

V. Nykonchuk, M. Krystopchuk, S. Pashkevych
National University of Water and Environmental Engineering, Rivne, Ukraine

FUNCTIONING OF TRANSPORT-INTERCHANGE NODES IN THE CITY TRANSPORT SYSTEM

The article identifies problem issues of the functioning of the route passenger transport system. The research reveals directions for increasing the efficiency of the public transport system and ensuring the quality of passenger service under the conditions of effective interaction between the service and consumer flow entities.

The article gives the definition of the concept of the “transport-interchange node” and classification of nodes according to various characteristics; it also presents a diagram of the types of transport-interchange nodes according to the spatial location of stops. The research determined that transport-interchange nodes perform the functions of redistributing passenger flows between different types of transport and ensure a reduction in the waiting time of transport passengers at stops in the city’s route network, taking into account existing technologies for organizing the operation of transport vehicles.

The research proposes practical recommendations on how to improve the interaction of passenger flows in transport-interchange nodes within the city passenger transport system. One of the solutions can be the establishment of the express transport connection between bus stations. The results of the research provide an opportunity to analyze the current situation in the city and to develop measures to improve public transport routes in the city of Rivne regarding transport-interchange nodes. These measures include, in particular, a complex of actions aimed at increasing the efficiency of the functioning of transport-interchange nodes in interaction with the city passenger transport system.

Key words: route network, public transport, stops, transport-interchange node, express connection.

INTRODUCTION

The modern stage of the development of urban passenger transport systems is characterized by an urgent need for reform, reorganization and search for effective methods of improving the quality of public transport services. The need to reform urban transport systems is based on the society’s needs for saving all types of available resources, reducing the negative impact of transport, increasing the population’s demands for urban mobility and the need for the comprehensive implementation of a strategy for the sustainable development of urban environments aimed at improving the quality of life of the population and ensuring their future development potential.

The transition to new operating conditions of public transport caused the emergence of the new forms of passenger services, which necessitated the formation and development of a route network. It includes, in particular, the establishment of transport interchange nodes that perform the functions of redistributing passenger flows between different modes of transport and reducing the waiting time of transport passengers at stops in the city’s route network, taking into account existing technologies for organizing the operation of transport vehicles.

ANALYSIS OF LITERATURE SOURCES AND STATEMENT OF THE RESEARCH PROBLEM

The problem of increasing the efficiency of the functioning and development of urban transport is quite important; it has been investigated, in particular, by such scientists as V.V. Aulin, K.Ye. Vakulenko, V.O. Vdovychenko, V.O. Hudkov, K.V. Dolia, V.A. Myhachov, P.F. Horbachev, O.O. Lobshov, O.P. Tson. Many scientific works have considered the theoretical regularities of the redistribution of passenger flows between routes [9]. These studies aimed to substantiate the rational location of bus transport-interchange nodes in cities and to assess the strategic directions for the development of urban public passenger transport [10].

The works by Z. Azarenkova and V. Shchurova investigate the problems of the quality of public transport services through the assessment of the efficiency of the functioning of urban transport and substantiate the consequences of changing the parameters of the route network [12, 13].

Despite the high level of the studies on this topic, there is a need for additional research into this issue, in particular, the interaction of passenger flows in transport-interchange nodes with the urban passenger transport system.

PURPOSE AND OBJECTIVES OF THE RESEARCH

The purpose of the research is to establish the influence of the of transport-interchange nodes location on the parameters of their interaction with the urban passenger transport system.

To achieve the purpose, the following tasks were set:

- to determine aspects of the functioning of the route passenger transport system;

- to define the types of transport-interchange nodes in their interaction with the city passenger transport system;
- to develop a set of measures aimed at increasing the efficiency of the functioning of transport-interchange nodes in their interaction with the city passenger transport system.

RESEARCH RESULTS

Transport-interchange nodes are important components in the structure of the urban transport. Together with the main transport lines, they play the role of fundamental infrastructure elements. Effective interaction in transport-interchange nodes has a positive effect on the quality of public transport services and, along with the task of increasing the speed of traffic on routes, is an effective method of reducing travel time.

An important element of creating an effective route passenger transport system is ensuring a high level of internal interaction of its structural elements [7]. Unfortunately, today, in most cases, different types of route passenger transport work independently of each other; technical, technological, organizational and legal forms of interaction are absent or underdeveloped [4, 8]. This problem is caused by the lack of a single management structure, which should cover all subjects of the transport market and provide an opportunity to implement the principles of their cooperation.

The introduction of new technologies for public transport services requires a simultaneous change in the regulatory and legal framework. Such requirements are based on the need to create conditions for the implementation of the principles of intermodal and multimodal passenger transportation technologies [3]. Current tasks in this direction include the development of contracts for transportation, determination of the rights, obligations, and responsibilities of the parties for the provision of low-quality services. In addition, a separate issue is the distribution of income between enterprises when the single ticket is introduced.

A component of the effective functioning of the route passenger transport system is the provision of the necessary resource conditions for the implementation of technological processes and their organization. An important source of transport organization is its interactive monitoring, which can be provided using telematics and is aimed at improving the information development of the transport infrastructure of cities [11].

The economic efficiency of the city transport, along with improving the quality of transport services, is one of the main tasks of its work. The efficiency should be ensured by implementing a comprehensive approach aimed at increasing the profitability of transport enterprises, meeting the marketing needs of the population and implementing rational technologies for the transport service [3, 10].

An urgent problem of route passenger transport in the conditions of unprofitable transportation is to ensure the necessary technical condition of the vehicles of passenger transport enterprises. Low renewal rates and a high level of vehicles wear are a source of reduced transportation comfort, reliability, and safety, and lead to an increase in the level of environmental pollution. When solving this problem, mechanisms for attracting investment funds are actively used, and appropriate associations of transport enterprises can be created [2, 6].

A significant factor of the decrease in the efficiency of the route passenger transport system is the lack of coordination of interaction within individual elements of the transport infrastructure. Discoordination of interaction manifests itself in the discrepancy between the capacity of the public transportation system and the intensity of incoming route flows, the inconsistency of traffic schedules, and the lack of effective fixing of traffic lanes by types of transport. The negative consequence of such actions is an increase in the time of non-productive downtime of vehicles, a decrease in the resource efficiency of transportation, and deterioration in the quality of transport services.

The social significance of passenger transport is determined by its role in ensuring the quality of life of the population. Today, there is an acute problem of increasing the level of meeting the transport needs of the population [2, 10], the solution of which can be achieved by implementing a set of management measures aimed at the full and timely satisfaction of the marketing requirements of passengers.

The creation of the effective route passenger transport system requires the construction and expansion of the appropriate infrastructure: connecting routes, bus stops, transport and transfer complexes, facilities for technical maintenance of transport, energy supply facilities for transport, etc.

All types of ground route passenger transport, along with individual cars, in the process of implementing their functions, use a single territorial space, which determines their mutual influence and makes it possible to group their problems into a single systematized structure, which can be divided into institutional, social, ecological, technical, technological and economic directions (Fig. 1).

Determining the key problematic aspects of the route passenger transport system allows systematizing modern and promising approaches to their solution.

To solve the problematic aspects of the route network, it is first of all advisable to form strategic directions for its improvement, among which the main ones are the integration of the route passenger transport into the functional structure of the urban environment, as a constituent element of the social subsystem; establishment of rational forms of structural organization of the transport system of the city as a whole; development of methods for evaluating the interaction of consumers of transport services with elements of the service subsystem; improving the interaction of transport entities within infrastructure facilities; creating new and increasing the use of existing energy-efficient types of route passenger transport; implementation of rational mechanisms for the organization of market relations within the route passenger transport; effective use of available resources and infrastructure facilities [4, 7, 8].

The main requirement for the formation of such a complex of management actions is the need to create prerequisites for the constant development of the potential of the urban environment by rationalizing the use of available resources, reducing the negative consequences of the transport operation and implementing the principles of its target orientation to improve the quality of life of the population.

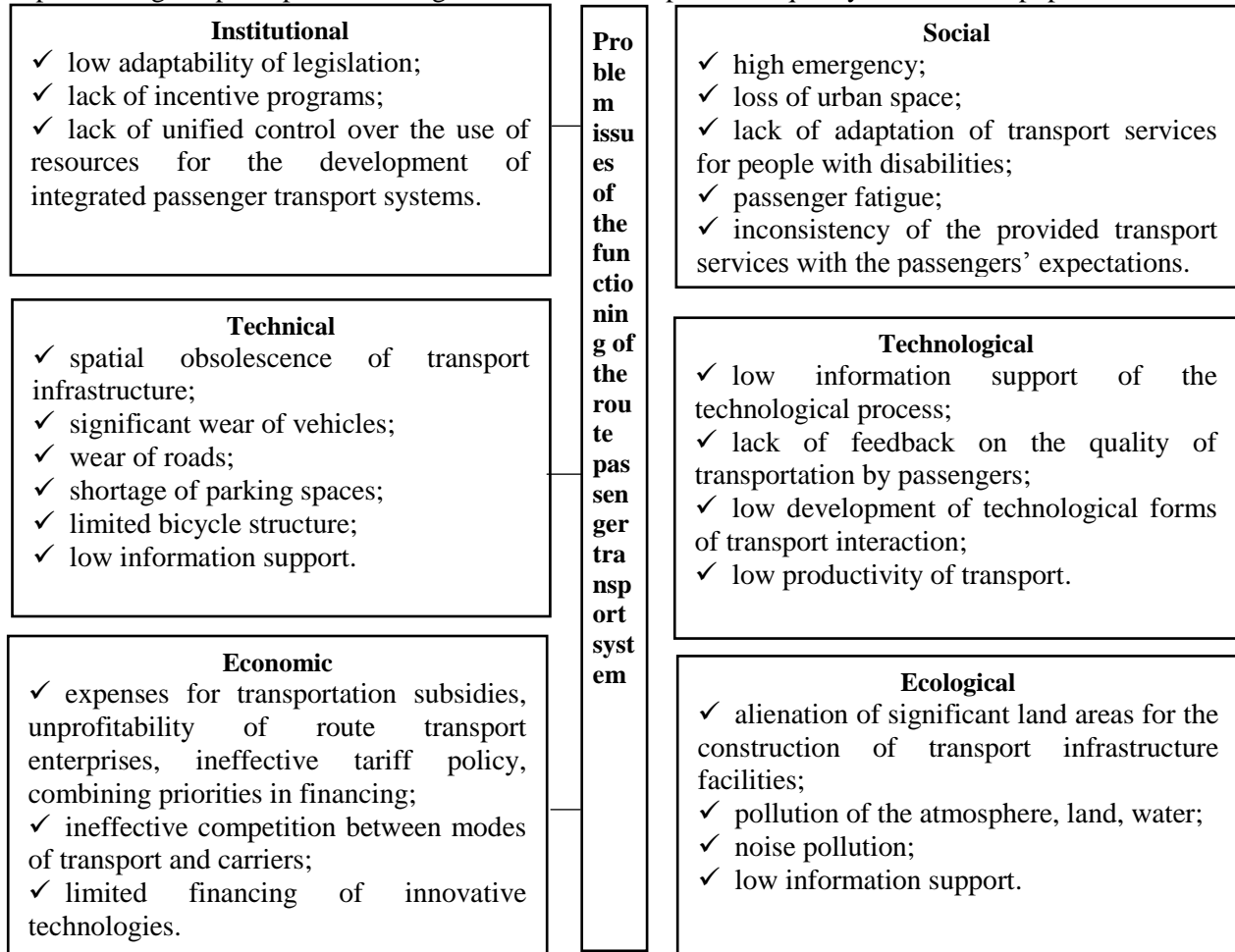


Figure 1. Problem issues of the functioning of the route passenger transport system.
Source: 4,7,8,9.

One of the key directions of improving the efficiency of the public transport system and ensuring the quality of passenger service is the formation of conditions for effective interaction between service and consumer entities.

A transport-interchange node is a key element of the planning structure of the city for transport and public purposes, in which passengers are transferred between different types of city passenger and external transport or between different lines of the same type of transport, as well as accompanying passenger service by social infrastructure facilities.

Nodes are classified according to various characteristics:

1. According to the role of interacting types of transport – regional, city-wide, intra-district;
2. According to the number of passengers – major, large, small;
3. According to the level of communication (class 1, 2, 3);

4. According to the position of the node in the transport infrastructure – between different types of urban, suburban, urban and suburban transport;
5. According to the number and type of interacting systems – transfer nodes of distribution, exchange and distribution, specialized and complex;
6. According to the types of transport – simple, basic, complex.

According to the spatial location of the stops that serve the transport-interchange node in interaction with the city passenger transport system, the main schemes are shown in Figure 2.

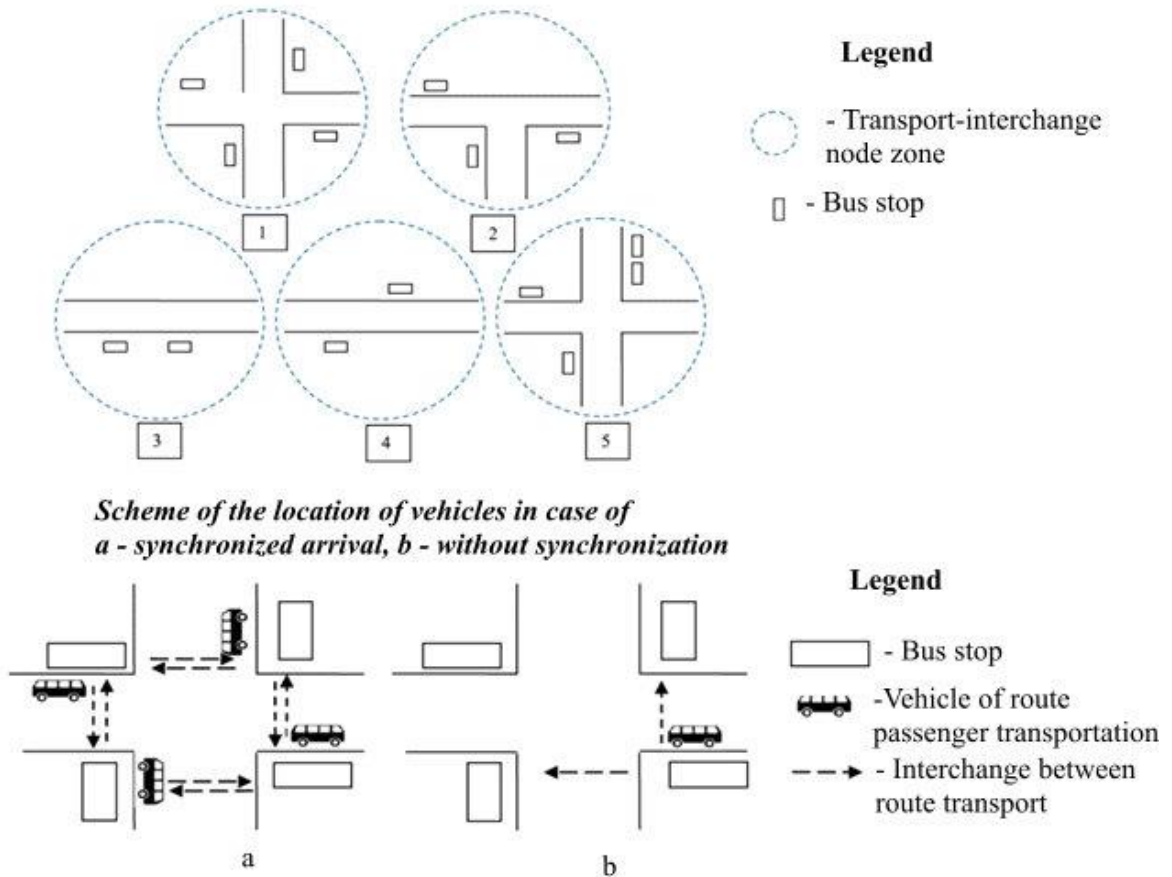


Figure 2. Types of transport-interchange nodes according to the spatial location of stops

A transport node cannot be considered in isolation from the city passenger transport system and individual transport flows. Transport-interchange nodes, where transfers take place within the framework of the ground passenger transport system, are located in different areas of the city.

Public transport stops in the city of Rivne, which are located in transport areas with the largest passenger flow due to the presence of passenger-generating points, were chosen for this study. The study considers three points to be transport-interchange nodes. They are Rivne Bus Station (Kyivska St.), Chaika Bus Station (Gagarina St.) and Zaliznychna (Railway) Bus Station, which connects railway and external ground transport (suburban connection) with the city transport passenger system (Fig. 3).

Transport-interchange nodes, where transfers take place within the framework of the ground passenger transport system, are concentrated in different areas of the city. Rivne Bus Station has 22 platforms that operate in different directions. 1178 departures are made from Rivne Bus Station every day. The number of departures in the suburban direction is 463, the peak hours of departures are from 7:00 am to 8:00 am (39 departures) and from 3:00 pm to 4:00 pm (38 departures).

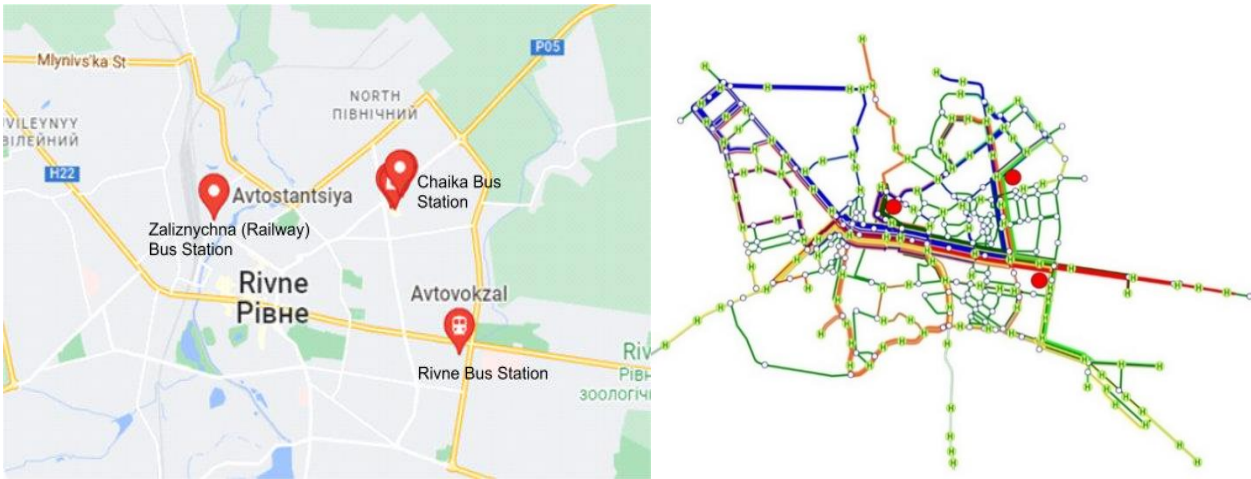


Figure 3. Scheme of the route network of the public transport system

There are 636 long-distance departures per day. In the morning from 8:00 am to 10:00 am, there are 126 departures and in the evening from 4:00 pm to 7:00 pm, there are 171 departures in intercity directions. Chaika Bus Station operates in suburban, intercity and international connections, and has 9 platforms for receiving buses. According to the current schedule of departures, 264 departures are made from the bus station per day, of which 44 are suburban, 212 are intercity.

The railway station transport-interchange node can be classified according to the number of interacting modes of transport as railway-ground transport node. In addition to the railway station, there is Zaliznychna Bus Station in the territory of the transport-interchange node. Peak hours are in the morning from 7:00 to 9:00 am and amount to 192 departures. The total number of departures per day on suburban routes is 854.

The Rivne Bus Station stop is characterized by a large passenger flow due to the large number of visitors, who are further distributed within the city's route network. The passenger flow is graphically shown in Figures 4 and 5.

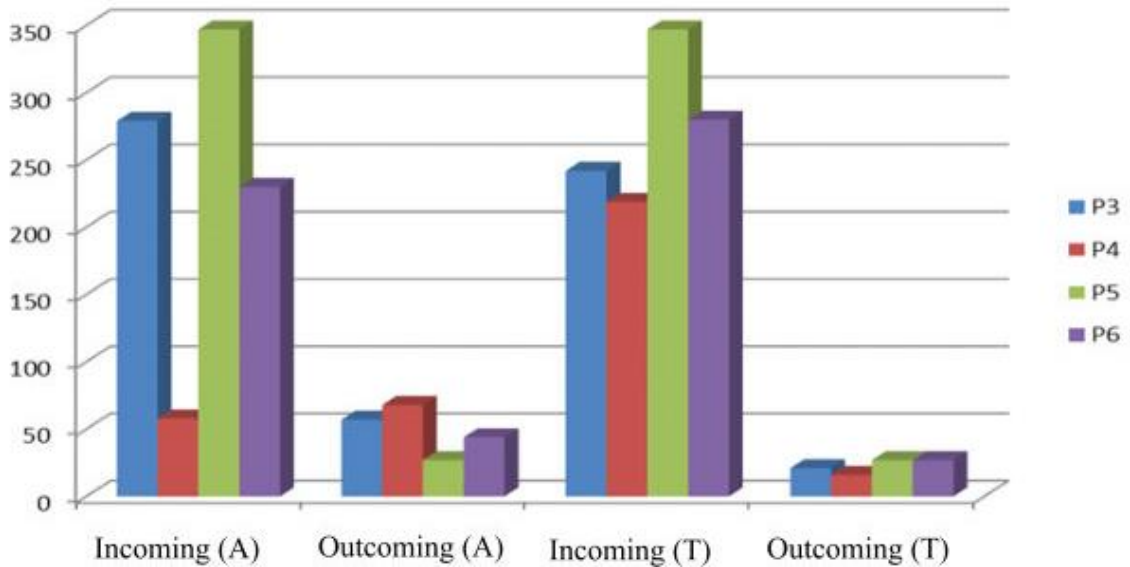


Figure 4. Passenger flow by types of city passenger transport from 8:30 am to 9:30 am at Rivne Bus Station stop

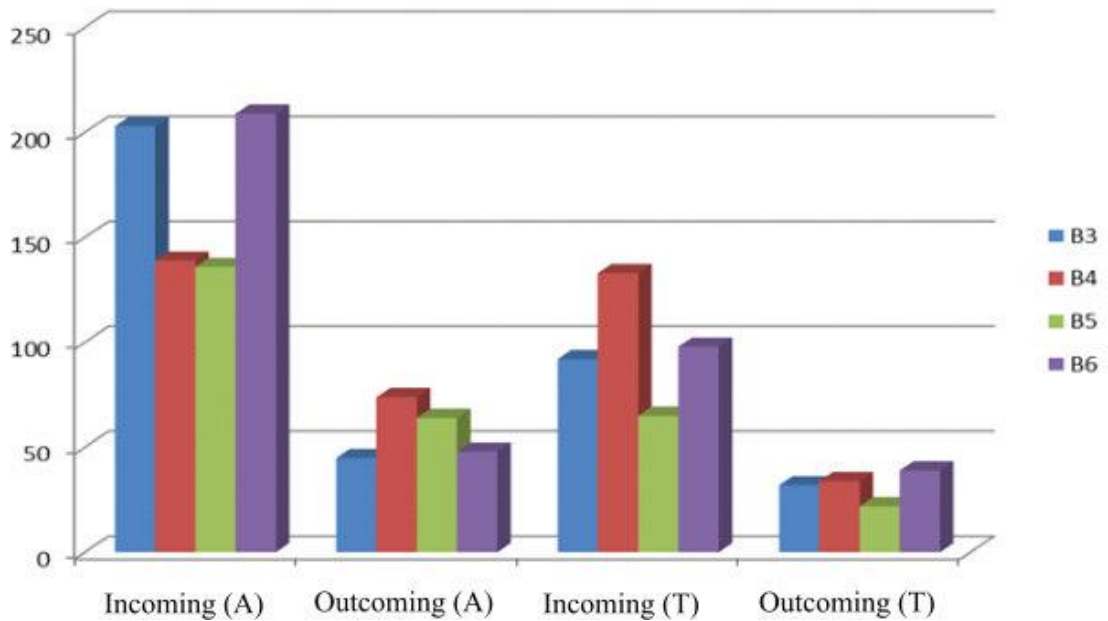


Figure 5. Passenger flow by types of city passenger transport from 5:30 pm to 6:30 pm at Rivne Bus Station stop

DISCUSSION OF THE RESEARCH RESULTS

As practical recommendation to improve the interaction of passenger flows in transport-interchange nodes with the city passenger transport system, one of the solutions can be the establishment of a transport connection between bus stations using the organization of express connections.

In order to evaluate the change in the state of transportation due to the introduction of the express traffic mode, the operation of buses on the routes was studied according to the duration of the round trip and the number of intermediate stops. According to the selected parameters, an analysis of the technical and operational indicators of buses in normal and express modes was carried out. The results of the research are presented in Figure 5.

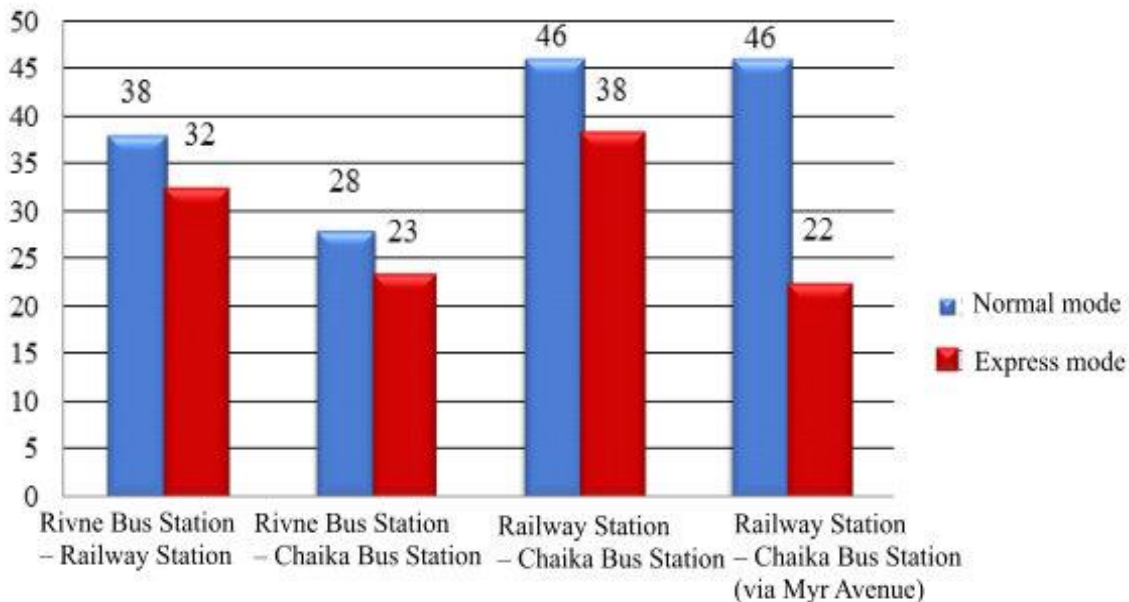


Figure 6. Comparative characteristics of bus operation on routes by the duration of the round trip

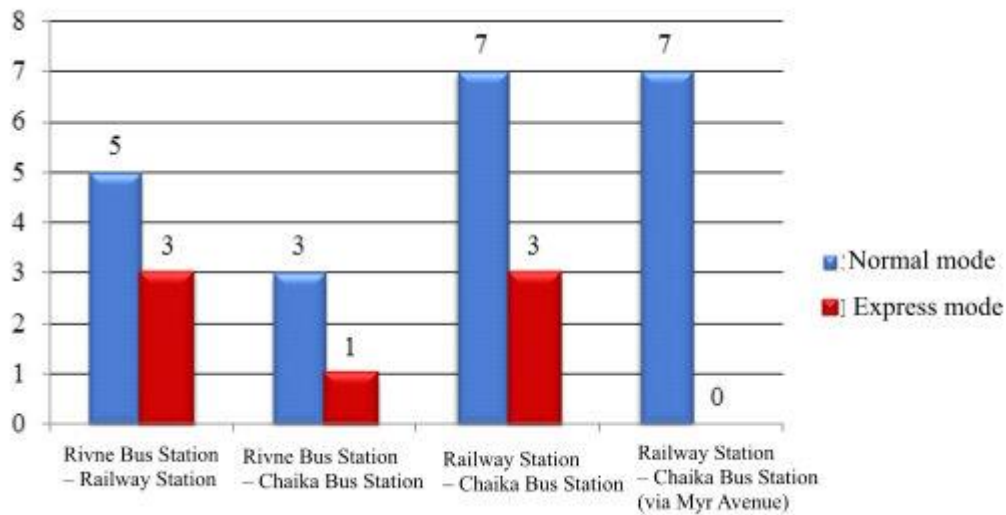


Figure 7. Comparative characteristics of bus operation on routes by the number of intermediate stops

As the research shows, effective interaction of public transport at transport-interchange nodes plays an important role in ensuring connection between Rivne districts and improving the quality of transport services. At the same time, the important criteria are ensuring the reduction of travel time between the main transport areas, which can only be achieved by express connection between these points. It can be organized parallel with the existing city passenger transport routes.

CONCLUSIONS

The results of the research provide an opportunity to analyze the current situation in the city transport and to develop measures to improve public transport routes in the city of Rivne in the areas of transport-interchange nodes. In particular, it is advisable to implement the proposed changes:

- to optimize traffic schedules for express connections;
- to rationally locate transport-interchange nodes, which should ensure the comfort of passengers;
- to substantiate time savings when transferring from one type of transport to another;
- to ensure the improvement of the quality of public transport services.

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В. Никончук, М. Кристопчук, С. Пашкевич. Підвищення ефективності функціонування транспортно-пересадочних вузлів транспортної системи міста

В роботі визначено проблемні аспекти функціонування маршрутної пасажирської транспортної системи. Розкрито напрями підвищення ефективності функціонування системи громадського транспорту та забезпеченні якості обслуговування пасажирів за умов ефективної взаємодії суб'єктів обслуговуючого та споживчого потоків.

Дано визначення поняттю «транспортно-пересадковий вузол», наведено класифікацію вузлів за різними ознаками, представлено схему видів транспортно-пересадочних вузлів за просторовим розташуванням зупинок. Визначено, що ТПВ виконують функції з перерозподілу пасажиропотоків між різними видами транспорту та забезпечують скороченню часу очікування пасажирями транспорту на зупиночних пунктах в маршрутній мережі міста, які враховують існуючі технології

організації роботи транспортних засобів.

На основі проведеного дослідження було обрано три транспортно-пересадочні вузли, які розташовані в транспортних зонах найбільшої пасажирської біржі. Транспортно-пересадочним вузлом розглядатимемо автовокзал та автовокзали міста, які на плані міста розташовані у трьох точках: Рівненський автовокзал (вул. Київська), Автовокзал Чайка (вул. Богоявленська, «Чайка»). торговий центр) та автовокзал Залізнична, що з'єднує залізничне сполучення, зовнішній транспорт (приміське сполучення) з пасажирською системою міського транспорту.

В якості практичних рекомендацій, з метою покращення взаємодії пасажиропотоків у транспортно-пересадочних вузлах із системою міського пасажирського транспорту одним із рішень може стати налагодження транспортного сполучення між автостанціями та автостанціями з використанням організації експресного сполучення. Результати дослідження дають можливість проаналізувати поточну ситуацію в місті та розробити заходи щодо вдосконалення маршрутів громадського транспорту м. Рівного в районі транспортних розв'язок. Зокрема, сформувані комплекс управлінських рішень, спрямованих на підвищення ефективності функціонування ТПВ у взаємодії з системою пасажирського транспорту міста.

Ключові слова: маршрутна мережа, громадський транспорт, зупиночні пункти, транспортно-пересадковий вузол, експрес сполучення.

НИКОНЧУК Вікторія Миколаївна, доктор економічних наук, доцент, в.о. завідувача кафедри транспортних технологій і технічного сервісу, Національний університет водного господарства та природокористування, e-mail: v.m.nykonchuk@nuwm.edu.ua; <https://orcid.org/0000-0001-7515-6016>

КРИСТОПЧУК Михайло Євгенович, кандидат технічних наук, доцент, доцент кафедри транспортних технологій і технічного сервісу, Національний університет водного господарства та природокористування, e-mail: m.ie.krystopchuk@nuwm.edu.ua; <https://orcid.org/0000-0002-8701-4469>;

ПАШКЕВИЧ Світлана Михайлівна, старший викладач кафедри транспортних технологій і технічного сервісу, Національний університет водного господарства та природокористування, e-mail: s.m.pashkevych@nuwm.edu.ua; [https:// https://orcid.org/0000-0001-7667-8932](https://orcid.org/0000-0001-7667-8932)

Viktoriia NYKONCHUK, D. Sc (Economics), Professor, Head of the Transport Technologies and Technical Service Department, National University of Water and Environmental Engineering, e-mail: m.ie.krystopchuk@nuwm.edu.ua; <https://orcid.org/0000-0001-7515-6016>;

Mykhailo KRYSTOPCHUK, PhD, Associate Professor of the Transport Technologies and Technical Service Department, National University of Water and Environmental Engineering, e-mail: m.ie.krystopchuk@nuwm.edu.ua; <https://orcid.org/0000-0002-8701-4469>;

Svetlana PASHKEVYCH, Senior Lecturer of the Transport Technology and Technical Service Department, National University of Water and Environmental Engineering, e-mail: s.m.pashkevych@nuwm.edu.ua. <https://orcid.org/0000-0001-7667-8932>.

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