Development of a Methodology for Creatıng an Agent Based Model of Transport Hubs in Suburban Area

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***Abstract*—The article emphasizes the importance of transport hubs in urban public transport and the need to create them. The reasons for the loss of passengers' time found in the course of a study carried out in settlements around Baku were explained. In order to improve the quality of passenger service, it was proposed to create a transport and transfer hub to coordinate the work of a high-speed railway line with bus routes. In the Anylogic 8.4.2 program, an algorithm was developed for constructing a simulation model to coordinate the schedules of buses and trains. The model also makes it possible to visually monitor the transplantation process.**

***Keywords*—transport hubs, bus, high speed train, simulation, Anylogic.**

I. INTRODUCTION

The demand for relocation grows as urban populations grow, their financial situation improves, and urban areas expand. These movements are carried out by different types of transport. Research shows that most of the city's population makes complex journeys from point of departure to destination. Most of these complex movements are also performed using two or more vehicles. At the same time, an increase in the number of modes of transport serving passengers and the number of passenger exchange points between them gives rise to the problem of coordination between them. To do this, it is advisable to create transport-interchange hubs in order to ensure the transfer of passengers between vehicles conveniently, safely and in the shortest possible time.

Transport hubs are the main elements of the transport hub of cities. It provides interconnection between the existing types of urban and mainline passenger transport. These nodes are formed by the interaction of two or more types of urban transport. Correct planning and technical organization and their placement help to improve accessibility conditions, to reduce the time spent on passengers.

II. FEATURES OF TRANSPORT HUBS

The development of transport infrastructure, the introduction of new types of transport into the operational process (light tram, monorail transport, etc.) complicate the planning and technical organization of transport interchange hubs. However, when designing transport hubs, it is necessary to find an optimal solution that meets the following requirements [1]:

- the convenience of passengers at transfer hubs;
- minimum time consumption;
- passenger safety;
- informativeness.

The transfer process in a transport hub includes movement from a stop (station) of one transport to a stop (station) of another, waiting for vehicles and boarding a vehicle.

The transport hub combines three major components: transport, road network and passenger traffic [2]. This integration serves to improve passenger comfort, simplify the operation of the transport system and reduce traffic congestion.

Actors in the field of mobility are now familiar with the term “interchange hub” (“transport hub” is also widely used, sometimes with the adjective “multimodal” to reinforce the idea of various modes of transport connecting there). The expression refers to a building and a space; its meaning encompasses various realities, functions and practices [3]. The efficiency of public transport depends on network effects and on the connectedness between transport modes or between the different lines of a mode. Multimodal transport hubs (MTHs), as both meeting places between modes and points of interconnection, play a crucial role in ensuring the good use of public transport. Interchange hubs help organise urban mobility systems. Their role is to facilitate transfers between different means of transport, and as part of the urban environment, act as interfaces between cities and transport networks. Offering mobility, accessibility and attractiveness, multimodal transport hubs differ vastly from one country or city to another, depending on the structuring modes of transport and on the maturity of the urban fabric.

The physical integration of the public transport network is considered as one of the most important factors of seamless transport. Measures essential to its implementation are [4]:

1. A comprehensive master plan for physical integration, based on a detailed field survey on transfer facilities;
2. A hub-like transfer facility, based on the master plan, and improvement of facilities;
3. Operation and management center for facilities; and

4. Improvement in law and principles related to development of transfer hubs.

The principles of forming a system of transport interchange hubs can be considered from several positions: on the one hand, when forming a transport hub, it is necessary to ensure maximum passenger comfort, on the other hand, a transport interchange hub is an important infrastructural element of the city's transport system. Transport hubs are formed at metro stations, along the perimeter of the city, in the peripheral zones. They can also be of agglomeration value [5].

III. CREATION OF A TRANSPORT HUB IN A SUBURBAN AREA

Several transport interchange hubs have been created in Baku to ensure the exchange of passengers between modes of transport. Analysis of the transport system of Baku [6] shows that it is necessary to create transport hubs to ensure the transfer of passengers traveling from suburban areas and settlements in the direction of the city, to the city public. Considering that high-speed railway lines serve the suburban population in the direction of Baku, we can see the importance of creating transport hubs in Khirdalan, Sabunchu, Zabrat and other territories.

According to the results of a survey conducted to study the current state of transport services in the settlements of Hokmali, Gobu, Atyali, Absheron region, it was determined that the majority of respondents (about 66%) lose most of their time to get to their destination [6]. The overwhelming majority of the population of the study area makes travel to Baku. The stations on January 20, Memar Ajami and Avtovagzal were indicated as the primary destination. As shown in Fig. 1 time of arrival at the destination located in Baku varies from 32 to 49 minutes. This is a fairly large figure.

As can be seen from the figure, the average arrival time from the Gobu village to Baku is 47 minutes, and the arrival time from the Atyali village is 49 minutes. However, the high-speed train passing through the Khirdalan railway station reaches the 28 metro station in 17 minutes. Taking into account the time of arrival of passengers at the station by buses, we can see how much the time will shorten to the destination.

In order to provide faster, more convenient and safer access to the destination for the population living in the considered territories, the routes of buses running in this area should contact the Khirdalan railway passenger station. To reduce the time of movement of the population by public transport, the route schedule in these settlements should be coordinated with the schedule of the high-speed train passing through the Khirdalan railway station.

The last stop of the bus route near the Khirdalan railway station is 100-150 meters from the station entrance. Although safe waiting areas for passengers - attics and seats - have been installed on the station platform, the condition of the overpass for entering the station platform is unsatisfactory. The passage here is open, the stairs are wooden. The transition is not able to be used by passengers with reduced mobility. The current state of the Khirdalan passenger railway station is shown in Fig. 2.

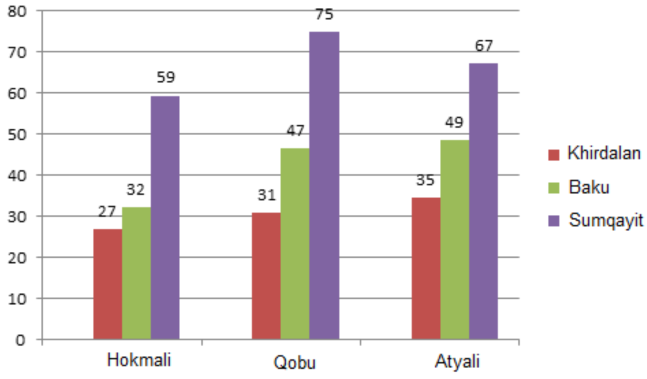

Fig. 1. Time of arrival from the settlements of Hokmali, Gobu and Atyali to Khirdalan, Baku and Sumgayit.

Fig. 2. Current state of the crossing at the Khirdalan passenger station.

To improve passenger exchange, the final stop of the bus route should be close to the train station. To improve the exchange of passengers between these types of public transport, the passage from all directions should be provided with escalators. The passage must be completely covered by a canopy. It is also desirable to install pedestrian lifts for passengers with reduced mobility and hand luggage.

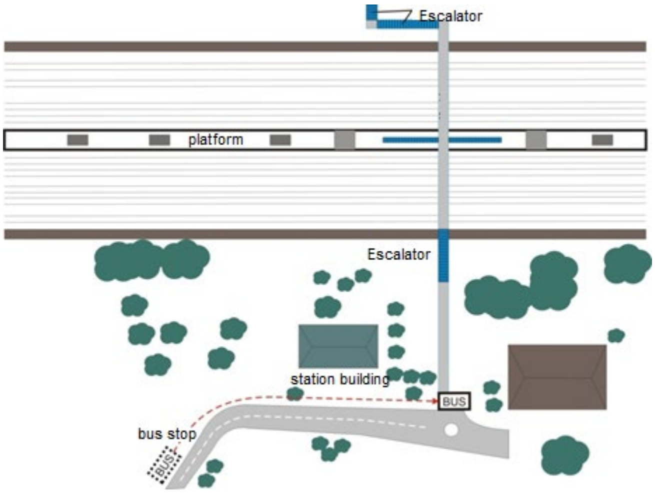

Fig. 3. Scheme for improving the exchange of passengers in front of the Khirdalan railway passenger station.

IV. AGENT BASED SIMULATION OF A TRANSPORT HUB

In recent years, some transport problems have been solved with the help of computer simulation. Three main types of simulation are widely used (system dynamics; discrete event simulation; agent-based simulation) [7]. Of these, the most suitable for modeling a public transport network is agent-based modeling, in which vehicles and passengers act as an agent [8].

It is proposed to build an agent-based simulation model in order to visualize the operation of the transport interchange hub and describe the exchange process between the bus stop and the Khirdalan railway passenger station. Anylogic 8.7.4 software was used to create the model.

Anylogis is an object-oriented program designed specifically for simulation, supported by user interfaces. The simple yet complex animation features of Anylogic allow you to create visually rich designs and interactive modeling environments.

A simulation model of the movement of passengers in a transport interchange hub was created in the Anylogis 8.7.4 program. using the tools of the Pedestrian Library library (PedGoTo, TargetLine, PedEscalator, PedWait, PedExit, PedSink, etc.). The boarding of passengers waiting at a stop is simulated using a queue model.

The logical model of the traffic pattern in the transport interchange hub is shown in Fig. 4.

To simulate the movement of buses, the tools of the Road Traffic Librare panel (Road, BusStop, CarSurce, CarMoveTo, Delau, etc.) are used. The tools RailWau Trakk, TrainSourse, TrainMoveTo are used to simulate the movement of trains. The logical diagram of passenger boarding is shown in Fig. 5.

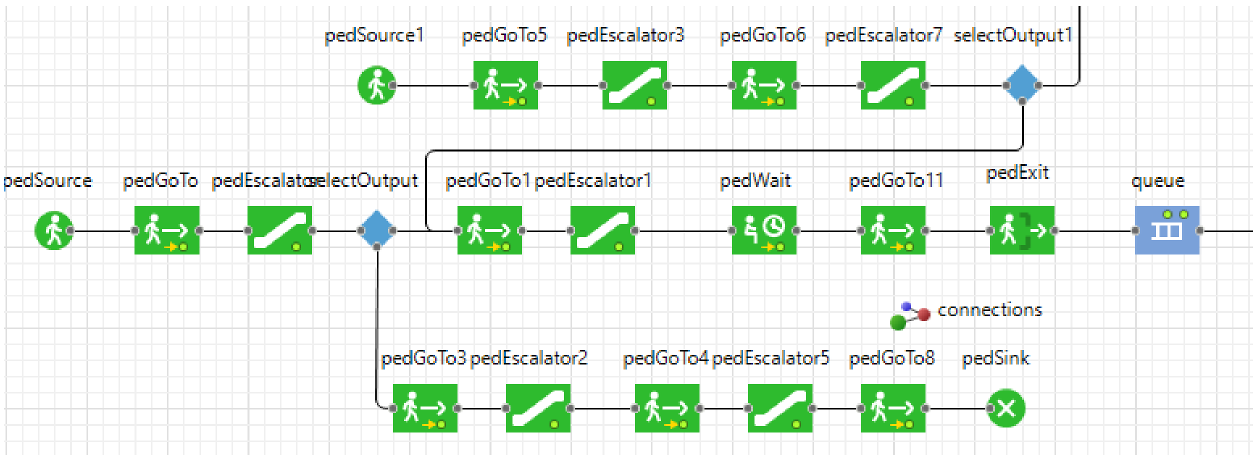

Fig. 4. Logical model for constructing a passenger traffic pattern

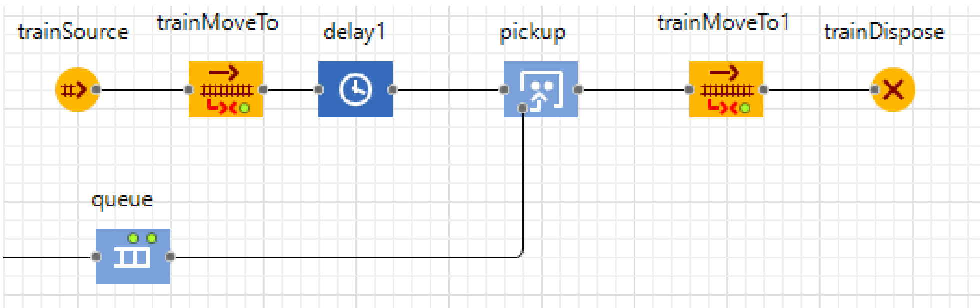

Fig. 5. Logic diagram of passenger boarding on the train

The 3D Window tool from the Presentation section is used to view the generated model in 3D. This tool is selected and placed on the analogy work area.

Figure 6 shows a three-dimensional image of a simulation model of a transport interchange hub proposed to be created around the Khirdalan railway station.

Fig. 6. 3D image of a simulation model of a transport interchange hub in front of the Khirdalan railway station.

CONCLUSION

The creation of public transport interchange hubs serving passengers living in suburban areas significantly affects the reduction of passengers' time losses. To organize the operation of such stations, it is advisable to use modern computer modeling. Such models make it possible to accurately predict the operation of a transport hub in changing situations (for example, a decrease in passenger traffic as a result of a pandemic).

REFERENCES

[1] Azarenkova Z. V. Planning organization of transport hubs // Academia. Architecture and construction. - 2011. - Issue. 1. - S. 76-80.
Азаренкова З.В. Планировочная организация транспортно-пересадочных узлов//Academia. Архитектура и строительство. – 2011. – Вып. 1. – С. 76-80.

[2] NapreenkoLidiya. Three-dimensional structure of transport hub in urban environment. INTERNATIONAL SCIENTIFIC JOURNAL "TRANS & MOTAUTO WORLD". Year VI, ISSUE 1, P.P. 11-12 (2021)

[3] Leticia Pinheiro RizerioCarmo. Multimodal Transport Hubs. AFD 2020. Paris, France. p. 180.

[4] Youngjong Kwon.Enhancing Urban–Rural Connectivity through Transport Hubs. 2020. https://development.asia/printpdf/insight/enhancing-urban%E2%80%93rural-connectivity-through-transport-hubs.

[5] Bulgakova E.A. Modern trends in the design of transport hubs in the infrastructure of a metropolis. Bulgakov, A.A. Savicheva // Eurasian Union of Scientists. - 2015. - No. 4 (13).
Булгакова Е.А. Современные тенденции проектирования транспортно-пересадочныхузлов в инфраструктуре мегаполиса / Е.А. Булгакова, А.А. Савичева // Евразийский союз ученых. – 2015. – № 4(13).

[6] The project "Development of decision-making mechanisms to increase the coverage and quality of public services (as a pilot in the transport sector of Absheron and Gobustan regions)." AzTU. January-April. 2021
“İctimai xidmətlərin əhatəliliyinin və keyfiyyətinin artırılması üçün qərarqəbuletmə mexanizmlərinin işlənməsi (pilot olaraq Abşeron və Qobustan rayonlarının nəqliyyat sektoru timsalında)” layihəsi. AzTU. Yanvar-aprel. 2021.

[7] GizemGunesh. Agent-based simulation and an example in anylogic. Yildiz technical university, industrial engineering department, İstanbul, 2014.

[8] Dashdamirov F.S. CREATION OF A SIMULATION MODEL OF BUS TRAFFIC IN URBAN ROUTES. ВІСНИК ПРИАЗОВСЬКОГО ДЕРЖАВНОГО ТЕХНІЧНОГО УНІВЕРСИТЕТУ. 2020р. Серія: Технічні науки Вип. 41. P.p.205-211