Formalizing the Task of Delivering Creative Teams to the Mass Entertainment Venues

Levkin G.G.[1][1], Simak R.S.[2][2], Mochalova S.V.[1][3], Nikiforov O.A.[3][4], Kurganov V.M.[4][5]
[1]*Omsk State Transport University*
[2]*Military Academy of Logistical Support "General of the Army A. V. Khrulyov"*
[3]*Saint Petersburg State University of Veterinary Medicine*
[4]*Tver State University*

Keywords: routing, mass entertainment events, mathematical model, automation, transport process.

Abstract: The article analyzes the organization of mass entertainment events and highlights the problem of delivering creative teams to performance sites and venues. It conducts an analysis of related literature and creates a mathematical model for scheduling the delivery of creative teams to venues, taking into account their systematic movement. A software for automatic vehicles distribution, delivering creative teams to performance sites, is proposed. Methodology of a systems approach, modern concepts of transport logistics and supply chain management, as well as economic, mathematical and statistical methods, were used to analyze the problem and draw conclusions.

1 INTRODUCTION

Mass entertainment events by nature are irregular and, therefore, do not resemble stable technological interaction. Nevertheless, the logistics approach to organizing transport services for participants of such events is appropriate and highly effective (Mirotin, 2003; Kurganov, 2003; Deripas, 2007).

The organization of intercity passenger transportation depends on the need to move a large number of people between zones of the city territory in the morning and evening hours (Gatiyatullin, Gizzatullina, 2021) or during mass events.

The scientific literature conveys the formalization of intercity passenger transportation by different types of transport, considers aspects of modeling the regional transport complex (Gimadi, Dobrodey, Matushkina, 2005) and its transition to an innovative development (Averina, Matushkina, Lavrikova, 2010). Along with the above-mentioned areas of scientific research in intercity passenger transportation, the authors consider ways to optimize logistics costs in the urban passenger transport system, as well as problems and prospects for the development of urban passenger transport (Guzenko, Mamaev, 2009; Sivakov, Kamynin, Tikhomirov, 2009; Guzenko, 2009).

The analysis of specialized literature has shown a lack of information about the formalization of the task of delivering creative teams to performance venues during mass entertainment events (for example, city day).The authorities responsible for organizing large-scale city events should consider the level of transportation costs, as well as anticipate possible risks associated with hosting such a large event (Levkin, Rudko, 2015).

One of the important tasks that need to be solved during the organization of the City Day is the task of optimizing the transportation process for getting creative teams to their performance venues. Planning optimal routes, accurately allocating vehicles according to the needs of the creative teams, calculating costs, and delivering teams at the lowest possible cost allows you to save financial resources.

[1] https://orcid.org/0000-0002-6165-3596
[2] https://orcid.org/0000-0009-2735-6924
[3] https://orcid.org/0000-0002-3580-4469
[4] https://orcid.org/0000-0002-9199-1609
[5] https://orcid.org/0000-0001-8494-2852

The aim of the article is to create a system for delivering creative teams to venues for performances during entertainment events.

To achieve this goal, you need to solve a number of tasks: to analyze the literature sources for reviewing trips related to mass entertainment events; to formulate a mathematical model for drawing up schedules in the delivery system of creative groups to performance venues, taking into account their rotation; offer software and mathematical automation of vehicle distribution when delivering creative teams to performance venues.

The object of research in this article is a transport system for delivering groups to the performance venues; the subject of the research is activities aimed at the effective operation of the logistics system for the delivery of creative teams.

2 METHODOLOGY

Economic, mathematical and statistical methods were used for modeling. Methodology of a systems approach, modern concepts of transport logistics and supply chain management, as well as economic, mathematical and statistical methods, were used to analyze the problem and draw conclusions.

In addition to special methods, general scientific methods were used, for example, analysis, synthesis, deduction and induction. The analysis method allowed us to identify the problem and identify its main components. As a result of the use of synthesis, a system for delivering creative teams to the performance venues was formed.

Using the deductive method, a system for delivering creative teams to performance venues was developed and the need for specialized software for automation was justified.Using the inductive method, conclusions were formed based on the analysis of individual facts.

Methods of empirical cognition include description, comparison, and measurement.

3 RESULTS AND DISCUSSION

3.1 A mathematical model of the system for delivering creative groups to venues

There are a number of creative groups (all or several of them, depending on the amount of transportation costs, holiday programs, and the need for their services) that need to be delivered to concert venues in Omsk. When planning routes, one should consider the following conditions:

1) Each event address must have at least 2 creative teams (or more) with a high rating. (to create interesting creative programs at all venues).

2) It is necessary to create a variety of programs with a number of different creative activities.

3) Both creative performances by groups and the overall program are limited in time (this condition should be taken into account when sending groups to the event venues, making rational programs of performances (programs should not be too short or too long)).

4) The same creative team can perform in several places, so you need to take into account the total time of participation in events and transportation costs (the time of participation depends on the physical qualities and initiative of the creative team. It includes travel time and waiting time. Each team sets the time of participation independently).

5) The number of dedicated vehicles is limited (this should be taken into account when delivering groups to the performance venues).

6) If the creative team is close to the performance venue, transportation is not required.

The following notation was used to construct the mathematical model:

n – the number of venues;

m – the number of buses;

k – the serial number of the creative team;

Σk – the number of creative teams;

i – the serial number of the bus;

j – the serial number of the venue;

p_{kj} – the genre of the k team at venue j;

μ_j – the number of performances at venue j;

T_{pacn} – concert start time;

S_i – number of seats in the bus i;

b_k – the number of people in a creative team;

V_{jk} – the duration of one performance at venue j by k team;

t – total bus operating time;

ta_i – the bus travel time from the car park to the collective;

tb_i – the bus travel time to the venue (waiting for the team time included) after the performance;

tc_i – the bus travel time from the collective to the car park;

t_{ij} – the bus i to venue j travel time;

t_{ik} – the bus i travel time to the team k;

t_i^H – start time of the bus from the car park;

w_{ik} – the waiting time of the bus i for the team k;

w_{ij} – the bus i waiting time at venue j;

τ_i – bus i delay time (random variable);

d_k – number of venues for the performance of the team k.

A mathematical model of the problem, based on the accepted initial conditions, was constructed.

The objective function is to minimize transportation costs.

$m = \Sigma\, b_k / S_i \rightarrow min$

Limitations of the mathematical model are the following conditions:

$$\begin{cases} t = ta_i + \Sigma\, tb_i + tc_i \\ t_{iн} = T_{расп} - (t_{ai} + t_{bi}) \\ ta_i = \sum_k t_{ik} + \sum_k w_{ik} + \sum_k \tau_i \\ tb_i = t_{ij} + 2w_{ij} + \sum_k V_{jk} + \tau_i \\ tc_i = t_{ik} + w_{ik} + \tau_i \\ \Sigma\, b_k \le S_i \\ p_{kj} \le \mu_j \\ \mu_j > d_k \end{cases}$$

If the creative team has a small number of participants, then the bus can collect other teams along the way up to the full capacity of the bus.

The number of participants in the groups and the availability of different genres of performances to accommodate on the bus are considered. At the same time, if creative teams of different genres are located geographically nearby, they will be a priority for one bus.

3.2 Automation of delivering creative groups to venues

The program - “AIS Logistics of events”, developed with the participation of the authors, is an automated information system for calculating the schedule of performances of creative groups and routes of vehicles (buses).

The "AIS Logistics of events" control panel is shown in Figure 1.

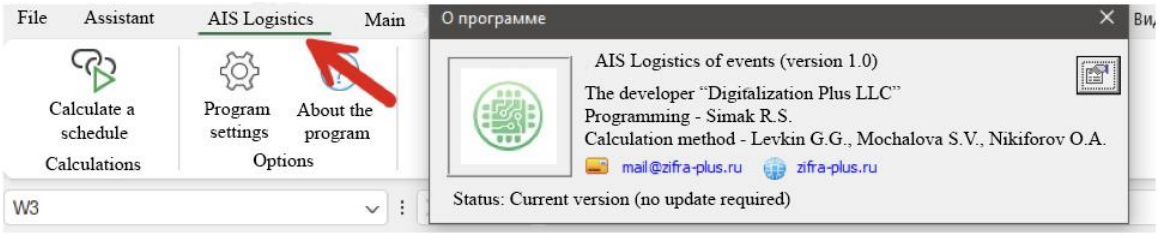

Figure 1: The control panel of “AIS Logistics of events”.

The program consists of four functional blocks:

1) Settings database
2) Source data
3) Schedule of performances
4) Traffic schedule

Before starting calculations, you need to fill in **the settings database**, the structure of which is shown in Figure 2.

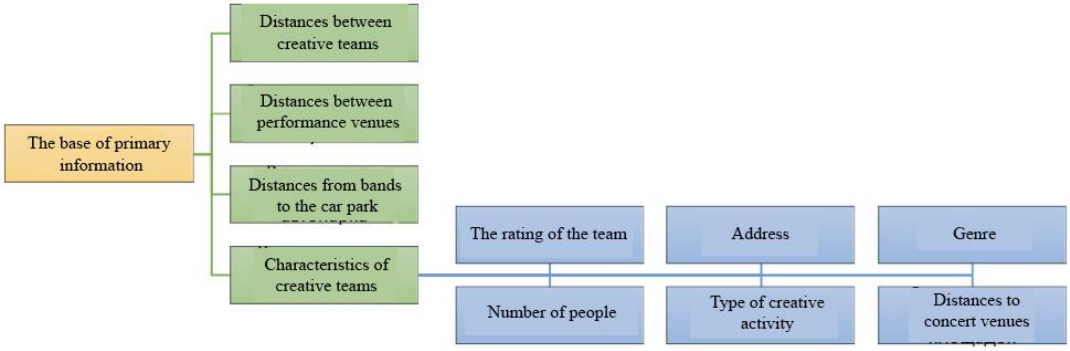

Figure 2: The settings database.

The program uses the following **source data** for calculations, which are filled in as shown in Figure 3:

- number of seats in the bus;
- start time of performances, h;
- duration of the concert, min.;
- maximum number of repetitions of one genre in a concert;
- waiting time for the team bus, min.;
- waiting time for the team bus on the site, min.;
- bus speed to the team, km / h;
- list of groups to perform in;
- list of venues for your speech.

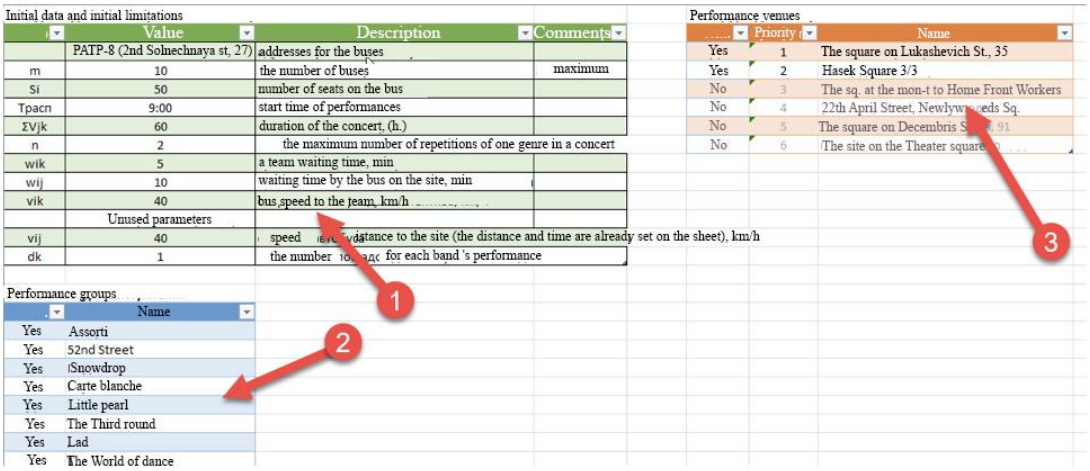

Figure 3: Filling a block with source data.

After filling in the initial data, the schedule of performances and the movement of vehicles to concert venues is calculated. To start the calculation, use the "Run schedule calculation" button on the program toolbar (fig. 1).

In the program settings (Settings button fig. 1), the option to display reference information before starting the calculation is available (pos. 1, Fig. 4), which displays the window shown in pos. 2 in Figure 4.

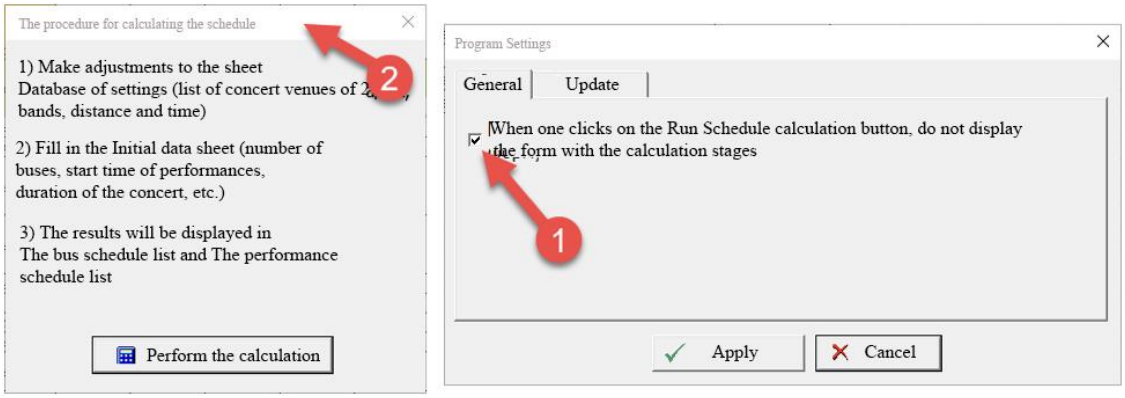

Figure 4: Program start options.

The calculation results are presented in the following data sets:

- T
e
a
m
- Start time of the movement.
- End time of the movement.
- T
a
m

An example of calculating the schedule is shown in Figs. 5, 6. Lines highlighted in color in Fig. 5 refer to specific concert venues where vehicles are moving and groups gather for performances.

The schedule of performances at the venues (fig. 6) includes a list of creative groups selected in accordance with the criteria specified in the source data (team rating and the maximum number of repetitions of one genre in a concert).

Bus schedule at the sites

Bus number	Departure point	Start time of the movement	The destination	The end time of the movement	Team
1	PATP-8 (2nd Solnechnaya st, 27)	7:47	Karl Marx Avenue, 24	8:14	Junior
1	Karl Marx Avenue, 45	8:19	Magistral'naya 57a	8:39	The Third Round
1	Magistral'naya 57a	8:44	Mira Avenue, 58	8:46	The Little Pearl
1	Mira Avenue, 58	8:51	the square near Lukashevich str. 35	8:50	THE PERFORMANCE BEGINS
2	PATP-8 (2nd Solnechnaya st, 27)	7:11	Buderkina str., 2	7:43	Surprise
2	Buderkina Str, 2	7:48	Mira Avenue, 58	8:10	Carte Blanche
2	Mira Avenue, 58	8:15	Krupskoy, 25/1	8:29	Assorti
2	Krupskoy, 25/1	8:34	2nd Poselkovayya str., 6	8:46	52nd Street
2	2nd Poselkovayya str., 6	8:51	the square near Lukashevich str. 35	8:50	THE PERFORMANCE BEGINS
3	PATP-8 (2nd Solnechnaya st, 27)	7:35	Bogdan Khmelnitsky str., 214	8:04	Russian Song
3	Bogdan Khmelnitsky str., 214	8:09	Beethoven str., 26	8:25	Lad
3	Beethoven str., 26	8:30	Ippodromnayya str., 12	8:46	Volencia....
3	Ippodromnayya str., 12			8:50	THE PERFORMANCE BEGINS
4	PATP-8 (2nd Solnechnaya st, 27)			8:33	Russian Voices
4	Lisa Chaikina str., 23			8:46	Musette
4	Leningradskaya Square, 1			8:50	THE PERFORMANCE BEGINS
5	PATP-8 (2nd Solnechnaya st, 27)			8:46	Indigo 1
5	Karl Marx Avenue, 45			8:50	THE PERFORMANCE BEGINS
6	PATP-8 (2nd Solnechnaya st, 27)			8:42	Solnyshko 2
6	Kirov str., 22/ 2			8:46	The World of Dance
6	Shcherbaneva str., 25	8:51	Gashek Square 3/3	8:50	THE PERFORMANCE BEGINS

Microsoft Excel
The calculation of the schedule is completed, time spent 6 seconds
OK

Figure 5: Results of calculating the bus schedule at the venues.

Schedule of performances at venues

Venues	Time	Teams	Addition. inform. Bus No	Seats
the square on 35 Lukashevich str.	9:00	Junior	1	20
the square on 35 Lukashevich str.	9:05	The Third Round	1	20
the square on 35 Lukashevich str.	9:09	The Little Pearl	1	10
the square on 35 Lukashevich str.	9:13	Surprise	2	12
the square on 35 Lukashevich str.	9:17	Carte Blanche	2	20
the square on 35 Lukashevich str.	9:21	Assorti	2	10
the square on 35 Lukashevich str.	9:25	52nd Street	2	6
the square on 35 Lukashevich str.	9:31	Russian Song	3	23
the square on 35 Lukashevich str.	9:34	Lad	3	12
the square on 35 Lukashevich str.	9:39	Volencia	3	12
the square on 35 Lukashevich str.	9:45	Russian Voices	4	25
the square on 35 Lukashevich str.	9:51	Musette	4	20
the square on 35 Lukashevich str.	9:56	Indigo 1	5	25
Gashek Square 3/3	9:00	Solnyshko 2	6	36
Gashek Square 3/3	9:04	The World of Dance	6	14

Figure 6: The results of calculating the schedule of performances at the venues.

"AIS Logistics of events" is written in the Visual Basic for Applications programming language and consists of 4 forms and 15 modules, as shown in Figure 7.

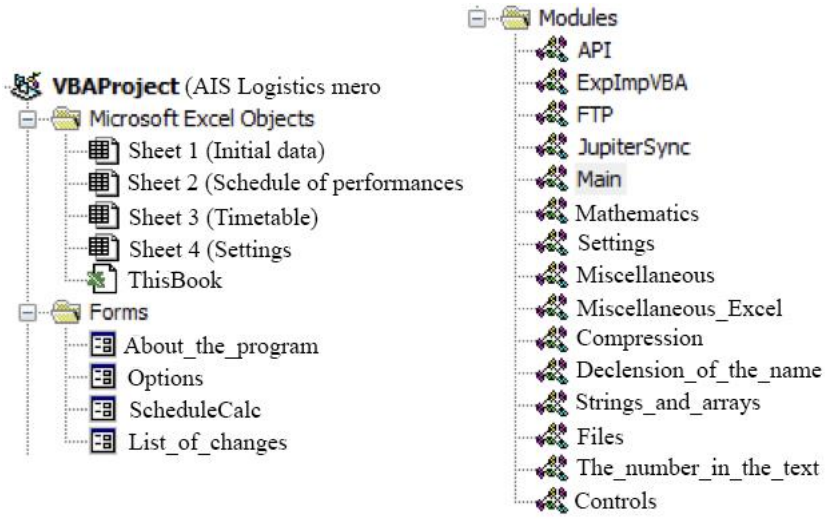

Figure 7: Structure "AIS Logistics of events".

The schedule calculation is performed using the "Calculation" function in the "Main" module, which works according to the algorithm shown in Figure 8

First, venues are searched. Then, a set of buses is formed at each venue, where creative teams are distributed, selected in accordance with the rating, the criterion of genre variability and the minimum distance on the delivery route both from the vehicle company and between neighboring groups on the same route and the concert venue.

The results of testing the program are presented in Table 1. If all other data not specified in the table are equal, they reflect a fairly high performance of the

developed system and a small time for calculating the model.

Table 1: Testing of "AIS Logistics of events" results.

Number	Number of buses	Number of buses	Number of the teams involved	Time for calculating, c.
3	20	14	35	7

Figure 9 shows the results of testing the program.

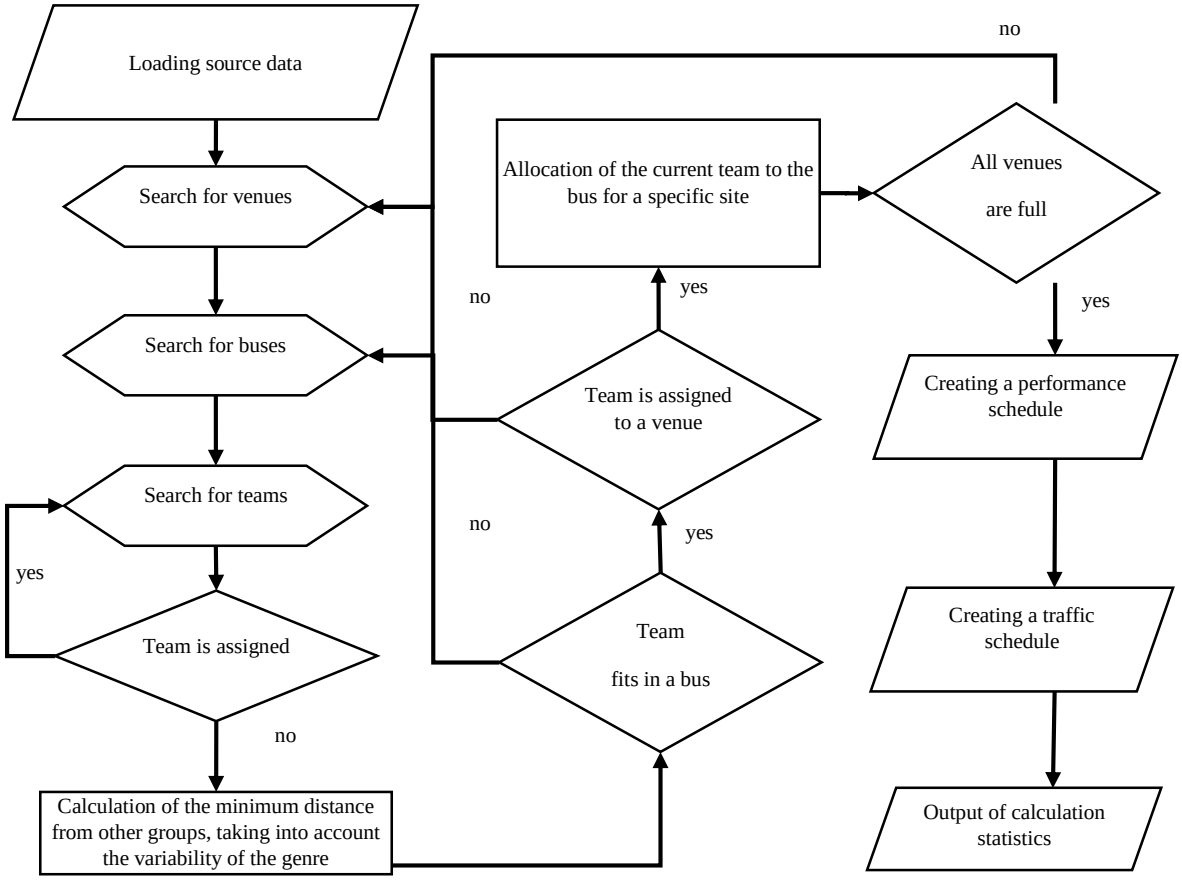

Figure 8: Operation algorithm of "AIS Logistics of events".

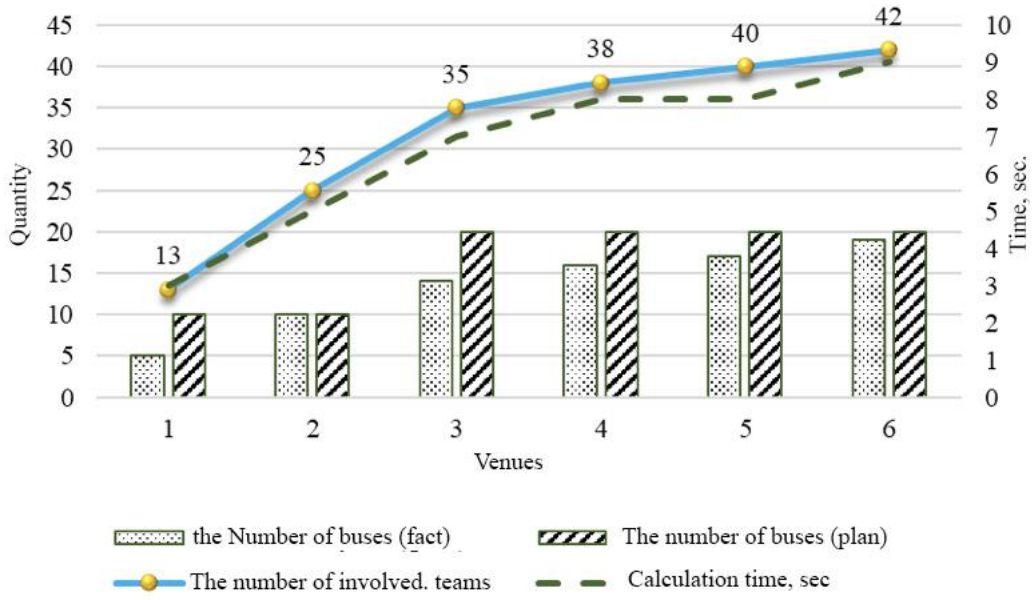

Figure 9: The results of testing the program.

3.3 Discussion

The problem under study was the lack of a well-defined delivery plan and methodology for generating routes for creative groups to perform at venues. Using the developed mathematical model and a special technique, you can manage routes based on various factors. To create a mathematical model and methodology for drawing up routes for creative teams, the following points were taken into account:

1. Transportation is carried out at the lowest cost.
2. The requirements for creating a schedule are taken into account, including limiting the number of creative groups at a venue..
3. When compiling programs for performances, the numbers of various creative groups with different genres are included.
4. The duration of programs at each venue is limited in time, depending on how many creative teams will present their performances.
5. The same creative team can perform at several venues if desired. This takes into account the time of their participation and waiting for transportation to the next venue.
6. The number of vehicles used to serve mass events is limited.
7. If the creative team is close to the venue of the performance, transportation is not used.
8. Routes are developed depending on the cluster location of creative teams and the location of a mass event.
9. Downtime while waiting for vehicles is minimized.

The difficulty in simultaneously fulfilling these conditions on a city scale made it necessary to develop a mathematical model and implement a software product.

In Omsk, there are a number of creative teams that need to be delivered to the venues of mass events. To do this, one selects the best routes based on the time, cost, and length of the route. When choosing a route, the main factors are time and compliance with the sequence of moving groups between concert venues in accordance with the program using a developed schedule of performances simultaneously at all city venues (Levkin, Rudko, 2015).

To create a methodology for programming events at all venues, we used the methods of schedule theory.

4 CONCLUSION

An analysis of literature sources on mass entertainment event transportation has shown a lack of methods and software products to automate the generation of routes for transporting creative teams to performance venues. This indicates the need to use a scientific approach to the issue of optimal delivery of creative teams to performance venues, since the search for optimal routes will reduce costs by reducing transport costs for municipalities.

The development of a mathematical model for the optimal solution of delivery of creative groups and route development is based on scheduling with the possibility of rotation of groups between concert venues.

Automation and reduction of the labor intensity of generating routes using a software product help to optimize transport costs, as well as the delivery of creative teams with minimal time and financial costs.

REFERENCES

Mirotin, L. B., 2003. Transport logistics: A textbook for transport universities. Transportnaya logistika: Uchebnik dlya transportnykh vuzov. pp. 380-383.

Kurganov, V.M., 2003. Situational management of automobile transportation. Monograph, M, Tekhpoligraftsentr. 197 p.

Deripas, A. Yu., 2007. Urban passenger automobile transportation: problems and solutions. *Bulletin of the Pacific National University.* No. 2 (5), pp. 117-126.

Gatiyatullin, M.H., Gizzatullina, Z.F., 2021. Passenger transportation of the city of Naberezhnye Chelny. *Transport technic and technology.* No. 1 (20). S. 10.

Gimadi, I.E., Dobrodey, V.V., Matushkina, N.A., 2005. Modeling the development of the regional transport complex. *Economy of the region.* 2005. No. 3 (3), p. 50-63.

Averina, L.M., Matushkina, N.A., Lavrikova, Yu.G., 2010. Transition of the regional transport complex to an innovative development path. *Regional Economy.* No. 4 (24), pp. 102-110.

Guzenko, A.V., Mamaev, E.A., 2009. Optimization of logistics costs in the urban passenger transport system. *Bulletin of Tomsk State University.* 2009. No. 327, p. 140-146.

Sivakov, V.V., Kamynin, V.V., Tikhomirov, P.V., 2009. Improving urban passenger transportation (using the city of Bryansk as an example). *Transport. Transport structures. Ecology.* No. 4, pp. 61-69.

Guzenko, A.V., 2009. Development of urban passenger transport of a megalopolis: problems and prospects. *Bulletin of Tomsk State University.* No. 321, pp. 135-138.

Levkin, G.G., Rudko, A.E., 2015. Setting the Task of Optimal Delivery of Creative Teams to Performance Venues on the City Day. From Knowledge Synergy to Business Synergy. Papers of the International Scientific and Practical Conference of Students, Postgraduates and Teachers,pp. 216-218.