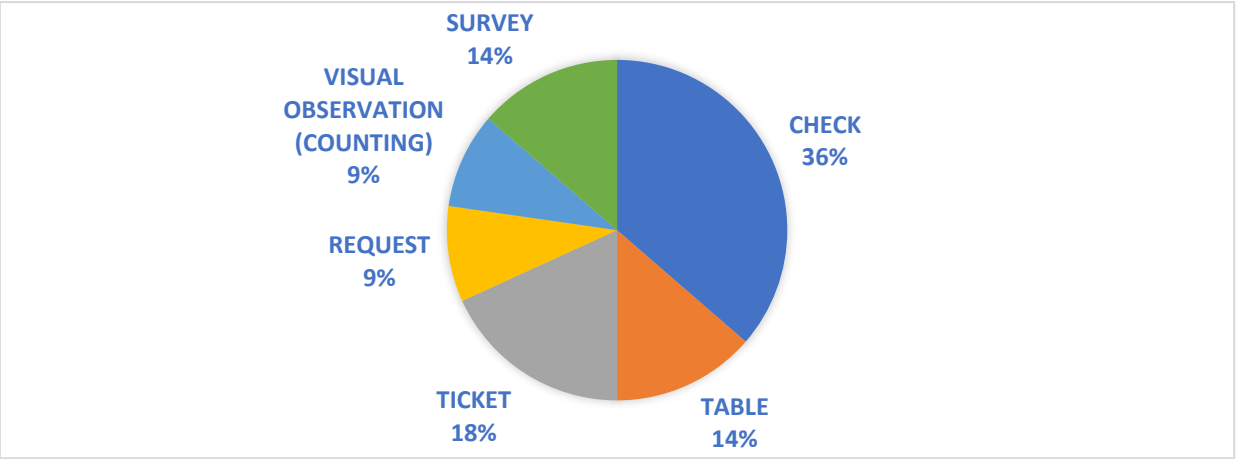
While the survey method is one of the best tools for addressing pressing transport issues, it has some drawbacks. These include:

1.The complexity of conducting the survey: Preparing the questionnaires, distributing them to each passenger, and collecting them back requires time.

2.The time-consuming nature of processing survey data: Analyzing the collected data and processing the results in a timely manner consumes time.

3.The accuracy of reflecting passenger flow during peak hours and the distribution of vehicles and segments along the route: Obtaining complete and precise data for routes is essential for monitoring passenger flow and determining the most effective way to manage vehicle movements.

Survey Method: This is one of the effective tools for studying passenger flow. In this method, special questionnaires are prepared and distributed among the population. The questionnaire includes questions about how many times and for what purpose each citizen has used transport services during a certain period, which route they traveled on, and how far they traveled. The data collected plays an important role in assessing the quality of transport services, developing future transport network plans, selecting the type of transport, and planning urban transport. The survey method is one of the effective tools for addressing pressing transport issues. However, this method has some drawbacks, including:



Pic 2. Methods of Studying Passenger Flow

Table 2. Sample of Passenger Flow Survey Questionnaire.

Question	Answer	Code
Which stop do you leave from and at what time when using transport to go to work, school, or leisure places?	"Gullar" Stop 6:30	
How much time do you spend getting to the transport stop, and which stop is it?	"Olmazor" Stop 9 Minutes	
Where and at what time do you transfer to another mode of transport for the first time?	"Siyob" Stop 12:20	

Check Method: The ticket method is one of the most commonly used methods for studying passenger flow. However, this method requires considerable effort to collect and analyze initial data. The main objective of the ticket method is to determine the number of passengers boarding, alighting, or passing by without boarding at stops. This method allows for the identification of passenger flow by time of day, route segments, and movement directions, as well as the calculation of unevenness coefficients, average travel distances for passengers, and the measurement of overall service efficiency (in passenger-kilometers).The process of studying passenger flow using the ticket method is carried out as follows: Tickets with a serial number greater than the total number of stops are prepared.

Table 2. Appearance of the Check

1	**2**	**3**	**4**	**5**	Please submit the ticket to the cashier when getting off.
6	**7**	**8**	**9**	**10**	
11	**12**	**13**	**14**	**15**	
16	**17**	**18**	**19**	**20**	

The enumerators indicate the stop from which each passenger is boarding the transport by marking the stop number on the ticket, which they return at the stop where the passenger alights. The ticket records which stop the passenger has alighted at. The collected data is analyzed to determine each passenger's connections between stops. The counts are conducted separately for each direction of transport movement (forward direction and reverse direction). The preliminary analysis of passenger data provides a basis for initial recommendations on which type of bus route should be established in the observed direction. The primary criterion for selecting the type of route is the level of passenger occupancy of the buses. In this case, it is necessary to choose the type of bus route in such a way that the level of bus capacity utilization is high (ensuring the route's

profitability) while also providing convenience for passengers, ensuring that the level of utilization does not exceed acceptable limits.

Table 3. Matrix for studying passenger flow using the check method (results).

1	**2**	**3**	**4**	**5**	**6**	Exit	Get	It was left bus
1	**10**	**25**	**30**	**20**	**10**	**95**	**-**	**95**
2		**20**	**25**	**25**	**15**	**85**	**25**	**155**
3			**20**	**15**	**30**	**65**	**30**	**190**
4				**25**	**25**	**50**	**55**	**185**
5						**-**	**185**	**-**
Get	**10**	**45**	**75**	**90**	**80**	**-**		

Visual Observation (Counting) Method: This is one of the simple and effective methods for determining passenger flow in transport. This method uses a six-point scale to assess the number of passengers on the bus. It is particularly applied at the most crowded stops and routes. The scoring system works as follows:

1 point: More than half of the bus seats are empty.

2 points: All bus seats are fully occupied.

3 points: Seats are full, and half of the standing spaces are occupied.

4 points: The bus is nearly full, with 2 passengers per square meter of available space.

5 points: The bus is at full capacity, with 4 passengers per square meter of available space.

6 points: The bus is overcrowded, with 8 passengers per square meter of available space, and there may also be passengers who cannot board the bus.This method is important for determining the condition of the transport vehicle and the original state of the seats. Despite its simplicity, the counting method is useful for conducting regular observations at different times of the day, on different days of the week, and during various seasons of the year. Therefore, this method is suitable for the regular study of passenger flow.

Table Method: The table method is often used to study passenger flow in urban public transport on a weekday, typically on Wednesdays or Thursdays. This method aims to conduct comprehensive and systematic observations of passenger flow across various routes simultaneously within all types of urban transport. When there is insufficient personnel in transport companies, college and university students are also involved in the observation tasks. Special tables are prepared in advance for the observation work and printed out. A group of enumerators and their leaders are appointed, and they carry out observations on several routes. Before starting the observations, group leaders provide instructions to the enumerators on how to fill out the tables. This is a crucial part of the process of studying passenger flow, as the accuracy of the data depends on the enumerators correctly filling out the tables. Additionally, a number of organizational issues for the observation day need to be addressed. For example, arrangements must be made regarding where the enumerators will gather, where they will start the observations, how they will return to their locations after the observations, and the schedule for breaks, among other matters.

Request Method: This method is considered an important tool for studying passenger flow and improving transport services. It is implemented in two different forms: In the first method, questionnaires with written questions are sent to the population via mail or communication offices. This survey can address several issues, including studying the connections between stops, determining the likelihood of transport hub locations, and gathering important information for establishing new routes to better serve populations that have relocated to new areas. Additionally, this method is crucial for correctly selecting the types and capacities of transport vehicles. In the second method, survey forms are not sent to the population via mail. Instead, enumerators directly interact with passengers at the stops and collect their responses to the questions. In some cases, survey forms are distributed to passengers while they are on transport, and the completed forms

are later collected. This method helps directly gather passenger opinions and provides a basis for further improving the transport system.

Table 4. Passenger Flow Request Questionnaire.

T/r	Question	Answer
1	Where is your place of residence?	
2	What time do you go to work or school?	
3	How much time do you spend getting to the bus stop, and which stop is it?	
4	Which stop do you leave from and at what time when going to work, school, or leisure places?	

Ticket Method: The method based on tickets is used to calculate passenger flow, the number of passengers transported, and their average travel distances. This method is implemented by analyzing daily or monthly tickets, allowing for more accurate tracking of passenger movements and transportation processes. This method is especially effective in routes where ticket control is absent (suburban, intercity, and other long-distance routes). In these routes, it is possible to accurately determine the number of passengers and their travel distances through tickets, which helps increase the efficiency of the transport network. However, there is one significant drawback to this method—it is not suitable for use in urban transport systems. The main reason for this is that a large portion of urban passengers benefits from concessions when using transport services. Due to the provision of free or discounted transport services to certain categories such as pensioners, students, and other privileged groups, the passenger flow identified based on tickets may not fully reflect the actual flow in the city. Therefore, it is necessary to apply other methods when studying passenger flow within urban areas.

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