RELIABILITY OF THE PROCESS OF URBAN TRANSPORTATION AND INDICATORS OF EVALUATION

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Abstract

There are various types of disruptions in the urban transportation process which lead to dynamic imbalances reducing the level of reliability of the transportation process.

In order to increase reliability, it is necessary to determine the factors that cause the failure of the transport company.

It is recommended to evaluate the reliability of urban transportation according to the stages of the transportation process (line omission, line work), and then developing appropriate methods for evaluating the system of indicators for the whole process.

*Key words***:** transport, public, passenger, process, index, reliability.

Introduction

Experience in the operation of urban public passenger transport shows that both the quality of service to the population and the technical and economic indicators of passenger transport work are greatly influenced by the level of reliability of the transportation process.

Studies have shown that the level of reliability of the urban public transportation process is affected by the number of line failures, the number of interruptions during work on the route, their interval and the line (line work) recovery time etc. [1,4,5].

Conflict setting

The most important task to increase the reliability of the transportation process is to reduce the number of line omissions, breakdowns during work and their recovery time. The solution to the problem is possible by determining the factors that cause the failure of the transport enterprise.

Research results

Determining the combined effect of factors on the number of failures in the transport process requires the construction of a multifactorial regression model where the dependent variable Q (number of failures) is considered as a function of the independent variables x (factors) [3].

The dependence of the factors on the number of failures can be expressed by the $Q(X)$ function, denoting the random factors $x_1, x_2, \ldots x_i$. If we assume that the relationship between X and Q is linear, then the regression equation will look like this

$$Q(X) = a_0 + a_1 x_1 + a_2 x_2 + \cdots + a_i x_i.$$

The given equation relates the average value of the $Q(X)$ function to each random factor x_i.

The coefficients of the regression equation $a_1, a_2, \ldots, a_i$ take into account the magnitude of the influence of each factor on the number of failures in the transport process [5].

The destabilizing factors affecting the reliability of the urban public transportation process are due to the influence of both external and internal environments.

The external factors affecting the reliability of the urban public transportation process are:

1. The impact of the time of year on the operation of rolling stock (RS). During the autumn and winter seasons, due to the technical unpreparedness of the RS, the frequency of dropping out of the car park decreases and the number of rejections increases due to low temperatures.

2. Weather conditions. With the worsening weather conditions (heavy snowfall, heavy rains, fog) the visibility and the speed of movement of the RS decreases, the malfunctions and the traffic accidents increase.

   It is practically impossible to eliminate the negative impact of environmental factors by urban passenger transport companies which is mainly due to objective reasons (weather conditions etc.).

3. High level of urbanization of the city and low level of road-transport development which leads to a sharp increase in traffic density and intensity. The latter lead to a high intensity of traffic, which reduces the speed of traffic and increases the number of possible accidents leading to passenger delays.

4. Off-site construction works carried out by other organizations in the street traffic which also leads to delays in the RS, consequently.

5. Strict system of forced regulation of road traffic. Intensity of the increase of traffic flows in the main directions, especially in the conditions of two-way traffic which leads to traffic jams at the intersections and lack of priority of public transport. Such a state of traffic flows inevitably leads to conflict situations, road accidents and, consequently, disruptions in the transportation process.

Factors influencing the reliability of the transportation process due to the influence of the internal environment can be grouped into three groups: structural, production and operational.

Structural factors lead to breakdowns due to the structural features of vehicles. Structural factors are eliminated by the manufacturing plant according to the requirements of the transport companies.

Factors of production are assessed by the level of maintenance, the state of technical readiness as well as the low levels of the qualification system of the service personnel, the collection and processing of statistical data.

RS maintenance, repair and low level of service leads to non-productive failures and downtime.

RS repair and maintenance of services in proper organization will reduce the number of failures.

The staff which is endowed with high knowledge and skills, detects and eliminates malfunctions fairly quickly.

Operating factors assess the level of impact of the conditions under which the population transports within the city. Among them are:

1. The degree of complexity of the route which includes the presence of road slopes and curves with a small radius leading to a decrease in the speed of the RS.
2. The condition of the route. The poor condition of the route, especially in winter, reduces the speed of the RS, increases the waiting time for passengers leading to violations of the time to reach the end line through the public transport.
3. The level of qualification of the driving staff. The low level of quality of the driving staff leads to the violation of the route, the inability to make immediate decisions reducing the indicators of reliability.
4. Level of work organization. It affects the uneven workload of the driving staff, the increase of their fatigue and the occurrence of failures creating preconditions for improper organization of works on the route.
5. Level of work planning of the rolling stock (wrong traffic mode, turning derailment, driver idle at the end point, etc.).
6. The level of organization of dispatch work.

In addition to the main factors that affect disruptions, there are a number of additional factors such as route crossings, railway crossings, long-term road construction and so on.

The reliability of the transportation process in cities is directly related to meeting the transport service needs of the population.

Measures aimed at ensuring the stability of the transportation process by increasing the reliability of urban transportation also serve as a means of improving the quality of urban transportation services provided to the population of the city.

Since the main thing in urban transportation is to provide a work schedule on the route, the reliability of the transportation process can be understood as the probability of organizing transportation on the routes according to the defined itinerary.

The reliability of the transportation process is assessed by the smooth operation of the rolling stock on each route (5). The time spent serving the population during the day is determined by the sum of the time the rolling stock leaves the assembly line.

However, studies have shown that various types of disruptions occur during this period leading to dynamic imbalances (2). These failures require the establishment and implementation of an intra-city Traffic Management Operational System (TMOS).

Taking this into account, there is an urgent need to examine the temporal sequence or frequency of failures the validity of the urban passenger transport UPS as a means of restoring the transportation process.

The reliability of the transport process means the provision of transport services to the population within a certain period of time, maintaining the values specified in the specifications defined by the regulatory documents (timetable, schedule time, etc.) in the appropriate conditions of rolling stock operation [1,2].

In our studies, the definition of the reliability of the transportation process to serve as a working model is very general and it requires certain details. Therefore, when solving the problem, it is advisable to assess the reliability according to the stages of the transportation process (line omission, line work), and then the transportation process as a whole (Fig. 1).
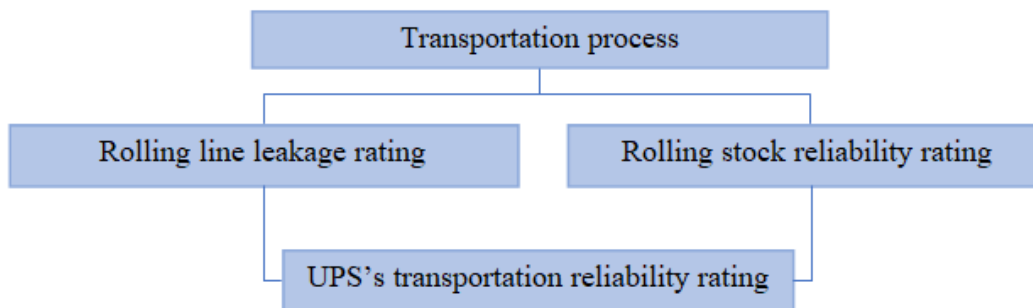

Fig. 1 Reliability of urban transportation process extended evaluation scheme

The reliability of the transportation process is determined by the probability of working on the line without leaving a fault line in the period from the departure of the urban passenger rolling stock to the return [2].

In this case, it is accepted that each of the stages of the transportation process is the simplest. It is assumed that it can be in only two states: working (passenger transportation provision) disrupted (cessation of transport services to passengers due to the impossibility of carrying out the transportation process).

Therefore, the state of the transport process is determined by the state of the elements that provide it. The failure criterion allows the whole set of states of the stages of the transport process to be divided into two subsets.

The first subset is characterized by the state of dynamic equilibrium of the transport process (functionality of all stages of transport), the second is characterized by the state of dynamic equilibrium of the transport process (disruption of any auxiliary phase) at time t.

The theoretical description of the transportation process can be presented as follows (function) [4].

$$X_i(t) \begin{cases} 1, \text{if the } i - \text{th element that provides the transfer process at time is active,} \\ 0, \text{if the } i - \text{th element that provides the transfer at time is in failure} \end{cases}$$

The state of the transport process, which consists of n supporting elements, is characterized by n-number vectors $X = (X_1, X_2, X_3, \ldots, X_n)$.

Therefore, the set of elements of the transport process, consisting of $2 \wedge n$ states, can be divided into two subsets: able-bodied states.

Given that the elements are interpreted as "right" and "wrong" logic values corresponding to the Boolean function of set (X) which is a structural function.

$$X \begin{cases} 1, \text{if state X, according to the selected criterion,} \\ \text{corresponds to the normal course of the transfer process,} \\ 0, \text{otherwise} \end{cases}$$

The properties of the Boolean function are that if $X = 1$, that is, all X_i, then, $\Phi(1) = 1$, if $X = 0$, that is, all X_i, then $\Phi(0) = 0$.

This property indicates that if all the components of the transportation process are working, then the transportation process is in good condition.

Conclusion

1. During the regulatory period, various types of disruptions occur in the process of urban road transportation which leads to dynamic imbalances and a decrease in the level of reliability of the transportation process.

2. In order to increase the reliability of the urban transportation process, it is necessary to reduce the number of line omissions, work-related failures and their recovery time. The solution to the problem is possible by determining the factors that cause the failure of the transport enterprise.

3. It is advised to assess the reliability of urban transportation according to the stages of the transportation process (line omission, line work), and then develop appropriate methods for evaluating the system of indicators for the whole process.

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ՔԱՂԱՔԱՅԻՆ ՈՒՂԵՎՈՐԱՓՈԽԱԴՐՄԱՆ ԳՈՐԾԸՆԹԱՑԻ ՀՈՒՍԱԼԻՈՒԹՅՈՒՆԸ ԵՎ ԳՆԱՀԱՏՄԱՆ ՑՈՒՑԱՆԻՇՆԵՐԸ

Միրզոյան Ն.Ա., Գրիգորյան Ք.Ա.
Շուշիի տեխնոլոգիական համալսարան

Քաղաքային ուղևորափոխադրման գործընթացում տեղի են ունենում տարբեր տեսակի խափանումներ, որոնք բերում են դինամիկ հավասարակշռության խախտումների և փոխադրման գործընթացի հուսալիության մակարդակի նվազման:

Հուսալիության բարձրացման համար անհրաժեշտ է որոշել այն գործոնները, որոնցով պայմանավորված է տվյալ տրանսպորտային ձեռնարկության պայմաններում խափանումների առաջացումը:

Առաջարկվում է քաղաքային ուղևորափոխադրումներում հուսալիության գնահատումը կատարել ըստ փոխադրման գործընթացի փուլերի (գիծ բաց թողում, գծում աշխատանք), այնուհետև ամբողջ գործընթացի համար, մշակելով ցուցանիշների համակարգի գնահատման համապատասխան մեթոդներ:

Բանալի բառեր. տրանսպորտ, հասարակական, ուղևորատար, գործընթաց, ցուցանիշ, հուսալիություն:

ОЦЕНКА НАДЕЖНОСТИ ПЕРЕВОЗОЧНОГО ПРОЦЕССА ГОРОДСКОГО ПАССАЖИРСКОГО ТРАНСПОРТА

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В процессе работы городского пассажирского транспорта происходят различные виды сбоев, которые приводят к нарушениям динамического баланса и снижению уровня надежности перевозочного процесса.

Для повышения надежности необходимо определить факторы, которыми обусловлено возникновение сбоев в условиях данного транспортного предприятия.

Предлагается оценку надежности городского пассажирского транспорта проводить по этапам перевозочного процесса (выпуск на линию, работа на линии), затем по всему процессу, разрабатывая соответствующие методы оценки системы показателей.

Ключевые слова: транспорт, общественный, пассажирский, процесс, показатель, надежность.