

# JOURNAL OF TRANSPORT



ISSUE 2, 2024 Vol. 1  
ISSN: 2181-2438



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**JOURNAL OF TRANSPORT**

RESEARCH, INNOVATION, RESULTS

**ISSN 2181-2438**

**VOLUME 1, ISSUE 2**

**JUNE, 2024**



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# TASHKENT STATE TRANSPORT UNIVERSITY

## JOURNAL OF TRANSPORT

SCIENTIFIC-TECHNICAL AND SCIENTIFIC INNOVATION JOURNAL

VOLUME 1, ISSUE 1 MARCH, 2024

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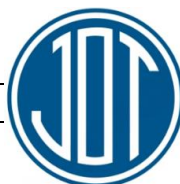
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# Analysis of the physical and mechanical properties of fine-grained concrete with superplasticizers and hydrophobic additives

N. Mukhammadiyev<sup>1</sup><sup>a</sup>, G.B. Malikov<sup>1</sup><sup>b</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** This article focuses on the analysis of the results obtained through experimental testing. That is, changes in physical and mechanical properties of concrete by adding superplasticizer and hydrophobic additives (in dry and liquid state) to ordinary concrete are presented. For testing, 48 samples were prepared based on a total of 8 compositions. These samples were tested for bending and compression on 3, 7, 14, and 28 days, and the effect of the amount of the above additives on the physical and mechanical properties of concrete was highlighted.

**Keywords:** hydrophobic (liquid, dry), cement, water, fillers and additives (mineral and chemical), superplasticizer, strength, bending, compression.

## 1. Introduction

Concrete and reinforced concrete structures play a crucial role in modern buildings and infrastructure. Concrete is made up of cement, water, fillers, and additives, both mineral and chemical. These components influence the characteristics and makeup of concrete, which must be carefully considered when designing its composition.

By incorporating various additives, such as chemical or active mineral components, the properties of mixtures and itself can be regulated. This includes aspects like accelerating or delaying the setting time, improving its workability and ease of placement, enhancing its strength

and durability, reducing water absorption, and minimizing deformation during the hardening process [1,5].

## 2. Methodology and materials

In order to determine the composition of the complex modified concrete developed by us, as well as to study the physical and mechanical properties of the concrete with these additives, we will analyze it by adding them to the mixture in different proportions.

Samples prepared for experimental testing and their contents are listed below in Table 1. From the table we can see the following:

Table 1


Composition of samples									
№	Attachments	Cement, gr	Sand, gr	Water, l	Water/sem	Hydrophobic, gr	percent %	Sup. plas.	percent %
N1	Ordinary concrete	500	1500	245	0,49	-	-	-	-
N2	When 1% Superplasticizer is added	500	1500	170	0,35	-	-	5	1
N3	1% Superplasticizer and 1% hydrophobic (liquid)	500	1500	165	0,35	5	1	5	1
N4	1% Superplasticizer and 3% hydrophobic (liquid)	500	1500	155	0,35	15	3		
N5	1% Superplasticizer and 6% Hydrophobic (liquid)	500	1500	140	0,35	30	6		
N6	1% Superplasticizer and 1% Hydrophobic (dry)	500	1495	170	0,34	5	1	5	1
N7	1% Superplasticizer and 3% Hydrophobic (dry)	500	1485	170	0,34	15	3		
N8	1% Superplasticizer and 6% Hydrophobic (dry)	500	1470	170	0,34	30	6		

\*The amount of elements listed in the table above is selected for a 40x40x160 mm prismatic mold. Each composition is made for one set of molds (1 set consists of 3 molds).

The experimental tests were carried out in the laboratory of the Tashkent State Transport University, "Construction of

Buildings and Industrial Facilities" department, within the scope of scientific research.

<sup>a</sup> <https://orcid.org/0009-0004-2390-6961>

<sup>b</sup> <https://orcid.org/0000-0003-3691-1079>



The samples prepared on the basis of the ingredients were compacted using a vibrating table during the molding process, then the sample-prisms were stored for 1 day in a natural environment, in a chamber that provides normal solidification and surface temperature of 20 °C and relative air humidity of 95% for 28 days.

For testing, special support equipment is used to place the sample on the press during the bending test. The procedure for placing the sample in the equipment is shown in Figure 1.

After the bending test, half of the samples are immediately subjected to the compression test. Samples are placed between two plates with smooth surface sides according to the dimensions of the plate (Fig. 2).

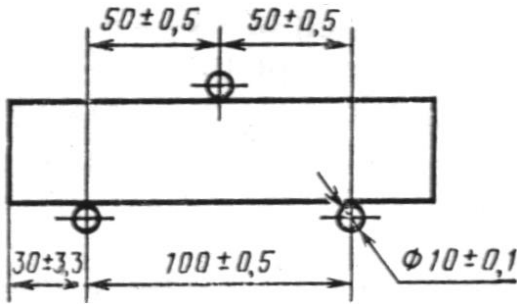


Figure 1. Scheme of installation of samples for bending test

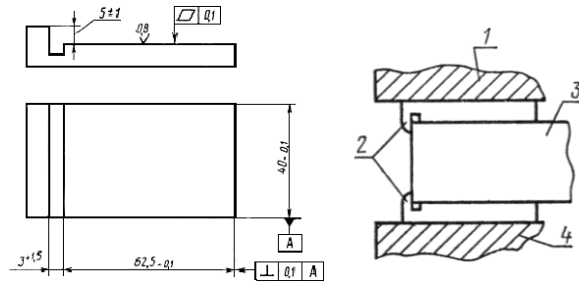


Figure 2. Scheme of placement of specimens for compression testing

### 3. Results

The samples were tested for bending and compression using a CT-D2000 press, these tests were conducted according to GOST 25192-2012.

When conducting compression tests, samples were continuously loaded in a sample press with a speed that ensured the increase of the calculated stress in the sample until its complete failure within the limits of 0.6 MPa/s.



Figure 3. Bending test of specimens



Figure 4. Compression testing of samples

The results of the experimental tests carried out on the samples are presented in the following tables and pictures.

Table 2

Bending and compressive strength of samples

Samples	R <sub>ben</sub>				R <sub>com</sub>			
	3	7	14	28	3	7	14	28
N1	1,8	3,2	4,4	5,5	3,0	7,0	14,0	28,0
N2	2,2	3,9	5,2	6,6	37,7	66,8	98,4	124,3
N3	2,0	3,6	4,8	6,1	55,8	98,9	126,2	159,3
N4	2,1	3,7	5,0	6,3	51,8	91,8	122,8	155,1
N5	1,8	3,3	4,4	5,6	54,0	95,7	119,4	150,8
N6	2,1	3,7	5,0	6,3	43,1	76,3	112,1	141,6
N7	2,2	4,0	5,4	6,8	55,2	97,8	124,7	157,5
N8	2,0	3,6	4,9	6,2	62,5	110,8	142,3	179,7

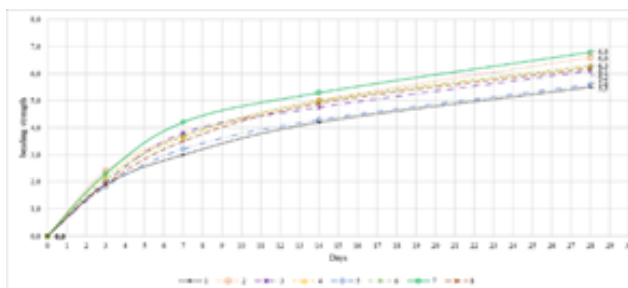


Figure 5. Bending strength of samples on 3, 7, 14 and 28 days

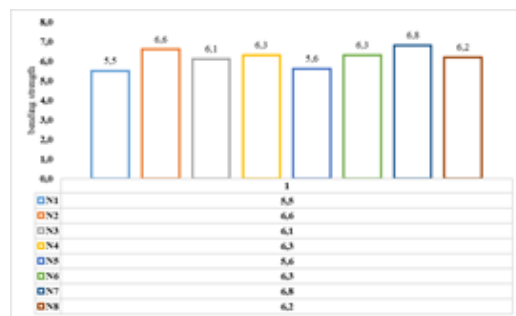


Figure 6. Bending strength of samples



Figures 5 and 6 present the analysis of flexural strength across different samples, illustrating their strength at 3, 7, 14, and 28 days. The analysis revealed that the sample composed of cement, water, sand, 1% cement superplasticizer, and 3% cement hydrophobic additives (in dry state) achieved notably high flexural strength. Specifically, its flexural strength was observed to be 24% higher compared to conventional concrete.

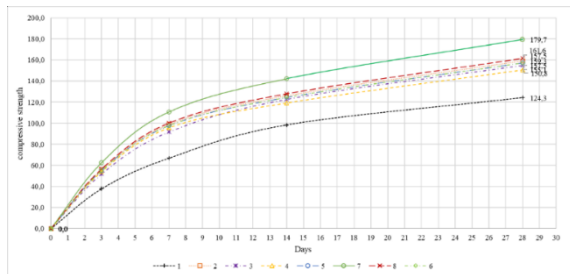


Figure 7. Compressive strength of samples on 3, 7, 14 and 28 days

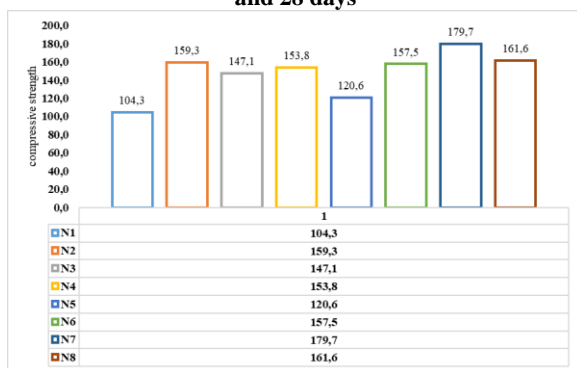


Figure 8. Compressive strength of samples

Figures 7 and 8 depicted the analysis of compressive strength across various samples, showcasing their strength at 3, 7, 14, and 28 days. Notably high compressive strength was attained in the sample comprising cement, water, sand, 1% cement superplasticizer, and 3% cement hydrophobic additives (in dry state). Comparatively, its compressive strength was observed to be 65% higher than that of conventional concrete.

We can see the influence of the amount of hydrophobic additives in concrete on concrete strength from the following figures 9, 10.

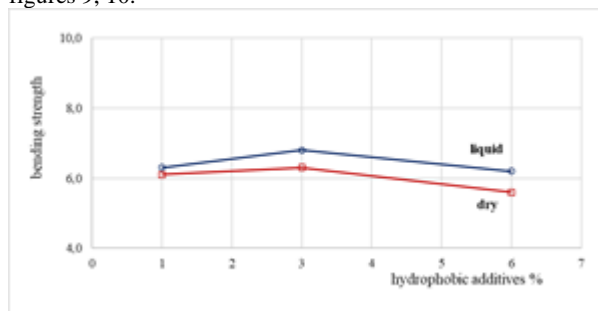


Figure 9. The effect of the amount of hydrophobic additives on concrete bending strength

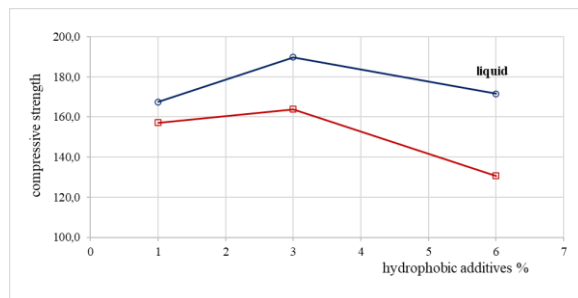


Figure 10. The effect of the amount of hydrophobic additives on concrete compressive strength

### 4. Conclusion

The inclusion of a superplasticizer in the concrete mixture resulted in a 30% reduction in water usage compared to regular concrete.

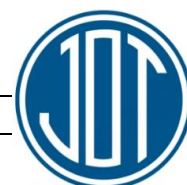
When comparing the strengths of the samples, the following results were obtained compared to ordinary concrete:

	N2	N3	N4	N5	N6	N7	N8
compression	159.3	155.1	150.8	141.6	157.5	179.7	161.6
%	28%	25%	21%	14%	27%	45%	30%
bend	6.6	6.1	6.3	5.6	6.3	6.8	6.2
%	20%	11%	15%	2%	15%	24%	13%

From the analysis of the results, it can be inferred that sample N7, consisting of cement, water, sand, 1% cement superplasticizer, and 1.3.6% cement hydrophobic additive (dry), exhibited notably higher flexural and compressive strengths compared to the previous year.

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**Information about the authors**

Muxammadiyev Tashkent davlat transport  
Ne'mat universiteti "Bino va sanoat  
Muxammadiyev inshootlari qurilishi" kafedrasida  
Ne'mat mudiri, dotsent, t.f.f.d (PhD),  
E-mail: [nemat.9108@mail.ru](mailto:nemat.9108@mail.ru)  
Tel.: +998909111106  
<https://orcid.org/0009-0004-2390-6961>

Malikov  
G'anisher  
Malikov  
Ganisher

Tashkent davlat transport  
universiteti "Ko'priklar va tonnellar"  
kafedrasida doktorant,  
E-mail: [ganisher@inbox.ru](mailto:ganisher@inbox.ru)  
Tel.: +998901893094  
<https://orcid.org/0000-0003-3691-1079>



## Earthquakes and measures to mitigate their impact

Kh.M. Nurmatov<sup>1</sup><sup>a</sup>, B.Ye. Medeshev<sup>1</sup><sup>b</sup>, M.M. Botirova<sup>1</sup><sup>c</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

Abstract: The article presents the causes of earthquakes in seismically active areas and the struggle to increase the stability of building structures, as well as foreign experience in earthquake forecasting.  
Keywords: earthquake, tectonic plates, seismic waves, seismic stability, epicenter, energy, monolith, forecast.

## Землетрясения и меры по ослаблению их воздействия

Нурматов Х.М. <sup>1</sup><sup>a</sup>, Медешев Б.Е. <sup>1</sup><sup>b</sup>, Ботирова М.М. <sup>1</sup><sup>c</sup>

<sup>1</sup>Ташкентский государственный транспортный университет, Ташкент, Узбекистан

Аннотация: В данной статье представлены причины возникновения землетрясений в сейсмически активных районах и борьба за повышение устойчивости строительных конструкций, а также зарубежный опыт прогнозирования землетрясений.  
Ключевые слова: землетрясение, тектонических плит, сейсмических волн сейсмоустойчивость, эпицентр, энергия, монолит, прогноз.

### 1. Введение

Землетрясение — одно из самых опасных явлений природы для человека. По своим разрушительным последствиям землетрясения не имеют себе равных среди стихийных бедствий. Проблема в том, что предсказывать его довольно сложно, поэтому редко удается заранее к нему подготовиться.

Ученые всего мира работают над тем, чтобы ослабить последствия этого страшного бедствия прежде всего тем, чтобы заранее предупредить население (особенно крупных городов) о приближении землетрясения. В настоящее время достаточно точно определены те районы, где в будущем произойдут землетрясения. Согласно теории тектонических плит, это те районы, которые расположены вблизи границ этих плит [1-3]. Однако, несмотря на успехи науки в этой области, пока не удалось найти метода достаточно точного определения времени начала землетрясения. Огромную роль в защите городов и его населения в сейсмически опасных районах играет разработка методов строительства сейсмоустойчивых зданий и сооружений с внимательным учетом особенностей того или иного района.

Вся поверхность земного шара делится на несколько огромных частей земной коры, которые называются тектоническими плитами. Это следующие плиты: северо-американская, евроазиатская, африканская, южно-американская, тихоокеанская, атлантическая. Тектонические плиты находятся в непрерывном движении. Согласно теории тектонических плит, землетрясения являются результатом столкновения этих плит и сопровождаются изменениями поверхности

земли в виде складок, трещин и т. п., которые могут простираться на большое расстояние (до нескольких тысяч километров).

Районы, расположенные вблизи границ тектонических плит, в наибольшей степени подвержены землетрясениям. Одной из главных характеристик землетрясения является его энергия. Энергия сейсмических волн (или магнитуда) может составлять от нескольких милливатт-час до сотен тысяч миллионов киловатт-час (или  $10^{20}$ ).


### 2. Методология


Единственно возможная защита от землетрясений заключается в противосейсмическом строительстве, которое помимо специальных устройств, обеспечивающих гашение энергии толчков, предполагает высокое качество строительства, с использованием только высококачественных и добротных материалов [4].

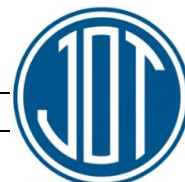
Сейсмоустойчивость необходима прежде всего тем строениям, которые подвергаются толчкам в 7-9 баллов (по шкале MSK). При силе толчка менее 7 баллов в противосейсмической защите нет необходимости, если соблюдаются общие правила строительства. При силе толчков свыше 9 баллов меры противосейсмической защиты уже недостаточны.

В непосредственной близости к эпицентру землетрясения на поверхности земли преобладают вертикальные перемещения, по мере удаления от эпицентра горизонтальные. Для борьбы с горизонтальными перемещениями, которые являются наиболее опасными для строительных конструкций, следует придерживаться нескольких общих правил

<sup>a</sup> <https://orcid.org/0009-0001-2736-0175>

<sup>b</sup> <https://orcid.org/0009-0000-9912-7578>

<sup>c</sup> <https://orcid.org/0009-0006-8542-003X>





строительства, которые заключаются в следующем. Прежде всего важен выбор формы сооружения. Наиболее сильным разрушениям подвергаются здания, имеющие неправильную форму. Симметричность формы здания обеспечивает наилучшее распределение нагрузки на каркас и другие его элементы [5].

Элементы конструкции должны быть связаны в единый прочный монолит, как правило, с помощью стальной арматуры, где не должно быть слабых точек.

Проблема защиты зданий от землетрясений особенно остро стоит в городах с большим населением, и особенно в тех из них, где ранее происходили землетрясения (Ташкент 1966 г. и др.) и где они вероятны в будущем.

Особенно остро проблема сейсмоустойчивости строительства развивающихся странах, где темпы роста численности городского населения велики, города разрастаются бесконтрольно, методы строительства несовершенны, осведомленность об опасности землетрясений низка.

По географическому положению около 40% этих городов лежит в районах сейсмической опасности, или на расстоянии 200 км от границ тектонических плит, или вблизи эпицентров землетрясений в прошлом [6].

Землетрясение несет в себе опасность разрушения зданий, сооружений и объектов, которые связаны с производством, хранением, использованием токсичных веществ. Зачастую тот ущерб, который может быть вызван утечкой этих веществ, представляет гораздо большую опасность, чем разрушения.

### 3. Результаты

Ежегодно на Земле происходят сотни тысяч землетрясений, но их амплитуда настолько незначительная, что они остаются незамеченными. Сильные же толчки чреваты серьезными разрушениями.

Вопрос о предсказании землетрясений является очень актуальным. Прогноз землетрясений – сложная научная проблема и благородная цель сейсмологии. Точно предсказать время возникновения очередных сейсмических толчков, а тем более предотвратить их, к сожалению, невозможно. Точность прогноза опасного для человека явления приравнивается практически к нулю. Однако разрушения и число человеческих жертв могут быть уменьшены путем проведения в сейсмоактивных районах разумной и долговременной государственной политики, основанной на повышении уровня осведомленности населения об угрозе землетрясений и умении противостоять подземной стихии. Трудности в отношении прогноза времени землетрясения огромны. До сих пор не разработаны принципиальные возможности и конкретные способы предвидения землетрясений в любой части сейсмически опасного региона с заданной точностью места и интенсивности в заданный отрезок времени.

Но сегодня, увы, ученые способны предсказывать сейсмokatastroфы за срок от нескольких месяцев до нескольких лет, но не могут дать точный краткосрочный прогноз. Специалисты признают, что хотя известно уже более 600 предвестников землетрясений, они не гарантируют точность прогноза подземного удара. Уверенно указать место, время, мощность катаклизма не

удается [7-8].

Над этим вопросом работают ученые всего мира, но до сих пор не существует такого метода, который позволил бы указать точную дату начала землетрясения. Ученые могут с большой степенью точности указать те районы, где произойдут землетрясения. Это, как правило, районы, близко расположенные от границ тектонических плит и где в прошлом часто происходили землетрясения. В природе существует ряд признаков, свидетельствующих о приближении землетрясения. Так, установлено, что за несколько дней до сильного землетрясения происходит серия слабых толчков. Но, с другой стороны, такая серия слабых толчков вовсе не означает, что обязательно произойдет землетрясение.

Считалось, что система предсказания землетрясения в Китае, построенная на основе широко организованного наблюдения за признаками, в том числе за поведением животных (кур, золотых рыбок и т. п.), является наиболее совершенной [9]. Достоверно засвидетельствовано, что многим сильным землетрясениям предшествует необъяснимое беспокойство животных на значительной территории. Такое наблюдалось, например, при Крымских землетрясениях 1927 года, перед Ашхабадским землетрясением. Современные сейсмические станции снабжены аквариумами со специальными рыбками, которые за семь-восемь часов до землетрясения начинают интенсивное движение в аквариуме, предчувствуя беду. Многие животные также обладают подобными свойствами [13]. Согласно этой системе каждому человеку, проживающему в сельской местности, вменялось в обязанности докладывать о наличии тех или иных признаков своему местному административному руководству, которое в свою очередь передавало эту информацию в вышестоящую инстанцию.

Узбекские учёные также предложили свои методы. Это содержание радона в подземных водах. Радон – это радиоактивный газ, присутствующий в грунтовых водах и в воде скважин. Он постоянно выделяется из Земли в атмосферу. Изменения содержания радона перед землетрясением впервые были замечены в Советском Союзе, где десятилетнее возрастание количества радона, растворенного в воде глубоких скважин, сменилось резким его падением перед Ташкентским землетрясением 1966 года. Появляются они как непосредственно перед толчками, но иногда могут происходить и за несколько суток.

Новый метод предсказания землетрясений предложен профессорами Афинского университета Варотросом, Алексопулосом, Номикосом и носит название «ВАН» (по начальным буквам фамилий авторов). По утверждению этих ученых, они могут предсказать время начала землетрясения с точностью от нескольких дней до нескольких часов, определить его магнитуду и местоположение его эпицентра. Перед началом землетрясения в земной коре возникают электрические импульсы, которые фиксируются согласно предложенному методу при помощи двух электродов, расположенных в земле удаленных один от другого на расстояние в несколько десятков метров [10].

Наиболее серьезное неудобство данного метода заключается в том, что вся территория страны должна быть опоясана целой сетью проводов с присоединенными к ним электродами. Эффективность



данного метода увеличится, если сеть будет развернута в случае предварительной регистрации серии слабых толчков или других признаков надвигающегося землетрясения.

Таким образом, незадолго до землетрясения при перемещении тектонических плит и их столкновении в земной коре индуцируются электромагнитные волны, которые могут быть зафиксированы приборами.

Тем не менее сейсмологам не удалось точно установить по этим признакам время начала землетрясения [11-12].

Наблюдения показывают, если в тех районах, которые подвержены землетрясениям, на протяжении долгого периода времени их не было, то возможное землетрясение будет очень сильным.

#### 4. Заключение

За всю историю существования человечества было сделано множество попыток прогноза землетрясений, но так и не было найдено точного решения этой проблемы. Распределение предвестников землетрясения мозаично. Связь с землетрясением какого либо геофизического параметра до сих пор не установлена.

Проблема прогноза не вышла за рамки научного поиска, остаются нерешенными все основные ее составляющие. Таким образом, при всем обилии проведенных и проанализированных наблюдений, место, время и магнитуда будущих разрушительных землетрясений, даже в неплохо изученных регионах, по-прежнему оказывается неожиданным. Каковы бы ни были перспективы прогноза или контроля, очевидно, что число жертв при землетрясениях и экономические потери могут быть существенно уменьшены, если специалисты направят свою изобретательность и труд в первую очередь на разработку более надежных строительных нормативов и создание более совершенных строительных конструкций. Каждое землетрясение – это и урок, и экзамен. И не только для сейсмологов, специализирующихся и, может быть, наиболее способных учеников по классу землетрясений в Школе Природы, но и для проектировщиков, землеустроителей и экономистов.

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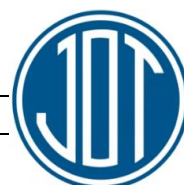
[13] А.И. Пеньков, старший преподаватель, А.Б. Сафронова, студентка Юргинский технологический институт. Всероссийская научно-практическая конференция молодых ученых, аспирантов и студентов «Экология и безопасность в техносфере: современные проблемы и пути решения»

#### Информация о авторах/ Information about the authors

Нурматов Ҳасанбой Мирзахмедович/ Nurmatov Khasanboy Mirzakhmedovich	Ташкентский государственный транспортный университет, старший преподаватель кафедры Техносферная безопасность <a href="https://orcid.org/0009-0001-2736-0175">https://orcid.org/0009-0001-2736-0175</a>
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Медешев Бахтиёр Ергешевич/ Medeshev Bakhtiyor Yergeshevich	Ташкентский государственный транспортный университет, старший преподаватель кафедры Техносферная безопасность <a href="https://orcid.org/0009-0000-9912-7578">https://orcid.org/0009-0000-9912-7578</a>
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Ботирова Мавлуда Мирходиевна/ Botirova Mavluda Mirkhodievna	Ташкентский государственный транспортный университет, старший преподаватель кафедры Техносферная безопасность <a href="https://orcid.org/0009-0006-8542-003X">https://orcid.org/0009-0006-8542-003X</a>
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## Development of a mathematical model for linking wagons to a schedule thread on railway sections

S.M. Suyunbaev<sup>1</sup><sup>a</sup>, Sh.B. Jumaev<sup>1</sup><sup>b</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** In this article, an analysis was carried out on the development of a mathematical model of attachment of rail cars to graphic times and experiments on minimizing the time of their stay at stations. Work has also been done to determine the number of walkway variants of a particular part of the group of wagons to be added up to a specified station using Gauss's method of "solving a system of linear algebraic equations". The functional possibilities of integrating the group of cars into commuter trains and optimizing their withdrawal from the overtaking stations on the railway site have been researched on the basis of the creation of a mathematical model.

**Keywords:** railway section, graphic times, train formatting plan, matrix element, transient train, section train, reserve locomotive, pick-up train.

## Temir yo'l uchastkalaridagi vagonlarni grafik vaqtlariga birlashtirishning matematik modelini ishlab chiqish

Suyunbayev Sh.M.<sup>1</sup><sup>a</sup>, Jumayev Sh.B.<sup>2</sup><sup>b</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Tashkent, O'zbekiston

**Annotatsiya:** Mazkur maqolada temir yo'l uchastkalaridagi vagonlarni grafik vaqtlariga birlashtirishning matematik modelini ishlab chiqish va ularni stansiyalarda turib qolish vaqtlarini minimallashtirishga doir tajribalar tahlili olib borilgan. Shuningdek, belgilangan stansiyagacha qo'shib yuboriladigan vagonlar guruhining ma'lum qismining yurish yo'li variantlari sonini Gaussning "Chiziqli algebraik tenglamalar sistemasini yechish" usuli yordamida aniqlash ishlari amalga oshirilgan. Vagonlar guruhini yo'l-yo'lakay poyezdlarga qo'shib yuborish va temir yo'l uchastkasidagi ortish-tushirish stansiyalaridan ularni olib chiqish bo'yicha optimallashtirish masalasining funksional imkoniyatlari matematik model yaratish asosida tadqiq etilgan.

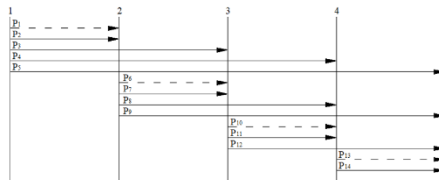
**Kalit so'zlar:** temir yo'l uchastkasi, grafik vaqtlari, poyezdlar tuzish rejasi, matritsa elementi, o'tkinchi poyezd, uchastka poyezdi, zaxira lokomotivi, terma poyezd.

### 1. Kirish


Bozor iqtisodiyoti va temir yo'l transportini qayta qurish sharoitida iqtisodiy ko'rsatkichlarni yaxshilashga, tashish sifati, temir yo'l transportining nufuzi va jozibadorligini oshirishga va uni amalga oshirish usullarini izlashga qaratilgan tashish jarayonining samarali texnologiyasidan foydalanish hozirgi zamon dolzarb masalalaridan biridir. Tashish sifatiga qo'yilgan zamonaviy talablar butun temir yo'l yo'nalishlarida foydalanish ishlarining muntazamliligini, aniqligini va ritmini oshirish zarurligini taqozo etmoqda. Shu bilan birga, yuk tashish tannarxini pasaytirish va ularning rentabelligini oshirish ko'p jihatdan bir qator tizimlarni ishlab chiqish va joriy etishga bog'liq bo'lib, ular ishlashini optimallashtirish temir yo'l transporti ishini yaxshilashga ta'sir qiladi. Shulardan biri stansiyalarda vagonlarning ortiqcha turib qolish vaqtlarini minimallashtirishning kompleks tizimini yaratishdir.


### 2. Tadqiqot metodikasi

Texnik stansiyalar (tadqiqot ishida beshta texnik stansiya qabul qilingan) misolida uzoq yo'nalishlardagi poyezdlardan nisbatan yaqin yo'nalishlardagi poyezd tarkibiga vagonlar guruhining ma'lum qismini qo'shib yuborish mumkin bo'lgan variantlar sonini ko'rib chiqamiz (1-rasm).



1-rasm. Beshta texnik stansiya sharoitida poyezdlar tuzish rejasining mumkin bo'lgan variantlari

<sup>a</sup> <https://orcid.org/0000-0002-4867-8270>

<sup>b</sup> <https://orcid.org/0000-0003-4905-9620>



1-rasmdan ko'rish mumkinki, agar vagonlar guruhining ma'lum qismini  $P_2$  yo'nalishidan nisbatan yaqin bo'lgan boshqa yo'nalishga ulash zarur bo'lsa, vagonlarni yetkazib berish varianti faqat bitta bo'ladi ( $P_1$  yo'nalish), ya'ni terma poyezd bilan olib chiqiladi.

Vagonlarning ma'lum qismini belgilangan yo'nalishdan boshqa nisbatan yaqin manzilga qo'shish zarur bo'lgan hollarda, vagonlar guruhini yetkazib berish variantlarini quyidagi jadvallardan ko'rish mumkin (1 – 3-jadvallar).

1-jadval

Vagonlar guruhining ma'lum qismini  $P_3$  yo'nalishidan boshqa nisbatan yaqin manzilgacha qo'shib yetkazib berish variantlari

Variant raqami	Yurish yo'li
1.	$P_1 \rightarrow P_6$
2.	$P_1 \rightarrow P_7$
3.	$P_2 \rightarrow P_6$
4.	$P_2 \rightarrow P_7$

2-jadval

Vagonlar guruhining ma'lum qismini  $P_4$  yo'nalishidan boshqa nisbatan yaqin manzilga qo'shib yetkazib berish variantlari

Variant raqami	Yurish yo'li	Variant raqami	Yurish yo'li
1.	$P_1 \rightarrow P_5 \rightarrow P_8$	7.	$P_2 \rightarrow P_5 \rightarrow P_9$
2.	$P_1 \rightarrow P_5 \rightarrow P_9$	8.	$P_2 \rightarrow P_6 \rightarrow P_8$
3.	$P_1 \rightarrow P_6 \rightarrow P_8$	9.	$P_2 \rightarrow P_6 \rightarrow P_9$
4.	$P_1 \rightarrow P_6 \rightarrow P_9$	10.	$P_2 \rightarrow P_7$
5.	$P_1 \rightarrow P_7$	11.	$P_3 \rightarrow P_8$
6.	$P_2 \rightarrow P_5 \rightarrow P_8$	12.	$P_3 \rightarrow P_9$

3-jadval

Vagonlar guruhining ma'lum qismini  $P_5$  yo'nalishidan boshqa nisbatan yaqin manzilgacha qo'shib yetkazib berish variantlari

Variant raqami	Yurish yo'li	Variant raqami	Yurish yo'li
1.	$P_1 \rightarrow P_5 \rightarrow P_8$	18.	$P_2 \rightarrow P_6 \rightarrow P_{12}$
2.	$P_1 \rightarrow P_5 \rightarrow P_9$	19.	$P_2 \rightarrow P_7 \rightarrow P_{10} \rightarrow P_{13}$
3.	$P_1 \rightarrow P_6$	20.	$P_2 \rightarrow P_7 \rightarrow P_{10} \rightarrow P_{14}$
4.	$P_1 \rightarrow P_6 \rightarrow P_9$	21.	$P_2 \rightarrow P_7 \rightarrow P_{11} \rightarrow P_{13}$
5.	$P_1 \rightarrow P_7$	22.	$P_2 \rightarrow P_7 \rightarrow P_{11} \rightarrow P_{14}$
6.	$P_2 \rightarrow P_5 \rightarrow P_8$	23.	$P_2 \rightarrow P_7 \rightarrow P_{12}$
7.	$P_1 \rightarrow P_7 \rightarrow P_{10} \rightarrow P_{14}$	24.	$P_2 \rightarrow P_8 \rightarrow P_{13}$
8.	$P_1 \rightarrow P_7 \rightarrow P_{11} \rightarrow P_{13}$	25.	$P_2 \rightarrow P_8 \rightarrow P_{14}$
9.	$P_1 \rightarrow P_7 \rightarrow P_{11} \rightarrow P_{14}$	26.	$P_2 \rightarrow P_9$
10.	$P_1 \rightarrow P_7 \rightarrow P_{12}$	27.	$P_3 \rightarrow P_{10} \rightarrow P_{13}$
11.	$P_1 \rightarrow P_8 \rightarrow P_{13}$	28.	$P_3 \rightarrow P_{10} \rightarrow P_{14}$
12.	$P_1 \rightarrow P_8 \rightarrow P_{14}$	29.	$P_3 \rightarrow P_{11} \rightarrow P_{13}$
13.	$P_1 \rightarrow P_9$	30.	$P_3 \rightarrow P_{11} \rightarrow P_{14}$
14.	$P_2 \rightarrow P_6 \rightarrow P_{10} \rightarrow P_{13}$	31.	$P_3 \rightarrow P_{12}$
15.	$P_2 \rightarrow P_6 \rightarrow P_{10} \rightarrow P_{14}$	32.	$P_4 \rightarrow P_{13}$
16.	$P_2 \rightarrow P_6 \rightarrow P_{11} \rightarrow P_{13}$	33.	$P_4 \rightarrow P_{14}$
17.	$P_2 \rightarrow P_6 \rightarrow P_{11} \rightarrow P_{14}$		

Shunday qilib, belgilangan stansiyagacha qo'shib yuboriladigan vagonlar guruhining ma'lum qismining yurish yo'li variantlari sonini Gaussning "Chiziqli algebraik tenglamalar sistemasi yechish" usuli yordamida aniqlash mumkin. Sistemani kengaytirilgan matritsa ko'rinishida quyidagicha ifodalash mumkin:

$$\begin{pmatrix} 2^n & 2^{n-1} & 2^{n-2} & \dots & 2^0 \\ 3^n & 3^{n-1} & 3^{n-2} & \dots & 3^0 \\ 4^n & 4^{n-1} & 4^{n-2} & \dots & 4^0 \\ 5^n & 5^{n-1} & 5^{n-2} & \dots & 5^0 \\ \dots & \dots & \dots & \dots & \dots \end{pmatrix} \begin{pmatrix} 1 \\ 4 \\ 12 \\ 33 \\ \dots \end{pmatrix} \quad (1)$$

Istalgancha stansiyalar soni uchun etib borish stansiyagacha vagonlar guruhining ma'lum qismini qo'shib yuborish mumkin bo'lgan variantlar sonini quyidagicha aniqlash mumkin:

$$\Sigma P = \frac{4}{3} \cdot K^n - \frac{19}{2} \cdot K^{n-1} + \frac{151}{6} \cdot K^{n-2} - 22 \quad (2)$$

bunda poyezd qayta ishlanadigan stansiyalar soni;  
 $K$  –

$n$  – matritsa elementining tartib o'rni.

4-jadvalda poyezdlar tuzish rejasidagi ma'lum bir yo'nalish bo'yicha vagonlarning yurish yo'lidagi temir yo'l uchastkasida 10 tadan ko'p texnik stansiya mavjud bo'lmashligini inobatga olgan holda, etib borish stansiyagacha vagonlar guruhining ma'lum qismini qo'shib yuborish mumkin bo'lgan variantlar soni keltirilgan [1].

4-jadval

Vagonlar guruhining ma'lum qismini qo'shib yuborishning mumkin bo'lgan variantlari soni

Stansiyalar soni ( $K$ )	Yetib borish stansiyagacha belgilangan yurish yo'li variantlari soni ( $\Sigma R$ )
2	1
3	4
4	12
5	33
6	75
7	146
8	254
9	407
10	613

Belgilangan stansiyagacha qo'shib yuboriladigan vagonlar guruhining ma'lum qismini yurish yo'lidagi variantlarining samaradorlik sohasi kompleks texnik-iqtisodiy hisoblar asosida aniqlanadi.

4-jadvaldan ko'rish mumkinki, yurish yo'lida texnik stansiyalar soni qancha ko'p bo'lsa, belgilangan stansiyagacha qo'shib yuboriladigan vagonlar guruhi ma'lum qismining yurish yo'lidagi variantlari soni shunchalik ko'p bo'ladi.

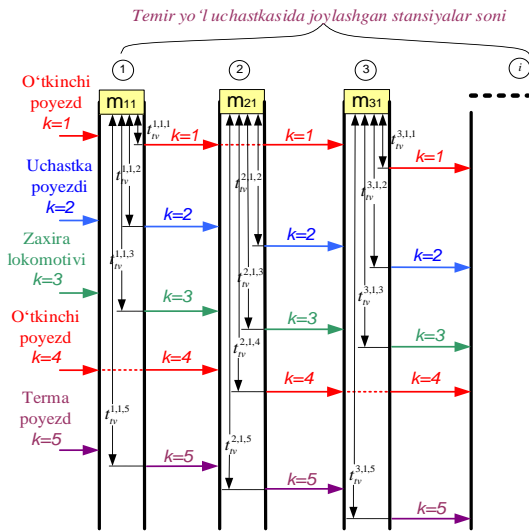
Yo'l-yo'lakay poyezdlarga vagonlar guruhini biriktirib jo'natish barcha hollarda ham o'zini oqlamaydi. Buning uchun avvalo, vagonlar guruhini biriktirishning maqsadga muvofiqligini, unga matematik yondashuv va modellar asosida aniqlash zarurdir.

Ishlab chiqarish sohasida vagonlarni poyezdlarga ulashgacha bo'lgan davrda ularning turib qolish vaqti muhim ahamiyat kasb etadi. Turib qolish vaqtining me'yordan ortib ketishi vagon aylanmasining sekinlashishiga, yuklarni yetkazib berish vaqtining cho'zilishiga sabab bo'ladi. 2-rasmda vagonlar guruhini yo'l-yo'lakay poyezdlarga ulashgacha bo'lgan davrda ularning turib qolish vaqtini aniqlash sxemasi keltirilgan.

Yuqorida keltirilgan chora-tadbirlar ilmiy-texnik adabiyotlarda [2 – 5] temir yo'l yo'nalishlari ishi ishonchligini oshirishda muhim omil sifatida belgilangan. Biroq hozirgi vaqtda, ularni "O'TY" AJ amaliyotda qo'llash samaradorligini har tomonlama baholashning matematik modeli ishlab chiqilmagan.







2-rasm. Vagonlar guruhini yo‘l-yo‘lakay poyezdlarga ulashgacha bo‘lgan davrda ularning turib qolish vaqtini aniqlash sxemasi

Muammoga qat‘iy matematik yechimlar kiritish, tortuv turlaridan yanada samarali foydalanishga, oraliq stansiyalarda vagonlarning turib qolish vaqtini kamaytirishga va mahalliy vagonlarni yetkazib berishni tezlashtirishga imkon beradi.

Vagonlarni grafik vaqtlariga birlashtirishning matematik modelini yaratishda vagonlar guruhini yo‘l-yo‘lakay poyezdlarga qo‘shib yuborish va temir yo‘l uchastkasidagi ortish-tushirish stansiyalaridan ularni olib chiqishning optimallashtirish masalasi funksional imkoniyatlarni minimalashtirish asosida hal etish mumkin:

$$\sum_i \sum_j \sum_k x_{ijk} \cdot t_{iv}^{ijk} \cdot m_{ij} \cdot e_{v-s} + y_{ik} \cdot \delta_{ik} \cdot (t_{iv,kj}^{ik} \cdot C_{bts} + C_{pt}) \rightarrow \min \quad (3)$$

- bunda  $i$  – vagonlar qo‘shilayotgan stansiyaning tartib raqami;
- $j$  –  $i$ -stansiyaga qo‘shib yuborishga tayyor bo‘lgan vagonlar guruhining raqami;
- $k$  –  $i$ -stansiyasida vagonlarni qo‘shib yuborish uchun to‘xtatilishi ko‘zda tutilgan poyezdning “grafik vaqti” raqami;
- $x_{ijk}$  –  $i$ -stansiyasida tuzilgan  $j$ -vagonlar guruhini  $k$ -poyezd “grafik vaqti”ga qo‘shib yuborish imkoniyatini aks ettiruvchi mantiqiy o‘zgaruvchi;
- $t_{iv}^{ijk}$  –  $i$ -stansiyadagi vagonlarning  $j$ -guruhini  $k$ -poyezdga qo‘shishdan oldin vagonlarning turib qolish vaqti davomiyligi, soat;
- $m_{ij}$  – vagonlar  $j$ -guruhining  $i$ -stansiyadagi soni, vag.;
- $e_{v-s}$  – bir vagon-soat xarajat stavkasi, so‘m;
- $y_{ik}$  –  $i$ -stansiyadagi  $k$ -“grafik vaqti”ga vagonlar guruhini qo‘shib yuborish imkoniyatini aks ettiruvchi mantiqiy o‘zgaruvchi;

$$y_{ik} = \begin{cases} 0, & \sum_j x_{ijk} = 0; \\ 1, & \sum_j x_{ijk} > 0; \end{cases} \quad \forall (i,k) \quad (4)$$

Ushbu chegarani quyidagicha yozish mumkin

$$\sum_i x_{ijk} \leq n \cdot y_{ik}, \quad j=1, 2, 3, \dots, n \quad (5)$$

$\delta_{ik}$  –  $i$ -stansiyadagi  $k$ -poyezdga vagonlar guruhini qo‘shib yuborish uchun to‘xtatish imkoniyatini aks ettiruvchi mantiqiy o‘zgaruvchi;

$$\delta_{ik} = \begin{cases} 0, & \text{agar } k\text{-poyezdning } i\text{-stansiya bo'yicha} \\ & \text{texnik to'xtashi ko'zda tutilgan bo'lsa;} \\ 1, & \text{aks holda.} \end{cases} \quad (6)$$

$t_{iv,kj}^{ik}$  –  $i$ -stansiyada  $k$ -poyezdning vagonlarni qo‘shib yuborish bo‘yicha texnologik amallar ostida turish vaqti, soat;

$C_{bts}$  – uchastkadagi poyezdlarning turib qolish vaqti bilan bog‘liq umumiy xarajatlar, so‘m;

$C_{pt}$  – vagonlar qo‘shib yuborilishi ko‘zda tutilgan stansiyalarda poyezdning to‘xtab-yurishi bilan bog‘liq umumiy xarajatlar, so‘m;

Vagonlar guruhini temir yo‘l uchastkasining ortish-tushirish stansiyalaridan poyezdlar qayta ishlanadigan stansiyalarga tashish shartini quyidagicha ifodalash mumkin:

$$\sum_k x_{ijk} = 1, \quad \forall (i,j) \quad (7)$$

Qo‘shib yuborilishi ko‘zda tutilgan vagonlar guruhi uzunligining  $k$ -poyezd tarkibiga sig‘ishi shartini quyidagicha ifodalash mumkin:

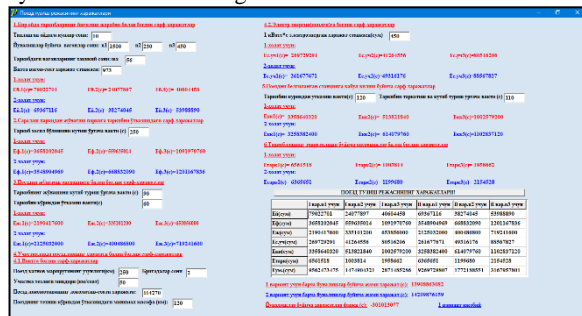
$$\sum_i \sum_j x_{ijk} \cdot m_{ij} \leq \Delta m_k, \quad \forall (k) \quad (8)$$

bunda  $\Delta m_k$  –  $k$ -poyezdga sig‘ishi mumkin bo‘lgan vagonlarning uzunligi, m.

Tadqiqot ishi davomida vagonlarni grafik vaqtlariga birlashtirishning matematik modelini ishlab chiqish asosida vagonlar guruhini yo‘l-yo‘lakay poyezdlarga qo‘shib yuborishning mumkin bo‘lgan variantlarini texnik-iqtisodiy baholash bo‘yicha dasturiy ta‘minotni yaratishga ehtiyoj sezildi.

### 3. Xulosa

Vagonlar oqimining nomutanosibligini inobatga olgan holda, vagonlar guruhini yo‘l-yo‘lakay poyezdlarga qo‘shib yuborishning amaliy natijalari joriy etilishi mumkin, lekin ularni qo‘shib yuborishda texnik-iqtisodiy ko‘rsatkichlariga alohida e‘tibor qaratish lozim. Yuqoridagilarni inobatga olgan holda, vagonlar oqimini tashkil etishning iqtisodiy samaradorligini aniqlash uchun *Delphi* dasturlash tilida “O‘zgaruvchan grafik sharoitida vagon oqimlarini tashkil etishning samarali variantini tanlash” nomli dasturiy ta‘minot ishlab chiqildi. Ushbu dasturiy ta‘minotning ishchi oynasi 3-rasmda keltirilgan.



3-rasm. “O‘zgaruvchan grafik sharoitida vagon oqimlarini tashkil etishning samarali variantini tanlash” nomli EHM uchun dasturining ishchi oynasi

Mazkur dasturiy ta‘minot poyezdlarni jo‘natishda vagon oqimlari harakatining samarali variantini poyezdlar harakati





bilan bog'liq bo'lgan quyidagi sarf-xarajatlarni hisobga olgan holda tanlash uchun mo'ljallangan:

❖ tarkiblarning yig'ilish jarayoni bilan bog'liq sarf-xarajatlar, so'm;

❖ saralash parkidan jo'natish parkiga tarkibni o'tkazish amallari hamda tuzish bo'yicha amallar bilan bog'liq sarf-xarajatlar, so'm;

❖ poyezdni jo'natish (ko'rikdan o'tkazish, jo'natishdagi kutish) amallari bilan bog'liq sarf-xarajatlar, so'm;

❖ uchastkalarda poyezdlarning harakati bilan bog'liq sarf-xarajatlar, so'm;

❖ poyezdni belgilangan stansiyaga qabul qilish bo'yicha amallar bilan bog'liq xarajatlar, so'm;

❖ tarkiblarning tarqatilishi bo'yicha amallar bilan bog'liq sarf-xarajatlar, so'm.

Ishlab chiqilgan matematik model va dasturiy ta'minot temir yo'llar ishida samarasiz yo'nalishlarni o'z vaqtida bekor qilinishini ta'minlash, samaralilarini esa tezkor aniqlash va ularni joriy etish imkonini beradi.

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## Mualliflar to'g'risida ma'lumot/ Information about the authors

Suyunbayev

Shinpolat

Mansuraliyevich /

Shinpolat

Mansuraliyevich

Suyunbaev

Toshkent davlat transport universiteti, "Temir yo'ldan foydalanish ishlarini boshqarish" kafedrasida professori, t.f.d., professor.

E-mail: [shinbolat\\_84@mail.ru](mailto:shinbolat_84@mail.ru)

Tel.: +99893 510 92 82

<https://orcid.org/0000-0002-4867-8270>

Jumayev Sherzod

Bahrom o'g'li /

Sherzod Bakhrom

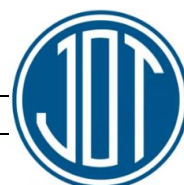
ugli Jumaev

Toshkent davlat transport universiteti, "Temir yo'ldan foydalanish ishlarini boshqarish" kafedrasida dotsenti, t.f.f.d (PhD), dotsent. E-mail:

[shbjumayev\\_92@mail.ru](mailto:shbjumayev_92@mail.ru)

Tel.: +99899 879 92 14

<https://orcid.org/0000-0003-4905-9620>



# Evaluation the remote system quality indicators using a mathematical model

V. Zakirov<sup>1</sup><sup>a</sup>, E. Abdullaev<sup>1</sup><sup>b</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** The popularity of web services has increased the demand for quality indicators of remote service systems. One of the indicators of the quality of such a service system is the response time of the system users. This time depends on several indicators, and if it exceeds a certain value, it causes inconvenience to the users of the system. Works based on previously conducted experimental investigations have a limited use. Unlike experimental studies, this research proposes using public service theory models to estimate the response time of user requests. Studies were done to identify system quality indicators using the suggested mathematical model. Based on the model, the waiting time for request responses, the dependence of the waiting time on the number of users, and the dependence of the waiting time on the service system's internal technical indicators were investigated. The studies done showed that the proposed model is completely consistent with the results obtained by the present experimental approach and may be widely employed in research.

**Keywords:** public service system, mathematical model, response time, request flow, random process, probability model, duration of service, quality indicators.

## 1. Introduction

After the COVID-19 epidemic, significant changes occurred around the world. At the same time, new ways of organising work have emerged in a variety of disciplines. For example, in the sphere of service supply, there have been significant developments in terms of distant service organisation.

This showed the need to re-analyze and improve the working principles of existing systems in the field. Because during the pandemic, all types of services were organized remotely, which caused a sharp increase in system users and the loads created by them. This led to the fact that this load was not provided with the required quality of service. This situation can happen in all service areas. Therefore, the study of the reasons for the increase in downloads and the correct Organization of methods of servicing them remains one of the important problems of the present day. Reasons for the origin of the problem [1], [2], [3], [23] considered in studies, they can be mainly told that one of the main reasons for the origin of problems is technical problems, which are considered directly related to an increase in the number of users. Because each service device has a capacity limit, consumers who surpass it will experience these problems. As a result, it is critical to examine the system operating methods and the potential for serviceability of the devices indicated in the research [3], [5], [10], and [11]. To do this, it is required to conduct research on service delivery methods based on mathematical models and create models appropriate for the service sector. According to research undertaken in the servicing of user requests, there are various reasons why difficulties emerge. These include limited service device capabilities, a lack of optimisation in user-generated software, and internet connection concerns. These issues were addressed in works [1], [16], [18], [23], [24] and determined through experimental research. These

experiments were conducted in many stages and included the following.


According to [1,] during the first phase of the analysis, there were issues with serving requests with the technical aspects of the service device (HDD, RAM), and their ability to serve multiple requests at once was limited, resulting in many incoming requests not being handled. The research used a system server with Intel® Core™i5-2310 CPU @2.90GHz x 4 processor, 8GB Hard disk, 1GB RAM specifications, and Apache JMeter 2.9 software, which is one of the programs for generating concurrent queries. A stream of timed requests was sent and analyzed. In this case, the number of requests was increased and when 51 requests were sent simultaneously, the system was overloaded and lost the ability to service requests.


In this case, the author made several changes to the device's technical parameters (SSD, RAM) to technically reduce the service time, and the service device is Intel® Core™i5-2310 CPU @2.90GHz x 4 processors, 8GB of solid state disc, 1GB of RAM, and as a result, the service time has been reduced by 98% compared to the previous one.

In the second stage, web server research was conducted, with the process-based web server (Apache) being replaced by an event-based web server (Nginx). In this scenario, the web servers were installed on a server with an Intel® Core™i5-2310 CPU @2.90GHz x 4 processor, 128 GB SSD, and 4GB RAM. When compared to the prior study, the service time was reduced by 34% as a result of this investigation.

The service time was implemented in the following steps of analysis using system software. It also made use of technologies such as caching, Gzip compression, and script optimization. As a result of the optimization technologies, the service time was decreased by 80%, 75%, and 24% compared to the baseline state.

Management of caches with the help of caching technology is intended to reduce the number of requests to

<sup>a</sup> <https://orcid.org/0000-0002-2290-2625>

<sup>b</sup> <https://orcid.org/0000-0002-8954-9731>



the server. As a result, the number of requests to the server decreased, and this, in turn, caused a decrease in service time.

Gzip compression technology reduces service time by employing compression technology to send result files generated in response to user requests. The technology's goal is to lower the size of various forms of data while also reducing the time it takes to transfer them to the user across the network. Because all data is sent over the network as packets, a tiny amount of data results in a small number of packets [4], [6]. This will cut down on the time spent on the request.

The technology of script optimization refers to the software of the service system, and it is meant to alter its sections of the software code from the general code to the necessary code. Because the result of the query served in the database is generated as a result of the software codes, the non-optimality of the codes results in a huge volume of the formed answer [5], [6]. This, in turn, increased the time it took to send them via the network, thus the author observed in the study report that optimizing scripts also influences service time, and making the scripts look the way they should achieve a reduction in service time in his experimental investigations.

Also, researches of this type were carried out in [12], [13], [14], [19], [20], [23], [24], and in them, researches were carried out using experimental methods.

It can also be concluded from the above that the researches related to the service of user requests were carried out only in an experimental - research method.

However, it is now necessary to pre-calculate or evaluate the way the systems perform, as well as the serviceability of the service device. This necessitates the investigation of service approaches based on mathematical models and the development of models appropriate for the service sector.

## 2. Materials and methods

In this research work, mathematical models were developed for researching the request service system, and based on it, service effectiveness was studied.

As previously stated, in this instance, it can be regarded as a typical flow of requests because user requests enter the system at various times. We believe that the length of their service is governed by a negative exponential law. In this process, requests entering the system are served by  $V$  service devices. The system serves requests in a waiting manner, and the number of waiting places is limited to  $r$ . Because, according to the service models in [15], serving with an unlimited number of waiting points, the number of requests in the queue part of the system occupies a large volume, the server cannot serve them all, and the system [1], will face the situation of not being able to serve requests like. Therefore, when organizing systems, waiting areas are limited. This, in turn, means the loss of incoming requests to the system when the service device and all queues are busy. In this process, the system serves requests in waiting areas in a FIFO manner. Thus, such a service arrangement corresponds to the  $M/M/V/r$  model of user request service based on [Kendal's] specification. The quality indicators of this system are determined as follows. According to it, the probability that all service devices and waiting areas in the system will be occupied corresponds to the case  $l = V + r$  and is defined by the following expression (1).

$$p_b = \sum_{i=V}^l p_i = \frac{\frac{Y^V}{V!} \frac{V}{V-Y} \left[ 1 - \left( \frac{Y}{V} \right)^{r+1} \right]}{\sum_{i=0}^{V-1} \frac{Y^i}{i!} + \frac{Y^V}{V!} \frac{V}{V-Y} \left[ 1 - \left( \frac{Y}{V} \right)^{r+1} \right]} \quad (1)$$

Here,  $Y = \lambda \cdot \bar{t}$  load generated by queries,  $\lambda = N \cdot \alpha$  the rate of user-generated requests,  $N$  number of system users,  $\alpha$  the rate of requests generated by a single user,  $\bar{t} = \bar{t}_1 + \bar{t}_x$  total time spent serving a single request,  $\bar{t}_1$  time spent on user identification,  $\bar{t}_x$  service time for one request (according to [3], it is determined based on the technical parameters of the server).

As can be seen from expression (1), if  $r = \infty$ , this expression becomes Erlang's second or C formula. If so, then it becomes Erlang's first formula. So, when the number of waiting places changes from  $\infty$  to 0, the expression (1) changes in the range of probability of losses according to  $M/M/V/\infty$  and  $M/M/V/r$  models. Therefore, this expression is a general calculation expression for two models  $r = \infty$  and  $r = 0$ .

(1) the expression can be expressed as the load acting on one device  $\eta = \frac{Y}{V}$

$$p_b = \sum_{i=V}^l p_i = \frac{1 - \eta^{r+1}}{\frac{1 - \eta}{E_V(Y)} + \eta - \eta^{r+1}} \quad (2)$$

In this case, the loss of requests in the system occurs when the number of pending requests exceeds  $r$ . Therefore, the following expression (3) can be reduced to (4) by the load falling on a single service device.

$$p_{ch} = p_i = \left( \frac{Y}{V} \right)^{i-V} \frac{Y^V}{V!} p_0 = \frac{\left( \frac{Y}{V} \right)^r \frac{Y^V}{V!}}{\sum_{i=0}^{V-1} \frac{Y^i}{i!} + \left( \frac{Y}{V} \right)^r \frac{Y^V}{V!} \frac{1 - \left( \frac{Y}{V} \right)^{r+1}}{1 - \frac{Y}{V}}} = \frac{\eta^r}{\frac{1}{E_V(Y)} + \eta - \eta^{r+1}} \quad (3)$$

In this case, based on the above formulas, the probability of waiting for requests in the system is determined by the following expression (5).

$$p_{w>0} = p_b - p_{ch} = \frac{Y^V}{V!} \frac{V}{V-Y} \left[ 1 - \left( \frac{Y}{V} \right)^r \right] p_0 = \frac{1 - \eta^r}{\frac{1 - \eta}{E_V(Y)} + \eta - \eta^{r+1}} \quad (4)$$

Also, the average waiting time for requests to be served is determined by the following expression (5):

$$W = \frac{P_{w>0}}{V - Y} \quad (5)$$

So, based on the mathematical model described above, it is possible to calculate the quality indicators of the request service system and select the technical indicators of the system based on the analysis of the results

## 3. Results and discussion

Using the above expressions, we will now research to determine the system's quality indicators.



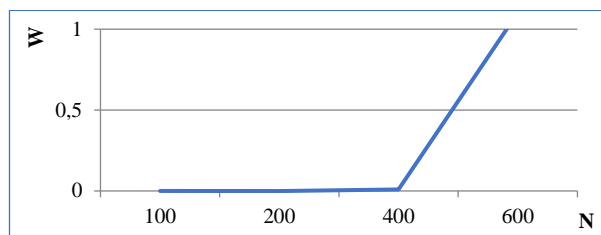


Figure 1. Graph of the dependence of the average waiting time on the number of users

Figure 1 depicts the graph of the average waiting time versus the number of users. The graph shows that as the number of customers increases, so does the average waiting time. When the number of users approaches  $N$ , the waiting time skyrockets and the system is unable to reply to queries. This situation supports the conclusion provided in [1]. As a result, the system with the aforementioned indications can provide  $N$  users with the desired quality indicators on average. Increasing the number of users from  $N$  results in a significant worsening of the system's quality indicators.

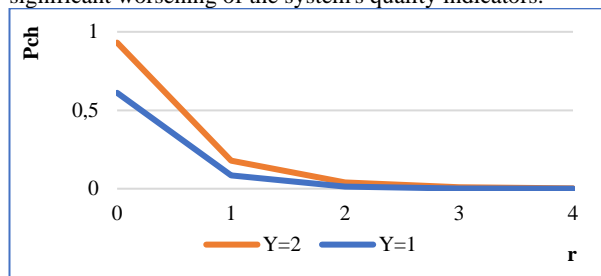


Figure 2. The graph of the dependence of the probability of losses on the waiting areas

Figure 2 depicts the graph of the chance of loss versus the number of waiting areas, which indicates that the probability of loss falls rapidly as the number of waiting spaces grows. This corresponds to the experiment results shown in [1]. Furthermore, the likelihood of losses in this circumstance is determined by the incoming load. The speed of user requests and the service time for one request determines the system load. The service time for one request depends on the following:

- processor power in the service system. It is known that the processor is one of the most basic devices of computer work and performs all its tasks [1], [3], [9], [17], [21]. It is its performance that determines the speed of the system. Because all requests are connected to the memory through the processor and its results are formed. Therefore, service times include the processor's request service time, which is a major part of the total service time;
- time to load HTML documents into the browser. In remote systems, data exchange between the client and the server is carried out through browsers. And it sends the query results to the client device in an HTML file format that the browser can understand [5], [6], [22]. This, in turn, requires the result of the request to be sent to the user via the Internet. In this process, the size of the file and the speed of the Internet connection mean that the service times will be longer or shorter;
- to the number of HTTP requests. Each request sent to the system server requires a certain amount of time from the server to be served [3]. Therefore, the increase in requests to the system causes the system to gradually fill up service devices and waiting areas [7], [8]. This, in turn, increases the

volume of the queue of requests as a result of the increase in the intensity of requests to the system, and this causes an increase in the service time. Sometimes, a sudden increase in the number of requests will cause the system to lose its ability to serve;

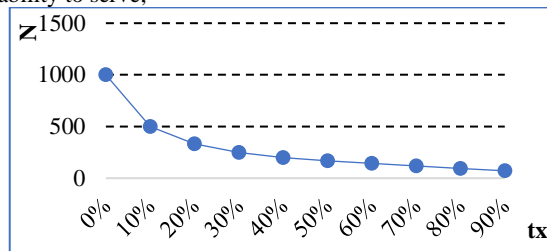


Figure 3. The graph of the dependence of the number of system users on the service time of one request

Figure 3 is a graph of the dependence of the number of system users on the service time of a single request, in which the service time of a single request is shown in the order of increasing percentages. As can be seen from the graph, the number of users of the system decreases as the request service time increases. If we approach this issue from the other side, we can see that it is possible to increase the number of users by reducing the time of serving one request. But the service time for this one request depends on a number of factors, including processor power, technical parameters of other server devices, optimization of the service software, internet speed, etc.

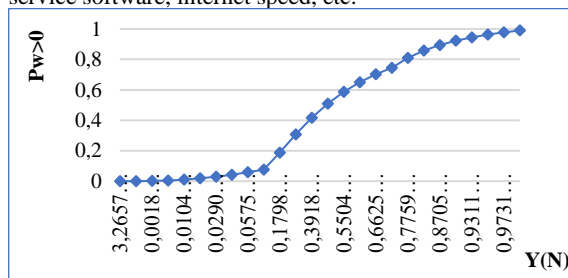


Figure 4. Graph of dependence of the probability of losses on the falling load

It is well known that an unexpected increase in system demands leads the system to behave somewhat differently than typical operating operations. Such conditions were vividly witnessed during the COVID-19 epidemic. In the following section of our investigation, we will look at the status of the service system, which is similar to the situation that occurred during the pandemic, in which the number of downloads or requests into the system has increased drastically. This condition is depicted in figure 4, which depicts the graph of the probability of losses as a function of falling load. The graph shows that as the load grows significantly, the likelihood of losses increases significantly as well, and the system's quality indicators significantly decline. For the reasons that the system's waiting rooms and service devices operate at maximum capacity due to a sudden spike in demand, as previously stated. Request queue times go longer as a result and the system's serviceability drops.





## 4. Conclusion

In summary, the mathematical model of the proposed user request service system is based on mass service theory and allows for the computation of the following system quality indicators:

The system's efficiency can be determined by implementing strategies to reduce the load and duration of service requests, calculating the likelihood of waiting for requests, calculating the likelihood of lost requests, and calculating the number of users based on quality measures.

Simultaneously, the results produced using the proposed model are completely consistent with the results of the experimental testing. This allows for the verification of the suggested mathematical model's correctness, as well as the identification and optimization of the quality indicators of the user request service system.

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**Information about the authors**

Zakirov Vahid  
Maripovich /  
Vakhid Zakirov

Toshkent davlat transport universiteti  
“Radioelektron qurilmalar va tizimlar”  
kafedrası professori v.b. t.f.n, E-mail:  
[vakhidzakirov@mail.ru](mailto:vakhidzakirov@mail.ru)  
Tel.:+ 998 97 780 03 21  
<https://orcid.org/0000-0002-2290-2625>

Abdullayev Eldor  
Sa’dulla o‘g‘li /  
Eldor Abdullaev

Toshkent davlat transport universiteti  
“Radioelektron qurilmalar va tizimlar”  
kafedrası doktoranti. E-mail:  
[eldorabdullayev0223@gmail.com](mailto:eldorabdullayev0223@gmail.com)  
Tel.:+99890 043 11 04  
<https://orcid.org/0000-0002-8954-9731>



## Use of multi-criteria decision-making methods in solving the problem of location selection in the organization of transport-logistics centers





G.A. Samatov<sup>1</sup> <sup>a</sup>, I.X. Absattorov<sup>1</sup> <sup>b</sup>, D.Q. Xakimov<sup>1</sup> <sup>c</sup>, Q.Sh. Matrasulov<sup>1</sup> <sup>d</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** Transport logistics centers are one of the important links of the transport process in the effective organization of the country's transport services in the domestic and foreign markets. In this scientific research, the level of use of multi-criteria decision-making methods in solving the problem of location selection of transport logistics centers is highlighted. During the research work, an analysis of the literature related to the topic was first carried out, and the decision-making criteria used in the field were clarified based on them.

**Keywords:** decision making, transport logistics center, location problem, evaluation criteria, MCDM, AHP, ELECTRE, PROMETHEE, TOPSIS, VIKOR.

## Transport-logistika markazlarini tashkil etishda joy tanlash muammosini yechishda ko'p mezonli qaror qabul qilish usullaridan foydalanish

Samatov G.A.<sup>1</sup> <sup>a</sup>, Absattorov I.X.<sup>1</sup> <sup>b</sup>, Xakimov D.Q.<sup>1</sup> <sup>c</sup>, Matrasulov Q.Sh.<sup>1</sup> <sup>d</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Toshkent, O'zbekiston

**Annotatsiya:** Transport logistika markazlari mamlakat transport xizmatlarini ichki va tashqi bozorda samarali tashkil etishda transport jarayonining muhim bo'g'inlaridan biri hisoblanadi. Ushbu ilmiy tadqiqot ishida transport logistika markazlarining joylashuv joyini tanlash muammosini yechishda ko'p mezonli qaror qabul qilish usullaridan foydalanish darajasi yoritib berilgan. Tadqiqot ishini bajarish davomida dastlab mavzuga tegishli adabiyotlar tahlili amalga oshirilgan va ular asosida sohada qo'llaniluvchi qaror qabul qilish mezonlari yoritib berilgan.

**Kalit so'zlar:** qaror qabul qilish, transport logistika markazi, joylashuv muammosi, baholash mezonlari, KMQQQ, AHP, ELECTRE, PROMETHEE, TOPSIS, VIKOR.

### 1. Kirish

Transport-logistika markazi (TLM) har bir davlat uchun muhim infratuzulma ob'ektlaridan biri hisoblanadi. Ular yuklarni yetkazib berish, transport va logistika xizmatlarini ko'rsatish orqali davlatning iqtisodiy o'sishiga ta'sir ko'rsatadi. Davlat hududida TLMlarini tashkil etish va mavjudlarini transport va logistika xizmatlari istemolchilari tomonidan shakillangan ta'labga to'liq javob bera olish qobiliyatini doimiy tahlil qilib borish va TLMlarni doimiy rivojlantirish choralarini ko'rish iqtisodiy o'sishga ijobiy ta'sir ko'rsatadi. TLMlarining samarali faoliyat ko'rsatishi ularning hududiy jihatdan joylashuv joylari bilan ham uzviy bog'liq hisoblanadi. Ohirgi yuz yill davomida omborlar, yig'ish va tarqatish markazlari, yuk terminallari va TLMlarini tashkil qilishda ularga har tamonlama mos keluvchi joylarni tanlashga qaratilgan usullar turli tadqiqotchi olimlar tomonidan ishlab chiqildi,

Tadqiqot ishida TLMlari uchun joy tanlash muammosini hal qilishda qo'llaniladigan ko'p mezonli qaror qabul qilish (KMQQQ) usullaridan foydalanish

takomillashtirildi va bugungi kunda ham bu borada jadal ishlar olib borilmoqda. Yetkazib berish tarmog'ida ob'ektlarning munosib joylarda joylashishi transport xizmatlari va yetkazib berishning umumiy xarajatlariga ta'sir ko'rsatadi. Yetkazib berish tarmog'i bo'ylab TLMlarining joylashuvi va soni maxsulotning oxirgi istemolchiga yetib borish narxiga ta'sir ko'rsatadi [1]. Yangi tashkil etilayotgan TLMlari uchun joy tanlash muammosi TLM biznes rejasini tuzishda muhim va chuqur o'rganib tahlil qilinadigan omil hisoblanadi. Ushbu tadqiqot ishida TLM uchun joy tanlash muammosini yechishda ko'p mezonli qaror qabul qilish usullaridan foydalanish va ular orqali erishiladigan natijalarning ishonchlik darajasi tahlil qilingan.

### 2. Tadqiqot metodikasi

darajasini aniqlash va ushbu usullar yordamida muammoning yechimini topish darajalarini aniqlashga qaratilgan. Shuningdek TLMlar uchun joy tanlash

<sup>a</sup>  <https://orcid.org/0000-0001-6479-6173>

<sup>b</sup>  <https://orcid.org/0000-0002-5968-0990>

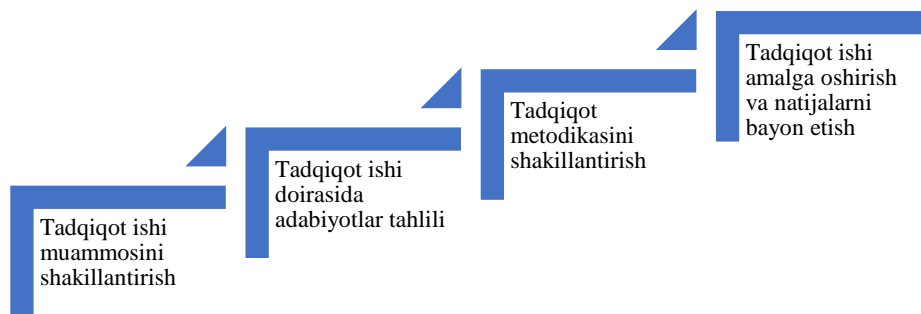
<sup>c</sup>  <https://orcid.org/0009-0009-8894-8915>

<sup>d</sup>  <https://orcid.org/0009-0004-3300-9228>



muammosiga yechim ishlab chiqish jarayonida KMQQQ usullarining birgalikda qo'llash sohasini o'rganish. Har qanday ilmiy tadqiqot ishini bajarish jaroyoni ilmiylik va

tizimlilikga asoslanishi zarur. Quyida 1-rasmda tadqiqot ishini amalga oshirish bosqichlari tasvirlangan.



1-rasm. Tadqiqot ishini amalga oshirish bosqichlari

KMQQQ usullarini qaror qabul qilish jarayonida qo'llash muammoning yechimini tartibli ravishda amalga oshirish va eng yaxshi natijani olishga qaratiladi. Quyida 2-rasmda

KMQQQ usullarining tadqiqot ishini amalga oshirishda qo'llashning bosqichlilik tarifi ko'rsatilgan.



2-rasm. Qarorlarni qabul qilish bosqichlari

2-rasmda keltirilgan qarorlarni qabul qilish bosqichlari odatda qaror qabul qilish usullarda qo'llaniladigan jarayonlardir. Albatta, bu bosqichlar qaror muammosining tuzilishi, hajmi va maqsadiga qarab farq qilishi mumkin.

KMQQQ usullari qaror variantlari orasidan eng yaxshisini tanlash va qarama-qarshi aniq va mavhum mezonlar yoki sifatlarga ko'ra variantlarni tartiblash yoki tasniflash uchun ishlatiladigan usullar hisoblanadi.

### 3. Natijalar

#### Adabiyotlar tahlili

Adabiyotlarda TLMlari uchun joy tanlashga qaratilgan turli ko'rinishdagi ammo yagona maqsadga qaratilgan ilmiy tadqiqot ishari mavjud. TLMlari uchun to'g'ri joy tanlash murakkab jarayon hisoblanadi. U odatda joylashuv joyiga ta'sir qiluvchi ko'plab mezonlarni (masofa va yer maydoni, xarajat, atrof-muhit, hududning iqtisodiy va jismoniy qobilyati va ijtimoiy omillar turkumiga kiruvchi mezonlar)

o'z ichiga oladi. Ushbu tadqiqot ishini bajarish davomida 15 ta TLMlari uchun joy tanlash masalasini hal qilishda ko'p mezonli qaror qabul qilish usullaridan foydalanilgan adabiyotlar tahlil qilib chiqildi. Tahlillar tadqiqot ishlarida tanlab olingan mezonlarni aniqlash, qaror qabul qilishda foydalanilgan usullarni aniqlashga va natijaga erishilganlik darajasini baholashga qaratildi. Tahlil qilingan adabiyotlar 1-jadvalga joylashtirildi

1-jadval

TLMlar uchun joy tanlashda ko'p mezonli qaror qabul qilish usullaridan foydalanilgan adabiyotlar va ularda qo'llanilgan usullar

Mualiflar	TLM uchun joy tanlashga ta'sir etadigan mezonlar	Tadqiqotda foydalanilgan usullar
Kurava A.Y.[2]	Iqtisodiy xolat, ijtimoiy xolat, siyosiy va huquqiy xolat, geografik xolat, ekologik xolat, transport infratuzilmasi	AHP
Sheikh Ariful Alam[3]	Magistral yo'ldan foydalanish imkoniyati, intermodal o'tkazuvchanlik sig'imi, port sig'imi, yerning mavjudligi	AHP
Murve Ozturk [4]	Ishchi kuchi, transport turlari (avtomobil, temir yo'l, dengiz va havo transporti) va masofalari, iste'mol – ishlab chiqarish markazlari va sanoat hududlarigacha bo'lgan masofasi, yer xususiyatlari va atrof-muhitga ta'siri.	AHP
Ayshe Merve CAN [5]	Eng yaqin magistralgacha bo'lgan asofa, eng yaqin portgacha bo'lgan masofa, eng yaqin temir yo'lgacha bo'lgan masofa, eng yaqin aeroportgacha bo'lgan masofa, shahar markaziga yaqinlik, kengaytirish imkoniyati, geografik va topografik yaroqlilik, yer narxi, uyushgan sanoat zonasigacha masofa	AHP, ELECTRE, TOPSIS



Cihan UYANIK [6]	Xarajat, tabiiy boyliklar, temir yo'lga yaqinlik, magistral tizimiga yaqinlik, shahar markaziga yaqinlik, portga yaqinlik, yer maydoni, kengaytirish imkoniyati, sanoat zonasiga yaqinlik, makroiqtisodiy foyda / samaradorlik, atrof-muhit ta'siri, yuk avtomabillari, qurilishga yaroqlilik (topografiya, geografiya, yer osti tuzilishi), qurilish jarayonining narxi (infratuzilma-suv, elektr, xavfsizlik, yo'l), xizmat ko'rsatish bozoriga kirish imkoniyati, transport va logistika jozibadorligi	AHP, Fuzzy-AHP PROMETH, TOPSIS ELECTRE, VIKOR
Muhammed BAMYACI [7]	Yer (yer maydoni, yerni kengaytirish imkoniyatlari, yerning infratuzilmasi, yerning jismoniy holati), xarajatlar (yer narxi, ob'ekt narxi, foydalanuvchilar uchun narx), yaqinlik (masofa) (ishlab chiqarish markazlariga yaqinligi, iste'mol markazlariga yaqinlik, aeroportga yaqinlik, temir yo'lga yaqinlik, magistral yo'lga yaqinlik, portga yaqinlik (dengiz), ichki suv yo'llariga yaqinlik) ijtimoiy-iqtisodiy ta'sirlar (shahar muhitiga ta'siri, shahar transportiga ta'siri, iqtisodiy hayotga ta'siri)	AHP
Fulya ZARALI [8]	Hudud, kengayish maydoni, infratuzilma ob'ektlari, shaharga yaqinlik, sanoat va savdo markazlariga yaqinligi, portga yaqinlik, avtomobil yo'l aloqasi, temir yo'l aloqasi, yer xarajatlari	AHP, ELECTRE, TOPSIS
H.TeSCAN UYSAL, Kemal YAVUZ [9]	Portga yaqinlik, aeroportga yaqinlik, yashash joylarigacha bo'lgan masofa, mehnatga kirish imkoniyati, ekologik xavfsizlik, magistral yo'llar va bog'lovchi yo'llarga kirish imkoniyati, trafik zichligi, havoning ifloslanishi, qurilish maydoni, mintaqaviy rag'batlantirish	ELECTRE
Burchin PACHACI va boshqalar [10]	Tashqi savdo, uyushgan sanoat zonalari, qishloq xo'jaligi uyushgan sanoat zonasi, avtomobil, temir yo'l va suv yo'llariga chiqish	AHP
Krzysztof Witkows va boshqalar [11]	Mahalliy hokimiyat, ko'p tarmoqli aloqa infratuzilmasining mavjudligi, aholi soni, iqtisodiy zonalarning mavjudligi, yer narxi, ish haqi, mol-mulk solig'i miqdori, bozorning mavjudligi, malakali kadrlar mavjudligi, rivojlanish rejalari, rejalashtirish hujjatlari yozuvlari, iqtisodiy zonalar hajmi, raqobotdosh markazkar soni, investitsiyalarning jozibadorligi	AHP
Baiyu Chen, Biying Wang [12]	Shahar joylashuvi koeffitsienti, shahar markazlashganligi, bozor farovonligi darajasi, yuk tashish hajmining nisbati, aholi jon boshiga YaIM, aholi soni.	AHP
Kursat Yildiz va boshqalar [13]	Narx (yuk tashish narxi), Transport turlari, yetkazib berish muddati, markazga yaqinlik, muqobil koridorning eng yaqin poezd stantsiyasidan masofasi.	AHP-VIKOR
Ismail Önden va boshqalar [14]	Avto magistralga yaqinlik, temir yo'lga yaqinlik, aeroportlarga yaqinlik, dengiz portiga yaqinlik, xalqaro savdo hajmi, aholi soni, dengiz portlarini boshqarish imkoniyatlari	AHP
Jacek ŻAK, Szymon WEGLIŃSKI [15]	Viloyatning umumiy maydoni, aholi soni, aholi jon boshiga YaIM, iqtisodiy rivojlanishning o'rtacha darajasi, investitsiya va logistika jozibadorligi, erkin iqtisodiy hududlar soni, infratuzilma, ijtimoiy va ekologik holat, ishsizlik darajasi, harakat xavfsizligi	ELECTRE III/IV
Maria CRISTEA va boshqalar [16]	Iqtisodiy samaradorlik, transport infratuzilmasi, raqobatbardoshlik darajasi, maqsadli bozor, iqtisodiy rivojlanish salohiyati, xorijiy investitsiyalar, eksport darajasi, davlat byudjeti subsidiyalari, ijtimoiy o'lchov, ish haqi, xavfsizlik, yashil maydonlar	ELECTRE III

1-jadvalda tasvirlangan adabiyotlar tahlillari natijasida shuni aytishimiz mumkinki TLMlar joylashuv joyini tanlashda qo'llaniladigan usullar, tasifiy qiluvchi mezonlar har bir mintaqa yoki davlatning transport infratuzilmasi va transport xizmatlariga bo'lgan ehtiyojidan kelib chiqib o'zgarishi mumkin.

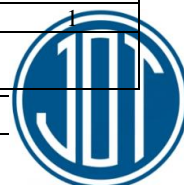
Tadqiqot ishi doirasida amalga oshirilgan adabiyotlar tahlilidan ko'rish mumkinki TLMlar joylashuvini tanlashda

qaror qabul qilishga ta'sir ko'rsatuvchi mezonlar tadqiqot ishining amalga oshirilish darajasiga qarab son jihatdan turlicha bo'lishi mumkin ekan. Quyida 2-jadvalda TLMlar uchun joy tanlashda qaror qabul qilishga ta'sir qiluvchi mezonlar tahlil qilingan adabiyotlar bo'yicha umumiy ko'rinishda son jihatdan tasvirlangan va ular 5 ta asosiy guruhga ajratilgan.

2-jadval

## Adabiyotlarda foydalanilgan baholash mezonlari va ularning foydalanilganlik chastotasi

Joylashuv	Mezonlarning adabiyotlarda takrorlanish darajasi		Mezonlarning adabiyotlarda takrorlanish darajasi
		Hovoning ifloslanishi	3
Temir yo'lga yaqinlik	11	Yashil hudud	1
Avtomagistralga yo'lga yaqinlik	12	<b>Yuk tashish hajmi/iqtisodiy aks ettirish</b>	



Aeroportga yaqinlik	10		Makro iqtisodiy ko'rsatgich	4
Suv po'rtiga yaqinlik	7		Avtomobil transportida yuk tashish hajmi	3
Yer maydoni	5		Temir to'1 transportida yuk tashish hajmi	3
Kengaytirish imkoniyati	4		Transport va logistika jozibadorligi	4
Iqtisodiy hududlarga yaqinlik	8		Transport infratuzulmasi	5
Qurilish uchun yaroqlilik	3		Xalqaro sovdoda hajmi	2
Geografik, tuproq xolati	2		Sovdo markazlari soni	1
Shahar markaziga yaqinlik	8		Rivojlanish darajasi	2
Joylashuv hududi	2		Iqtisodiy tasir	4
Joy infratuzulmasi	4		Tashqi investitsiya	1
Ichki suv yo'llariga yaqinlik	1		Investitsiya darajasi	3
Ishlab chiqarish korxonalariga yaqinlik	5		Biznes muhiti	3
Bozorga yaqinlik	3		Raqobat darajasi	2
Istemolchilarga yaqinlik	2		<b>ijtimoiy omillar</b>	
<b>Xarajat</b>			Xafsizlik va qo'riqlash	3
Yer narxi	4		Aholi soni	3
Tashish xarajatlari	3		Ijtimoiy foyda	2
<b>Atrof-muhit</b>			Yerga egalik shakli	1
Tabiiy boyliklar	2		Ishchilar malakasi	2
Ekologik tasir	6		Qonun ustuvotligi va hokimiyat organlarining ro'li	4
Ekologik xafsizlik	3		Ijtimoiy barqarorlik	1

Yuqorida 2-jadvalda tasvirlangan mezanlar asosida TLMlari uchun joy tanlash muammosini yechisga KMQQQ usullaridan foydalanish eng samarali usullardan bir deyishimiz mumkun. Chunki KMQQQ usullari ko'plab sohalarida qaror qabul qilish muammolarini hal qilishda, muqobillarni ma'lum mezonlar bo'yicha tartiblash va eng yaxshi muqobilni tanlashda qo'llaniladi [17].

KMQQQ usullari ichida joy tanlash masalasini yechishda eng ko'p qo'llaniladigan usullardan bir AHP (Analytic Hierarchy Process) usulidir. AHP usuli 1977-yilda Tomas L. Saati [18] tamonidan ko'p mezonli muammolarni hal qilish uchun ishlab chiqilgan. U sifat va miqdoriy o'zgaruvchilarni tahlil qilish orqali muammolarni hal qiladigan usul hisoblanadi. [19]. Ushbu usul ko'p mezonli muammolarni ierarxik tuzilishda modellashtiradi va muammoni tashkil etuvchi asosiy maqsadlar, mezonlar, kichik mezonlar va alternativalarining munosabatlarini ochib beradi [20]. AHP muammoni tashkil etuvchi mezonlar va kichik mezonlarning muhimlik darajasini hisoblab, o'lchamlarni qisqartirishni amalga oshiradi. U eng yaxshi mezonni mumkin bo'lgan natijalarga kiritish uchun mezonlarni ahamiyati bo'yicha tartiblash imkoniyatini beradi.

AHP usulini qo'llash bosqichlari quyidagilardan iborat:

1. Ierarxik tuzilmani o'rnatish
2. Har bir mezon bo'yicha muqobil va mezonlarni juftlik bilan taqqoslash
3. Nisbiy ahamiyatli vaznlarni normalash va hisoblash
4. Konsistensiya koeffitsientini hisoblash
5. Muqobil uchun har bir mezonning ahamiyatlilik vaznlarini hisoblash
6. Variantlarning vaznlarini aniqlash

Adabiyotlarda TLMlari uchun joy tanlash muammosi yechimini topishda qo'llaniladigan usullardan biri ELECTRE (Elimination and Choice Expressing Reality) usuli hisoblanadi va uni Benayoun, Roy va boshqalar tomonidan ishlab chiqilgan. ELECTRE usulining asosi har bir mezon bo'yicha muqobillarni juftlik bilan taqqoslash

orqali "ustunlik munosabatlarini" o'rnatishdir. TLMlari uchun joy tanlashda qaror qabul qiliuvchilar ELECTRE usuli orqali ko'plab miqdoriy va sifat mezonlarini kiritishlari mumkun, bu orqali u optimallashtirishga yo'naltirilgan matematik dasturlash usullari qatoriga kiradi. ELECTRE usulidan foydalanishda birinchi amalga oshiriladigan ish har bir mezon bo'yicha muqobillarni juftlik bilan taqqoslashdir. i mezon bo'yicha taqqoslangan muqobillarning muvaffaqiyat qiymatlari  $gi(Aj)$  va  $gi(Ak)$  sifatida ko'rsatilgan va ikkala muqobil o'rtasidagi farq  $gi(Aj)-gi(Ak)$  sifatida ifodalanadi. Muqobil variantlar o'rtasida farqni aniqlash uchun ma'lum chegara qiymati aniqlanadi va ikkita muqobil uchun "befarqlik, zaif afzallik, mutlaq afzallik yoki taqqoslanmaydi" degan xulosaga keladi.

TLMlari uchun joy tanlashda turli ta'sir qiluvchi mezonlar mavjudligini hisobga olsak juftlik taqqoslash munosabatlarini yoki boshqacha aytganda, ustunlik munosabatlarini majmuini aniqlash juda muhimdir. ELECTRE usuli mezonlar har xil ahamiyatga ega bo'lgan holatda ularning ahamiyat darajasini aniqlash uchun mezonlarga og'irlik qiymatlarini berish imkoniyatiga ega.

ELECTRE usuli ustunlik munosabatlarini to'plamini aniqlash natijasida muqobillarning bir-biridan ustunligini isbotlash uchun muvofiqlik indeksini hisoblab chiqadi. Bu TLM uchun joy tanlash muammosiga qaratilgan yechimning ishonchliligini taminlaydi. Bundan tashqari, ELECTRE usuli yordamida kelishmovchilik indeksini va uning qarama-qarshi ko'rsatkichini, ya'ni kelishmovchilikni keltirib chiqaradigan indeksni hisoblab chiqish mumkun. Shuning uchun, ELECTRE usuli yordamida TLM uchun tanlangan muqobil joyni ustunlik munosabatlarini asosida turli xil variantlar orasidan ajratib olish mumkun. ELECTRE usuli ayniqsa, mezonlarni kam, ammo muqobillarni ko'p bo'lgan qaror qabul qilish muammolari uchun yaxshi natijalar beradi [21]. Bundan kelib chiqib aytishimiz mumkunki, ELECTRE usulini TLM uchun joy tanlashda bir nechta muqobil joylar ichidan joy tanlash muammosiga ta'sir qiluvchi mezonlar kam bo'lgan holatda qo'llash ko'p samara berar ekan.





ELECTRE usuli oilaniga kiruvchi ELECTRE I, II, III, IV, IS, TRI usullari mavjud. Ular qaror qabul qilish muammolariga qaratilgan turli yondashuvlar va qo'llanilish sohalariga ko'ra ELECTRE usulining takomillashtirilgan yoki moslashtirilgan usullaridir. Bir-biridan kichik farqlar bilan farq qiladigan ushbu usullar yordamida qaror qabul qiluvchi muqobil variantlarning ko'plab miqdoriy va sifat mezonlarini kiritish orqali muammoga qaratilgan muvofiq mezonlarning ahamiyatini aniqlashi va tegishli muqobil variantlar ichidan eng muqobilini tanlash imkoniyatiga ega bo'ladi [22]. Joy tanlash masalalariga qaratilgan tadqiqot ishlarida ELECTRE, ELECTRE I, ELECTRE III va ELECTRE IV usullari eng ko'p qo'llaniladi. ELECTRE usulidan foydalanishda 3-jadvalda berilgani kabi ko'p mezonli qaror jadvali tuziladi.

### 3-jadval

**ELECTRE usulida Ko'p mezonli qarorlar jadvali**

Muqobillar				
	$c_1$	$c_2$	...	$c$
$a_1$	$g_1(a_1)$	$g_2(a_1)$	...	$g_n(a_1)$
$a_2$	$g_1(a_2)$	$g_2(a_2)$	...	$g_n(a_2)$
...	...	...	...	...
$a_m$	$g_1(a_m)$	$g_2(a_m)$	...	$g_n(a_m)$

Bu yerda  $a$  muqobil joyini va  $c$  ularga mos mezonlarni belgilaydi.

Shuningdek TLM uchuj joy tanlash muammosini yechishda qo'llash mumkin bo'lgan KMQQQ usullardan biri PROMETHEE (Preference Ranking Organization Method for Encrichment Evaluations) 1982 yilda Kvebekda (Kanada) bo'lib o'tgan konferentsiyada J. P. Brans tomonidan taqdim etilgan KMQQQ ustuvorlik usulidir. PROMETHEE usulining maqsadi amalga oshirish jarayonida tadqiqotlarda qo'llaniladigan ustuvorlik usullarining qiyinchiliklarini kamaytirishdir. Bu usul boshqa ko'p mezonli qaror qabul qilish usullariga nisbatan soddaroq tuzulgan susul hisoblanadi. Ko'plab qaror qabul qilish usullari murakkab tuzilishga ega bo'lib, ulardan foydalanish jarayonida tadqiqotchilarda turli tushunmovchiliklar vujudga kelishi mumkin. PROMETHEE usulining soda tuzilishga ega ekanligi uning boshqa qaror qabul qilish usullaridan ajratib turuvchi jihattir.

PROMETHEE usuli 7 bosqichdan iborat [23] va bular:

- ma'lumotlar matritsasini yaratish
- mezonlarga ustunlik funksiyalarini aniqlash
- umumiy afzallik funksiyalarini aniqlash
- afzallik indekslarini aniqlash
- muqobil variantlar uchun ijobiy (PH+) va salbiy (P-) afzalliklarni aniqlash
- PROMETHEE I bilan alternativlar uchun qisman ustuvorliklarni aniqlash
- PROMETHEE II bilan muqobillar uchun aniq ustuvorliklarni aniqlash

PROMETHEE usuli muqobillarni eng yaxshidan eng yomonigacha tartiblash uchun ishlatiladi. U odatda qaror qabul qilish jarayonida har bir mezonning ahamiyatini baholash uchun ishlatiladi. PROMETHEE usulini TLMlari uchun joy tanlashda qaror qabul qilish uchun qo'llash joylashuv o'rni tanlashga tasir qiluvchi mezonlarning afzal ko'rish darajalarini tushunish, muqobil bir hil variantlarni aniqlash, ma'lum mezonlar bo'yicha muqobillar orasidan

eng ko'p mos keluvchi muqobillarni aniqlash va muqobillarni orasidagi farqlarni aniqlash mumkin.

Ob'ektlarni joylashtirish masalalarini yechishda foydalaniladigan usullardan biri TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) usulidir. TOPSIS usuli 1981-yilda Xvang va Yoon tomonidan ishlab chiqilgan [24]. TOPSIS ko'p mezonli qaror qabul qilish usuli bo'lib, u n ta muqobil va m mezonidan iborat qaror muammosiga sifatli tarjima qilinmasdan bevosita ma'lumotlarga qo'llanilishi mumkin. Kichik miqdordagi kirish parametrlari bilan oson tushunarli natijalarni ta'minlovchi TOPSIS usulida tanlangan muqobil ideal yechimga eng yaqin bo'lishi kutiladi, ideal yechim bo'lmagan alternativdan esa eng uzoqda bo'lishi kutiladi [25]. TOPSIS usulida quyidagi yechim bosqichlarini bajarish mumkin.

- muammoning maqsadlari va baholash mezonlari aniqlash
- qaror matritsasini yaratish (A)
- standart qaror matritsasini (R) yaratish
- Og'irlangan normalangan qaror matritsasi (V) yaratish.
- ijobiy ideal (A+) va salbiy ideal (A-) yechimlarni yaratish
- ajratish choralarini hisoblash
- ideal yechimga nisbatan yaqinlikni hisoblash

TLMlari uchun joylashuv joyini aniqlashga qaratilgan tadqiqot ishlarini olib borishda VIKOR usulidan ham foydalaniladi. Ushbu usul ko'p mezonli kompleks tizimlarni optimallashtirish uchun Yu va Zeleniy tomonidan ishlab chiqilgan. VIKOR usul 2004 yilda Opricovic va Tzeng tomonidan turli o'lchov birliklari bilan olingan ma'lumotlar guruhlarida qo'llanilishi mumkin bo'lgan ko'p mezonli qaror qabul qilish usuli sifatida takomillashtirilgan. VIKOR usuli qarama-qarshi mezonlar bilan qaror qabul qilish muammosiga umumiy yechim taklif qiladi va idealga eng yaqin muqobil yechimni ko'rsatadi. TLMlari uchun joy tanlash muammosini yechishda qaror qabul qilishda ta'sir etuvchi mezonlar mavjudligi sababli ushbu jarayonda VIKOR usulidan foydalanish kerakli yechimni topishda yaxshi ish beruvchi usul hisoblanadi [26]. VIKOR usulida boshqa QMQQQ usullaridan farqli ravishda mezon og'irliklari teng deb hisoblanadi va turli usullardan olingan qiymat og'irliklari ham hisoblash dasturi bosqichlariga kiritilishi mumkin. VIKOR usulidan foydalanish quyidagi bosqichlarni o'z ichiga oladi:

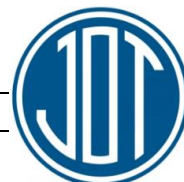
- eng yaxshi va eng yomon mezonlarni aniqlash
- aniqlangan mezonlarni muvofiqlashtirish jarayoni (qaror matritsasini tuzish)
- muvofiqlashtirilgan matritsani og'irligini o'lchash
- qiymat mezonlarini hisoblash
- mezon og'irliklarini hisoblash
- variantlarni saralash va shartlarni tekshirish

Muqobil variyati quyidagi ikkita shartga tekshiriladi:

1-shart. Qabul qilinadigan afzallik

2-shart. Qabul qilinadigan barqarorlik sharti [27].

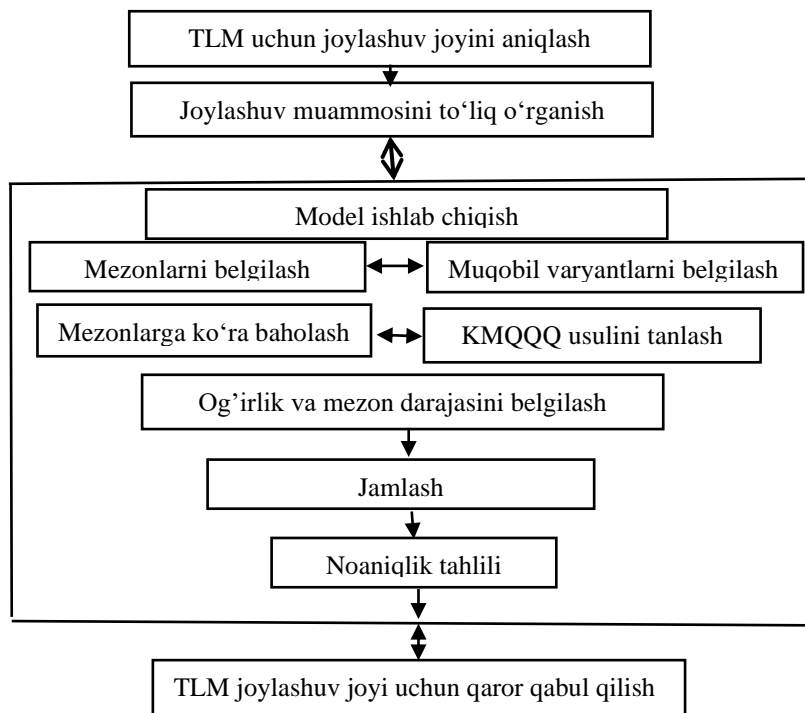
Ushbu shartlarga javob bergan muqobil yechim muammonini eng yaxshi yechimi sifatida olinadi. TLMlari joylashuvini tanlash muammosini yechishda yuqorida sanab o'tilgan KMQQQ usullardan birgalikda foydalanish mumkin.



## 4. Muhokama

KMQQQ usullar asosan biron bir sohada tegishli muammo yechimi bo'yicha qaraor qabul qilishda samarali yechimga ega bo'lishni ta'minlaydi. KMQQQ usullarini TLMlarining joylashuvi muammosida qo'llanilishi, baholash jarayoni uchun to'g'ri qaror mezonlarini tanlashda juda muhim bo'lib, u yechimga ijobiy ta'sir ko'rsatadi. TLMlarining joylashuvini tanlash muammosini KMQQQ

usullaridan foydalangan holda turli nuqtai nazardan o'rganib chiqish va muammoni baholash uchun turli mezonlarni shakllantirish mumkin. Yuqorida yoritib o'tilgan qaror qabul qilish usullarini TLMlari joylashuvini tanlashda to'loqonli yechiga erishish vositasi sifatida talqin etib bo'lmaydi. KMQQQ usullarining TLMlari joylashuvini tanlashda 3-rasmda tasvirlangan tartibda amalga oshirish mumkin.



3-rasm. KMQQQ usullarini TLM uchun joylashuv joyini tanlashda qo'llash

TLMlari uchun joylashuv muammosini yechishga qaratilgan ilmiy izlanishlar natijalari va tadqiqotchi olimlar tomonidan yaratilgan usullar tahlili shuni ko'rsatadiki, bugungi kunda TLMlari uchun joylashuv muammosini yechish uchun butun dunyoda bir xilda to'liq yechimga erishish imkonini beruvchi mukammal usul mavjud emas. Mavjud usullar qaysidir jihatlari bo'yicha muammoni yechimini topishda malum bir og'ish chegaralariga ega. Bundan kelib chiqadigan aytishimiz mumkinki bugungi kunda TLMlarini joylashtirish joyini tanlashga qaratilgan ilmiy tadqiqot ishlarini olib borish va joy tanlash muammosini yechishda qo'llaniladigan mavjud usullarni takonillashtirishga yetarilcha talab mavjud. Biz yuqorida tahlil qilgan va bayon etgan KMQQQ usullarini yakka tartibda emas, balki o'zaro hamjihatlikda qo'llash yuqoriroq samaraga erishishni taminlaydi. AHP, ELECTRE, TOPSIS usullarini birgalikda qo'llashning yuqori samaradorligi biz tahlil qilgan adabiyotlarda erishilgan natijalarda yaqqol namoyon bo'lgan.

## 5. Xulosa

Transport logistika markazlarini har tamonlama qulay joyga joylashtirish ularning transport xizmatlarini ko'rsatish samaradorligini oshirishda muhim ahamiyat kasb etadi. TLMlari joylashuv joyini tanlashga qaratilgan ilmiy tadqiqot

ishlarini olib borish darajasini oshirish va ularda erishilgan natijalarni sohaga jalb qilish yurtimizda transport xizmatlari samaradorligini oshirishga xizmat qiladi. Ushbu ilmiy maqola transport logistika markazlari geojoylashuvini asoslashga qaratilgan PhD dissertatsiya ishi doirasida tadqiqot ishi muammosini kengroq o'rganish maqsadida amalga oshirildi. Albatta, ushbu ilmiy maqola mazmun jihatidan to'liq yakunlanmagan hisoblanadi va u tadqiqot ishi uchun ilmiy yangiliklarni ishlab chiqishda dasturiy amal vazifasini bajaradi. Tadqiqot ishining ilmiy yangiliklari ushbu mavzuga bag'ishlangan navbatdagi ilmiy maqolalarda bayon etiladi.

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## Mualliflar to‘g‘risida ma‘lumot/ Information about the authors

Samatov G‘affor Toshkent davlat transport universiteti,  
/ Gaffor Samatov “Transport logistikasi” kafedrası mudiri,  
i.f.d. prof,  
E-mail: [transportlogistikasi@mail.ru](mailto:transportlogistikasi@mail.ru);  
Tel: +99897 404 90 56  
<https://orcid.org/0000-0001-6479-6173>

Absattorov Toshkent davlat transport universiteti  
Isomiddin / tayanch doktoranti,  
Isomiddin E-mail: [isomiddinabsattorov@gmail.com](mailto:isomiddinabsattorov@gmail.com)  
Absattorov Tel: +99894 574 59 97  
<https://orcid.org/0000-0002-5968-0990>

Xakimov Toshkent davlat Transport universiteti  
Diyorbek / “Transport logistikasi” kafedrası assistenti,  
Diyorbek E-mail: [xakimovdiyorjon1817@gmail.com](mailto:xakimovdiyorjon1817@gmail.com)  
Khakimov Tel.:+99897 966 86 87  
<https://orcid.org/0009-0009-8894-8915>

Matrasulov Toshkent davlat Transport universiteti  
Qahramon / “Transport logistikasi” kafedrası assistenti,  
Kahraman E-mail:  
Matrasulov [kaxramonmatrasulov207@gmail.com](mailto:kaxramonmatrasulov207@gmail.com)  
Tel: +99890 807 82 07  
<https://orcid.org/0009-0004-7308-9238>



## Improving the quality of passenger transportation services

N.J. Suyarov<sup>1</sup><sup>a</sup>, E.X. Abdusamatov<sup>1</sup><sup>b</sup>, U.I. Isokhanov<sup>1</sup><sup>c</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** In this research work, the main requirements for improving the quality of passenger transport services in the city's public transport are highlighted. The purpose of transportation of passenger buses is to reduce travel time, ensure regular bus service and meet the transportation needs of the population, taking into account the possibility of guaranteeing travel opportunities. Planning, organizing, promoting, regulating and ensuring quality control of passenger transportation, which covers the operation of all forms of ownership of vehicles for the provision of quality passenger transportation services

**Keywords:** passenger transport, transport services, passenger, transportation. public transport, service descriptions, service provision.

## Yo'lovchi tashish xizmatlari sifatini oshirish

Suyarov N.J.<sup>1</sup><sup>a</sup>, Abdusamatov E.X.<sup>1</sup><sup>b</sup>, Isoxanov U.I.<sup>1</sup><sup>c</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Toshkent, O'zbekiston

**Annotatsiya:** Ushbu tadqiqot ishida shahar jamoat transportida yo'lovchi tashish xizmatlari sifatini oshirishga qo'yiladigan asosiy talablari yoritilgan. Yo'lovchi avtobuslarini tashishdan maqsad yo'l vaqtini qisqartirish, avtobuslarning muntazam qatnovini ta'minlash va sayohat qilish imkoniyatlarini kafolatlash imkoniyatini hisobga olgan holda aholining transportga bo'lgan ehtiyojini qondirish. Sifatli yo'lovchi tashish xizmatlarini ko'rsatish uchun barcha mulkchilik shaklidagi transport vositalarining ishlashini qamrab oladigan yo'lovchi tashishni rejalashtirish, tashkil etish, rag'batlantirish, tartibga solish va sifatini nazorat qilishni ta'minlashdan iborat.

**Kalit so'zlar:** yo'lovchi tashish, transport xizmatlari, yo'lovchi, tashish. jamoat transporti, xizmat ta'riflari, xizmat ko'rsatish

### 1. Kirish

Ijtimoiy tizimning muvaffaqiyatli o'zgarishi, bozor munosabatlarining chuqurlashishi, ko'p tarmoqli iqtisodiyotning shakllanishi va rivojlanishi mamlakatimiz uchun muhim ahamiyatga ega bo'lgan muammolardir. Ularning qarorida hal qiluvchi rol xizmat ko'rsatish sohasiga tegishli bo'lib, uning holati va samaradorligi mamlakatning iqtisodiy va ijtimoiy taraqqiyot yo'lida muvaffaqiyatli rivojlanishiga bog'liq. Bu yo'lovchilarni transport vositalarida tashish bo'yicha xizmatlar ko'rsatish sohasiga to'liq taalluqlidir. Shuning uchun bozor iqtisodiyoti sharoitida ularning samaradorligi va raqobatbardoshligini oshirish uchun asos sifatida ushbu turdagi xizmatlarning sifat menejmentini barqaror takomillashtirish tobora zarur va amalda ahamiyatli bo'lib bormoqda. Mamlakatimiz uchun transportning ahamiyati juda katta, chunki bu mamlakatning turli mintaqalarini yagona davlatga birlashtirgan transportdir [1].

Yo'lovchi tashish jamiyat va uning fuqarolari hayotida alohida ijtimoiy-iqtisodiy ahamiyatga ega, shuningdek

transport faoliyatining eng muhim turlaridan biridir. Shahar darajasida transport vositalarining tirbandligi, yo'lovchilarga xizmat ko'rsatishning past sifati va atrof-muhitga salbiy ta'sir ko'rsatish muammosi mavjud. Mintaqaviy darajada yo'l transporti aloqalari va transport vositalarining eskirishi bilan bog'liq muammolar qo'shiladi [2]. Yo'lovchi tashish har xil transport turlari (temir yo'l, avtomobil, dengiz, ichki suv va havo) bilan amalga oshiriladi, ular narx, tezlik, muntazamlik va qulaylik jihatidan teng emas. Yo'lovchi aylanmasi bo'yicha birinchi o'rinni avtomobil transporti egallaydi, uning ulushi 46,8% ni tashkil qiladi, temir yo'l transporti barcha transport turlari yo'lovchi aylanmasining 38,5% ni, havo transporti esa 14,5% ni tashkil qiladi.

### 2. Tadqiqot metodikasi

Transport xizmatlari bozorida yo'lovchi tashish quyidagi turlarga bo'linadi:

<sup>a</sup> <https://orcid.org/0009-0005-5208-8395>

<sup>b</sup> <https://orcid.org/0009-0007-1194-9085>

<sup>c</sup> <https://orcid.org/0009-0008-0058-9560>





1. Tashilgan yo'lovchilar soni bo'yicha shaharlararo transport eng muhim hisoblanadi. Katta shaharlarda shaharlararo tashish avtobuslar, trolleybuslar, tramvaylar, shaxsiy avtomobillar va mikroavtobuslarda amalga oshiriladi.

2. Shahar atrofi transporti shaharlararo transportdan keyin mashhurlik bo'yicha ikkinchi o'rinda turadi. Ushbu turdagi transport xizmatlari bozori temir yo'l, avtobus va shaxsiy transport vositalaridan iborat.

3. Mahalliy transport asosan temir yo'l va avtobuslarda amalga oshiriladi. Shaharlararo transport - asosan temir yo'l va havo transportida amalga oshiriladi, avtobus va suv xizmatlarining kichik qismi.

Yo'lovchilar transport turini tanlashda asosiy ustuvorliklar quyidagilardir:

Arzon narx, transport xavfsizligi va sayohat vaqti. Ushbu turdagi transport yo'lovchilari tomonidan shaharlararo va shahar atrofi poyezdlari ish sifatini baholash natijasida ish sifatidan norozilik, shuningdek, yo'lovchilarga ko'rsatilayotgan qo'shimcha xizmatlardan xabardorligi pastligi kuzatilmoqda [3-4].

Yo'lovchilarga xizmat ko'rsatish sifatini oshirish va aholiga transport xizmatlari bozorida raqobat asosida xarajatlarni kamaytirish maqsadida barcha transport turlari bo'yicha yo'lovchi tashish bozorida marketing tadqiqotlarini o'tkazish yo'lovchilar kompleksini samarali boshqarishning zarur shartidir, shu bilan birga, yo'lovchi tashish sifatini miqdoriy baholashni xarajatlarni baholash bilan birgalikda amalga oshirish maqsadga muvofiqdir.

Aholini transport xizmatlari bilan ta'minlash muhim ijtimoiy vazifa hisoblanadi. Chiziqli tuzilmalar nuqtai nazaridan sifatni yaxshilash uchun ularning ishlashini ularga qo'yiladigan talablarga muvofiq, shuningdek, yo'lovchilarning o'z xohish-istaklarini inobatga olgan holda optimallashtirish kerak, chunki ular bevosita foydalanuvchi hisoblanadi. Oxirgi o'n yillikda yo'lovchi tashishning barcha turlari bo'yicha yo'lovchi tashish hajmining pasayishiga nisbatan salbiy tendentsiya kuzatildi, bu aholining transport harakatchanligining umumiy pasayishi, tariflarning oshishi, raqobatning kuchayishi bilan bog'liq. turli transport turlari o'rtasida, shuningdek, yo'lovchi tashishga bo'lgan talabning pasayishi [5].

Shunday qilib, zamonaviy sharoitda transport infratuzilmasini mutanosib rivojlantirish mintaqqa iqtisodiyotini rivojlantirishning uzviy omili hisoblanadi. O'z navbatida, aholiga transport xizmatlari ko'rsatish sifatini barqarorlashtirish va yaxshilash masalalarini hal qilish (xususan, shahar atrofi va shaharlararo tashish sharoitida) transport infratuzilmasining rivojlanish darajasi bilan bog'liq.

Yo'lovchi tashish xizmatlari sifati tushunchasi va mohiyati

Yo'lovchi tashishning odamlar hayotidagi ahamiyati mamlakatimizda aholi soni ortib borayotganligi, chekka hududlarning markazdan sezilarli hududiy uzoqligi, aholi zichligi yuqoriligi bilan bog'liq. O'z transport vositalari har doim ham odamlarning shahar ichida yoki butun mamlakat bo'ylab harakatlanishi bilan bog'liq barcha muammolarni bir qator sabablarga ko'ra hal qila olmaydi: yoqilg'i narxining ko'tarilishi, tamir talab yo'llar, to'xtash joyi yo'qligi va boshqalar, Shu bois jamoat transportida yo'lovchi tashish ulushi muttasil ortib bormoqda.

Yo'lovchi avtobuslarini tashishdan maqsad yo'l vaqtini qisqartirish, avtobuslarning muntazam qatnovini ta'minlash va sayohat qilish imkoniyatlarini kafolatlash imkoniyatini hisobga olgan holda aholining transportga bo'lgan ehtiyojini qondirishdan iborat.

Yo'lovchi tashish qo'ydagi asosiy vazifalarni o'z ichiga oladi:

- qatnovchi avtobuslarning jadval bo'yicha harakatlanishi, yo'lovchi tashish xavfsizligi;

- harakatlanuvchi tarkibdan samarali foydalanish, ya'ni rejani amalga oshirish, haydovchilar ishini oqilona tashkil etish.

Bu vazifalarni amalga bajarish uchun korxonaga yo'lovchilar oqimi to'g'risida ma'lumot olish, avtobuslarning maqbul yo'nalish sxemalarini tanlash, sig'imi bo'yicha avtobuslarni tanlash, avtobus tezligini tartibga solish, yo'nalishli avtobuslar jadvalini tuzish, avtobuslarni liniyaga chiqarishni tashkil etish kabi masalalarni hal qiladi, harakat xavfsizligini ta'minlash va yo'lovchilarga xizmat ko'rsatish va boshqalar. Tashishni tashkil etishning barcha vazifalari transport turlari bo'yicha alohida hal qilinadi. Yo'lovchi avtobuslarini tashish xizmat turlari bo'yicha tasniflanadi: shahar, shahar atrofi, mahalliy, shaharlararo va xalqaro.

Shahar transportining o'ziga xos xususiyati uning kuchli yo'lovchi oqimlari va zich yo'nalishlar tarmog'idir. Shahar transporti qulay sharoitlari, avtobuslar orasidagi vaqt oralig'ining qisqaligi, yo'lovchilar uchun qisqa masofalar, yo'lovchilarni chiqarish va tushirish uchun tez-tez to'xtab turishi, past tezlik bilan tavsiflanadi. Shahar atrofi transporti - bu aholi punkti chegaralaridan tashqarida 50 km dan 100 km gacha bo'lgan masofada yo'lovchilarni tashish. Ular shahar transportidan kamroq yo'lovchilar soni, yo'lovchilar oqimining mavsum bo'yicha notekisligi (yo'lovchilar sonining keskin o'sishi bahor-yoz davrida sodir bo'ladi), yo'lovchilar uchun uzoqroq sayohat masofalari va shunga mos ravishda kamroq to'xtashlar bilan farqlanadi. [6].

Shaharlararo tashish shahar chegaralaridan 50 km dan ortiq masofada tashkil etilgan, marshrut uzunligi 1000 km gacha yetishi mumkin, yo'l sharoitlari odatda yaxshi. Bu xususiyatlar avtobuslarga qo'yiladigan talablarni belgilaydi. Qo'l yukini saqlash joylari, hojatxonalar va bufetlar bilan jihozlangan qulay tezyurar avtobuslardan foydalaniladi.

Xalqaro tashish - bu ikki yoki undan ortiq davlatning davlat chegaralari kesib o'tiladigan transport. Shaharlararo avtomobillarda tashish uchun quyidagi toifadagi transport vositalaridan foydalanish mumkin (Vazirlar Mahkamasining 2003-yil 4-noyabrdagi 482-son qaroriga) asosan:

- M1 (yo'lovchilar soni 8 dan kam bo'lgan transport vositalari, ya'ni yo'lovchi taksilari);

- M2 (yo'lovchilar sig'imi 8 dan ortiq bo'lgan va og'irligi 5 tonnadan ortiq bo'lmagan transport vositalari - mikroavtobuslar);

- M3 (yo'lovchilar sig'imi 8 dan ortiq va og'irligi 5 tonnadan ortiq bo'lgan transport vositalari - avtobuslar).

Avtotransport vositasini tanlashda e'tiborga olinadigan avtobuslarning asosiy xususiyatlari:

- sig'im;

- maksimal tezlik;

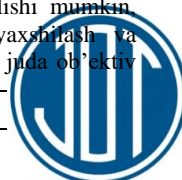
- ichki qulaylik;

- avtomobilning mamlakat bo'ylab o'tish qobiliyati;

- yoqilg'i samaradorligi.

Ko'rib chiqilgan barcha xususiyatlar ro'yxatdan o'tgan transport narxiga ta'sir qiladi. Muntazam tashish narxi transport kompaniyasining tariflariga bog'liq [7].

Sifat ko'p jihatdan davlat nufuzini belgilaydi, har bir inson va umuman jamiyat ehtiyojlarini qondirish uchun asos bo'lib xizmat qiladi va raqobatbardoshlikning eng muhim tarkibiy qismidir. Faqatgina uning asosida korxonaga raqobat muhitida omon qolishi va kerakli foyda olishi mumkin, shuning uchun bozor sharoitida sifatni yaxshilash va ta'minlash bo'yicha faoliyat ustuvor bo'lishi juda ob'ektiv





ko'rinadi. Xizmat deganda, mehnat munosabatlari asosida amalga oshiriladigan faoliyat bundan mustasno, boshqa shaxslarning ehtiyojlarini qondirishga qaratilgan faoliyat tushuniladi [8, 9].

Xizmatlarni belgilashdagi bunday farqlarga qaramay, barcha xizmatlarga xos bo'lgan bir qator xususiyatlar mavjud. Xizmatlarning xarakteristikalari 1-jadvalda keltirilgan.

1-jadval

Xizmat ta'rifi	Xizmat ko'rsatish xususiyatlari
Xizmatning nomoddiyligi	Xizmatni ko'rish, tatib ko'rish, teginish yoki eshitish mumkin emas. Yo'lovchilar o'zlari ko'rgan joy, xodimlar, narx, jihozlar va xizmat ko'rsatish vositalariga qarab sifat haqida o'z xulosalarini chiqaradilar.
Xizmatning ajralmasligi	Xizmat shaxs yoki mashina tomonidan taqdim etilishidan qat'i nazar, xizmatlarni manbalaridan ajratib bo'lmaydi. Xizmatlarning ajralmasligi - bu boshqa iste'molchilar tomonidan ularni ko'rsatish jarayonida mavjudligi va ma'lum bir ishtiroki.

Xizmatni sotib olishdan oldin uning aniq xususiyatlari yo'qligi sababli, sotib olishda noaniqlik darajasi oshadi. Uni kamaytirish uchun xaridorlar xizmat sifatining "signallari" ni izlaydilar. Shuning uchun xizmat ko'rsatuvchi ishlab chiqaruvchining maqsadi xizmatlarning aniqligini oshirishdir.

Xizmat ishlab chiqarishda har doim xaridor mavjud bo'lganligi sababli, etkazib beruvchi va xaridor o'rtasidagi o'zaro ta'sir xizmatlar marketingining alohida jihati hisoblanadi. Yakuniy mahsulot-xizmat sifati etkazib beruvchiga ham, xaridorga ham bog'liq.

### 3. Xulosa

Bozor iqtisodiyoti sharoitida sifat masalasi hal qiluvchi rol o'ynaydi. Yo'lovchilarga yuqori sifatli transport xizmatlarini ta'minlash zarurati to'g'ridan-to'g'ri Vazirlar Mahkamasining avtomobil transporti Nizomi bilan belgilanadi, u xalq xo'jaligi va aholining avtomobil transportiga bo'lgan ehtiyojlarini to'liq qondirish yo'lovchi avtotransport korxonalarining asosiy vazifasi sifatida belgilab qo'yilgan. Yo'lovchilarni tashish xavfsizlik, zarur qulayliklar va yo'lovchilarga xizmat ko'rsatishning yuqori darajasi bilan amalga oshirilishi kerak.

Sifatli yo'lovchi tashish xizmatlarini ko'rsatish uchun barcha mulkchilik shaklidagi transport vositalarining ishlashini qamrab oladigan yo'lovchi tashishni rejalashtirish, tashkil etish, rag'batlantirish, tartibga solish va sifatini nazorat qilishni ta'minlash kerak.

Yo'lovchi tashish xizmatlarining (YTK) tegishli sifatini ta'minlash har bir yo'lovchi avtotransport tashuvchisining asosiy vazifasi hisoblanadi. Iste'molchilarga tegishli sifatli xizmatlarni taqdim etish majburiyati Mamlakat Fuqarolik Kodeksi, "Iste'molchilarning huquqlarini himoya qilish to'g'risida", Vazirlar Mahkamasining "Mahsulotlar va xizmatlarni sertifikatlash to'g'risida" gi qonunlari bilan belgilanadi. [10].

Yo'lovchilarga xizmat ko'rsatish sifati ko'rsatkichlariga qo'yiladigan umumiy talablar:

- yo'lovchilar va jamiyatning real manfaatlarini aks ettirish; o'lchanganligi;
- transportni tashkil etish holati va darajasiga bog'liqligi (sezuvchanlik);
- individual ko'rsatkichlarning bir-biridan mustaqilligi (aks holda ular orasida ortiqchalari ham bor).

Maqola loyihasi so'rovnomasida asosida yo'lovchi tashuvchi avto korxonalar xizmatlari sifatini baholadi. So'rov natijalari avtovokzalda umuman ko'rsatilayotgan xizmatlar sifati haqida tasavvur beradi. 16 foizi xizmat ko'rsatish sifatini a'lo, 42 foizi xizmat sifatini yaxshi deb baholagan, yo'lovchilarning 24 foizi ko'rsatilayotgan xizmatlar sifatiga qoniqarli baho bergan, 18 foizi hech qanday baho bermagan. Umuman olganda, Krasnoyarsk avtovokzalida ko'rsatilayotgan xizmatlar sifati yo'lovchilar talabiga javob beradi, deb aytishimiz mumkin.

Yo'lovchilarga xizmat ko'rsatish sifatini oshirish maqsadida avtovokzal binosini nogironligi bo'lgan shaxslarning haraklanishi uchun qulaylikni oshirish maqsadida vositalari (panduslar) bilan jihozlash kabi chora-tadbirlar ishlab chiqilib, nogironligi bo'lgan shaxslar uchun joylar belgilab qo'yildi.

Sifatni ta'minlash faqatgina xizmatlarni ko'rsatish tarifida (yo'lovchilarga xizmat ko'rsatish tarifi) chiziqli inshootlarning barqaror ishlashi uchun zarur xarajatlarni to'g'ri hisobga olgan holda xizmat ko'rsatish sifatini oshirish mumkin.

Maqola yo'lovchilarga xizmat ko'rsatish faoliyatining amalga oshirilishi xizmatlar sifatining integratsiyalashgan darajasini 0,09 ga oshirish ehtimoli aniqlandi oshirdi. Avtovokzal binosida yo'lovchilarga xizmat ko'rsatish bosqichida vaqt ko'rsatkichi 0,027 ga, qulaylik ko'rsatkichi ham 0,024 ga oshgani yo'lovchilarga xizmat ko'rsatish sifatini oshirishga qaratilgan chora-tadbirlar samaradorligidan dalolat beradi.

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### Mualliflar to'g'risida ma'lumot/ Information about the authors

Suyarov Nurali  
Nurali Suyarov

Toshkent davlat transport universiteti “Yo‘l harakatini tashkil etish” kafedrasida assistenti, E-mail: [nuralisuyarov19@gmail.com](mailto:nuralisuyarov19@gmail.com)

Tel.:+9989743357632

<https://orcid.org/0009-0005-5208-8395>

Abdusamatov  
Erkinjon  
Erkinjon  
Abdusamatov

Toshkent davlat transport universiteti “Yo‘l harakatini tashkil etish” kafedrasida assistenti, E-mail:

[erikxalilovich9793@mail.ru](mailto:erikxalilovich9793@mail.ru)

Tel.:+998901131112

<https://orcid.org/0009-0007-1194-9085>

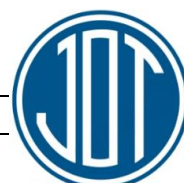
Isoxanov Utkir  
Utkir Isokhanov

Toshkent davlat transport universiteti universiteti “Yo‘l harakatini tashkil etish” kafedrasida katta o‘qituvchi, E-mail:

[utkirisohanov71@gmail.com](mailto:utkirisohanov71@gmail.com)

Tel.:+998977377398

<https://orcid.org/0009-0008-0058-9560>



## The method of selecting the spreading disc of combined road machines (MAN CLA 18.280 4x2 BB CS45) by calculating the parameters

S.K. Turdibekov<sup>1</sup><sup>a</sup>, Sh.X. Shermatov<sup>1</sup><sup>b</sup>, E.X. Abdusamatov<sup>1</sup><sup>c</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** In this article, in order to increase efficiency and ensure traffic safety when it is widely used to eliminate slippage on the road surface in the winter season, the size of the wheel radius of the special road machine (MAN CLA 18.280 4x2 BB CS45), the height of the wheel installation, the rotation speed and how far the spray has been studied. Technological material spreaders are equipment that is permanently installed on car chassis or trailers or can be quickly separated, spreader disk, the forces acting on the particle of technological material (salt-sand) during the rotation of the spreader disk are considered.

**Keywords:** road, disc radius, disc height, distance, rotational speed, spread and sprinkle, angular velocity, sowing width.

## Kombinatsiyalangan yo‘l mashinalarining (MAN CLA 18.280 4x2 BB CS45) yoyib sepish diski parametrlarni hisoblab tanlash usuli

Turdibekov S.K.<sup>1</sup><sup>a</sup>, Shermatov Sh.X.<sup>1</sup><sup>b</sup>, Abdusamatov E.X.<sup>1</sup><sup>c</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Toshkent, O‘zbekiston

**Annotatsiya** Ushbu maqolada qish mavsumida yo‘l qoplamasida sirpanchilikni bartaraf etishda keng foydalanilayotganda samaradorlikni oshirish hamda harakat xavfsizligini ta‘minlash uchun maxsus yo‘l mashinasi (MAN CLA 18.280 4x2 BB CS45) inchi disk radiusi o‘lchamining, disk o‘rnatilish balandligi, aylanish tezligi va qancha masofaga sepish o‘rganib chiqilgan. Texnologik material yoyib sepish moslamalari avtomobil shassilari yoki tirkamalariga doimiy ravishda o‘rnatiladigan yoki tez ajraladigan uskunalari, yoyib sepish diski, yoyib sepish disking aylanishida texnologik material (tuz-qum) zarrachasiga ta‘sir qiluvchi kuchlar ko‘rib chiqilgan.

**Keywords:** yo‘l, disk radiusi, disk balandligi, masofa, aylanma tezlik, yoyib sepish, burchak tezligi, sepish kengligi.

### 1. Kirish

Shaharlar, ularning hududlari va aholisining o‘shishi transport oqimlari ko‘payishi va tarmoqlarining takomillashtirilishiga olib keladi. Shu sababli, zamonaviy yirik shaharning hayotiy faoliyati ko‘p jihatdan turli mavsumiy davrlarda transport aloqasini na‘minlashda yo‘l qoplamasining sifati va holatiga bog‘liq bo‘ladi.

Yo‘llarni saqlash va tozalov-qarov ishlari bo‘yicha asosiy va eng ko‘p mehnat talab qiladigan ishlar qish mavsumida qor o‘z xususiyatini qisqa vaqt ichida o‘zgartirishi bilan bog‘liq bo‘lib, sirpanchiq yoki yaxmalakka aylanishi, bu transport vositalari va piyodalarning harakatiga xavf tug‘diradi.

Barcha mamlakatlarda yo‘l xizmatlari qor va muzlamani yo‘l qatnov qismidan bartaraf qilish uchun texnologik materiallardan (qum-tuz aralashmasi) foydalanadi. Texnologik materiallardan foydalanish nisbatan qisqa vaqt ichida yo‘l qoplamasidan muz va qorni bartaraf etish hamda


tezlikni kamaytirish, baxtsiz hodisalardan hamda iqtisodiy jihatdan yo‘qotishlarni kamaytirish imkonini beradi.

### 2. Tadqiqot metodikasi

Texnologik materiallarni sepish uchun maxsus mashinalar qo‘llaniladi: texnologik material yoyib sepish moslamalari avtomobil shassilari yoki tirkamalariga doimiy ravishda o‘rnatiladigan yoki tez ajraladigan uskunalariga ega. Texnologik materiallarning samarali taqsimlanib sepilishini amalga oshiruvchi o‘rganlarning parametrlari va ish rejimlarini to‘g‘ri tanlashga bog‘liq bo‘lib, bu juda dolzarb vazifadir.

Qish mavsumida yo‘l qoplamasida sirpanchilikni bartaraf etishda keng foydalanilayotganda samaradorlikni oshirish hamda harakat xavfsizligini ta‘minlash uchun KYM yoki MYM (MAN CLA 18.280 4x2 BB CS45) ihchi o‘rganlarining ya‘ni disk radiusi o‘lchamining, disk o‘rnatilish balandligi, aylanish tezligi va qancha masofaga sepish ko‘rsatkichlarining o‘zaro bog‘liqlik qonuniyatini

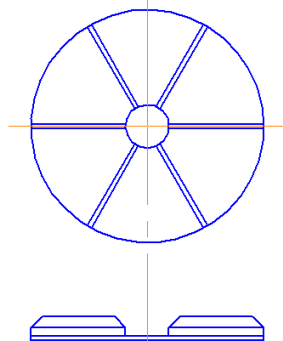
<sup>a</sup> <https://orcid.org/0009-0001-6098-5775>

<sup>b</sup> <https://orcid.org/0009-0007-8165-0097>

<sup>c</sup> <https://orcid.org/0009-0007-1194-9085>



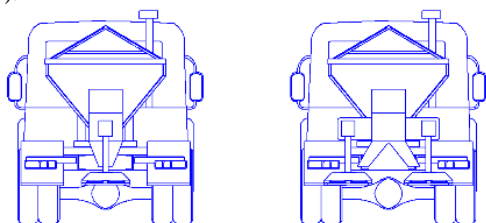
bilish kerak, ushbu masalani echish bo'yicha diskni o'natilishi sepish kengligiga bog'liqligini o'rganish hisoblash va talriba tayyiqotlari olib borildi. Turli xil etkazib berish usullari bilan material vertikal o'qda gorizontaal aylanadigan metallardan yasalgan yoyib sepadigan diskka tushadi. Diskning yuqori ishchi yuzasida radial qovurg'alar payvandlanadi (1-rasm). [9-15]



1-rasm Yoyib sepish disk

Texnologik materiallar ma'lum bir burchak tezligida aylanayotgan yoyib sepish diskning markazidan markazdan qochma kuch ta'sirida disk yuzasida qarshilikni engib, qovurg'alar bo'ylab tashqi chetiga o'tadi va ma'lum masofaga etib borib qatnov qism yuzasiga tushadi. Turli xil mashinalarda diskning diametrlari 0,60 dan 0,70 metrgacha, aylanish tezligi esa 200 dan 600 ayl/min gacha o'zgarishi mumkin.

Materiallarni yo'l yuzasi bo'ylab yoyib sepish uchun ham yakka disk, hamda juft diskardan foydalaniladi (2-rasm).



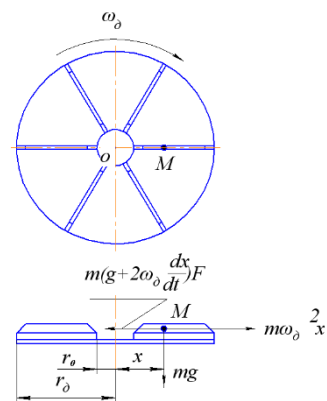
2-rasm Yakka va juft yoyib sepish diskleri

Bir xil gorizontaal tekislikda joylashgan juft yoyib sepish diskleri bir sepib o'tganda jyo'l yuzasida materiallarning sepilish maydoni hamda miqdorini oshirishga imkon beradi.

Parametrlarni hisoblash uchun biz quyidagi qiymatlarni qabul qilamiz: qiymatlar bo'yicha parametrlarni minimaldan maksimalgacha tanlash:

- disk diametri  $\varnothing$  0,5 dan 0,7 metrgacha yoki radius  $r_0$  0,25 dan 0,35 metrgacha;
- disk tezligi 200 dan 400 ayl/min gacha, yoki diskning burchak tezligi  $\omega_0$  20,94 dan 41,86 1/sek gacha;
- yo'l qoplamasidan diskning balandligi  $H_0$  0,2 dan 0,6 metrgacha;
- mashinaning tezligi  $V_M$  5 dan 15 km/s gacha yoki 1,38 dan 4,16 m/sek gacha.

Asosiy hisob-kitoblarni boshlash uchun texnologik materiallarni yoyib sepish diskning parametrlarini ko'rib chiqamiz (2.1.3. rasm). [15 adabiyot]



3-rasm Yoyib sepish diskning aylanishida texnologik material(tuz-qum) zarrachasiga ta'sir qiluvchi kuchlar chizmasi.

Aylanadigan diskda joylashgan  $M$  materialning zarrachasiga quyidagi kuchlar ta'sir qiladi:

og'irlik kuchi  $mg$ ;

markazdan qochma inertsia kuchi  $m\omega_0^2 x$ ;

Koriolis inertsia kuchi  $2m\omega_0 \frac{dx}{dt}$ ;

og'irlik kuchi ta'sirida disk yuzasida ishqalanish kuchi

$Fmg$

va Koriolis inertsia kuchi  $2Fm\omega_0^2 \frac{dx}{dt}$ ,

bu yerda  $m$  zarracha massasi  $kg \cdot sek^2/m$ ;

$x$  – ko'rilyotgan nuqtadan disk markazigacha bo'lgan masofa  $m$ ;

$\omega_0$  – diskning burchak tezligi 1/sek;

$t$  – vaqt, sek;

$g$  – erkin tushish tezlanishi, 9,81 m/sek<sup>2</sup>;

$F$  – qumning ishqalanish koeffitsienti.

Zarrachaning og'irligi boshqa kuchlarga nisbatan juda kichik, shuning uchun odatda  $mg=0$  sifatida qabul qilinadi. [9]

$M$  zarrachaning  $L$  uzoqligacha uchib borish diapazonini topish uchun zarrachaning  $V_r$  disk radiusi bo'ylab nisbiy tezligini topish kerak.

$$V_r = r_0(n - F)\omega_0 \text{ m/sek}, \quad (1)$$

bu yerda  $r_0$  – yoyib sepish diskning radiusi;

$\omega_0$  – yoyib sepish diskning burchak tezligi 1/sek;

$F$  – qumning metallga ishqalanish koeffitsienti 0,5;

$n$  – kirish koeffitsienti  $n = \sqrt{1 + F^2} = 1,2$ .

Aylanma tezlik  $V_a$  ga teng

$$V_a = r_0\omega_0 \text{ m/sek}, \quad (2)$$

Disk chetidagi nuqtaning to'liq tezligi  $V_N$ ,

$$V_N = \sqrt{V_r^2 + V_a^2} \text{ m/sek}, \quad (3)$$

$M$  zarracha diskdan chiqib, havoda vertikal tekislikda harakatlana boshlagan paytdagi tezligi mashinaning uzunlamasiga to'g'ri keladigan  $V_N$  va  $V_M$  tezliklarining algebraik yig'indisiga teng.

$$V = V_N + V_M \text{ m/sek}, \quad (4)$$

bu yerda  $V_M$  - mashinaning tezligi m/sek. [15]

Vertikal tekislikda harakatlanayotgan zarrachaning tezligi mashinaning uzunlamasiga to'g'ri kelganligi sababli, sepish kengligini aniqlash uchun mashinaning  $V_M$  qiymatini  $V_M=0$  deb hisoblaymiz.

$M$  zarrachaning  $L$  uzoqligacha uchib borish diapazoni masofasini quyidagi formula yordamida topish mumkin

$$L = VT \cos\alpha \text{ m}, \quad (5)$$

bu yerda zarrachaning uchish  $T$  vaqti m/sek.



M zarrachaning uchish vaqti T quyidagi formula bo'yicha topiladi,

$$H_{\theta} = \frac{gT^2}{2} - V T \sin \alpha \text{ m}, \quad (6)$$

bu erda  $H_{\theta}$  - balandlik m.

$\alpha=0$  bo'lgani uchun formula quyidagi ko'rinishga ega bo'ladi,

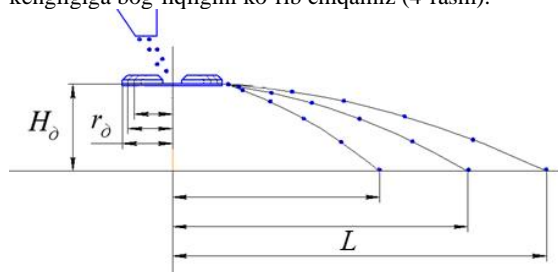
$$H_{\theta} = \frac{gT^2}{2} \text{ m}, \quad H_{\theta} = 4,9 T^2 \text{ m}, \quad (7)$$

endi, zarrachaning uchish vaqtini T topamiz ,[22]

$$T = \sqrt{\frac{H_{\theta}}{4,9}} \text{ sek}, \quad (8)$$

Yoyib sepish disk parametrlarini tanlash uchun biz qiymatlarni o'zgarib kiritamiz va ularning sepish kengligiga ta'sirini ko'rib chiqamiz.

Birinci holda, yoyib sepish diskining radiusi  $r_{\theta}$  o'zgaruvchan, diskning  $H_{\theta} = \text{const}$  balandligi va diskning o'zgarmas  $\omega_{\theta} = \text{const}$  burchak tezligi o'zgarmas bo'lganida M zarrachaning L uchish diapazoni qiymati ya'ni sepish kengligiga bog'liqligini ko'rib chiqamiz (4-rasm).



4-rasm. Yoyib sepish disk aylanish tezligi, diskning  $r_{\theta}$  radiusi va  $H_{\theta}$  disk balandligi M zarrachaning L uchish masofasiga ta'siri.

Bunda, disk radiusi  $r_{\theta}$  o'zgaruvchan, disk balandligi  $H_{\theta} = \text{const}$  va burchak tezligi qiymati o'zgarmas  $\omega_{\theta} = \text{const}$  bo'lganida. (1-jadval).

1-jadval

№	Parametr nomi		
	Disk radiusi $r_{\theta}$ m	Disk balandligi $H_{\theta}$ m	Diskning burchak tezligi $\omega_{\theta}$ 1/sek
1	0,25	0,20	41,86
2	0,30		
3	0,35		

Ikkinchi holda, yoyib sepish diskining burchak tezligi  $\omega_{\theta}$  o'zgaruvchan, diskning  $H_{\theta} = \text{const}$  balandligi va diskning radiusi  $r_{\theta} = \text{const}$  o'zgarmas bo'lganida M zarrachaning L uchish diapazoni qiymati ya'ni sepish kengligiga bog'liqligini ko'rib chiqamiz. Bunda diskning burchak tezligi  $\omega_{\theta}$  o'zgaruvchan, disk radiusi  $r_{\theta} = \text{const}$  va disk balandligi  $H_{\theta} = \text{const}$  qiymati o'zgarmas bo'lganida. (2-jadval).

2-jadval

№	Parametrlar nomi		
	Diskning burchak tezligi $\omega_{\theta}$ 1/sek	Disk radiusi $r_{\theta}$ m	Disk balandligi $H_{\theta}$ m
1	20,94	0,25	0,6
2	31,40		
3	41,86		

Uchinchi holda, yoyib sepish diskining balandligi bo'lganida  $H_{\theta}$  o'zgaruvchan, diskning burchak tezligi  $\omega_{\theta} = \text{const}$  va sepish diskining radiusi  $r_{\theta} = \text{const}$  o'zgarmas bo'lganida M zarrachaning L uchish masofasi bo'yicha bog'liqligi. Bunday holda, disk balandligi  $H_{\theta}$  o'zgaruvchan, diskning burchak tezligi  $\omega_{\theta} = \text{const}$  va disk radiusi  $r_{\theta} = \text{const}$  o'zgarmas bo'lganida. (3-jadval).

3-jadval

№	Parametrlar nomi		
	Disk balandligi $H_{\theta}$ m	Diskning burchak tezligi $\omega_{\theta}$ 1/sek	Disk radiusi $r_{\theta}$ m
1	0,20	20,94	0,35
2	0,40		
3	0,60		

### 3. Xulosa

Sepish kengligi va zichligiga ta'sir qiluvchi texnologik materiallarni yoyib sepish moslamasi(uzeli) parametrlarini tanlash usuli amalga oshirildi. Shunday qilib, yo'l yuzasiga nisbatan sepish kengligiga quyidagilar ta'sir qiladi: sepadigan diskning burchak tezligi; sepadigan diskning diametri va sepadigan diskning yo'l yuzasiga nisbatan balandligi; sepishning yo'l yuzasidagi zichligiga, esa o'z navbatida asosiy mashinaning tezligi, materiallarni etkazish tezligi va diskning burchak tezligi ta'sir qiladi.

Yoyib sepish diskning parametrlarini tanlash metodologiyasi ishlab chiqilgan bo'lib, u turli konstruktiv parametrlarini o'z ichiga oladi: disk diametri, disk balandligi, diskning burchak tezligi. Yoyib sepish diskining har bir parametrini o'zgartirilganda, zarrachaning uchish oralig'iga ta'sir qiladigan ko'rsatkichlar aniqlandi. Shunday qilib, hisobga olingan parametrlardan birining minimal qiymatlari bilan zarrachaning uchish masofasi(1,5-4,3 m) ya'ni sepish kengligi minimal 3 dan maksimal 8,6 metrgacha qiymatgacha bo'lganligini yuqorida berilgan grafiklardagi bog'liqliklarga asoslanib aytishimiz mumkin.

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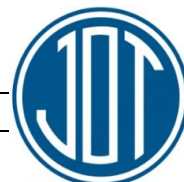
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## Mualliflar bo'yicha ma'lumot/ Information about the authors

Turdibekov Saloxiddin Salokhiddin Turdibekov  
Toshkent davlat transport universiteti  
"Yo'l harakatini tashkil etish"  
kafedrasida katta o'qituvchi, E-mail:  
[saloxiddinturdibekov987@gmail.com](mailto:saloxiddinturdibekov987@gmail.com)  
Tel.:+998977017410  
<https://orcid.org/0009-0001-6098-5775>

Shermatov Shamshir Shermatov  
Toshkent davlat transport universiteti  
"Yo'l harakatini tashkil etish"  
kafedrasida katta o'qituvchi, E-mail:  
[shamsher@inbox.ru](mailto:shamsher@inbox.ru)  
Tel.:+998977732200  
<https://orcid.org/0009-0007-8165-0097>

Abdusamatov Erkinjon Erkinjon Abdusamatov  
Toshkent davlat transport universiteti  
"Yo'l harakatini tashkil etish"  
kafedrasida assistenti, E-mail:  
[erikxalilovich9793@mail.ru](mailto:erikxalilovich9793@mail.ru)  
Tel.:+998901131112  
<https://orcid.org/0009-0007-1194-9085>



## Options for solving two-dimensional elastic bodies using the finite element method

M.M. Rasulmuhamedov<sup>1</sup><sup>a</sup>, Sh.B. Shukurova<sup>1</sup><sup>b</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** The finite element method is an effective numerical method used to solve various problems in engineering, physics, mathematics and other fields, which allows to divide complex geometry into simple elements and find approximate solutions to them

**Keywords:** finite element, finite difference, method, principle, geometric field.

## Ikki o'lchovli elastik jismlarni chekli elementlar usulida yechish imkoniyatlari

Rasulmuhamedov M.M.<sup>1</sup><sup>a</sup>, Shukurova Sh.B.<sup>1</sup><sup>b</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Toshkent, O'zbekiston

**Annotatsiya:** Chekli elementlar usuli - texnika, fizika, matematika va boshqa sohalardagi turli masalalarni yechishda qo'llaniladigan samarali raqamli usul bo'lib, murakkab geometriyani oddiy elementlarga ajratish va ularga taxminiy yechimlarni topish imkonini beradi.

**Keywords:** chekli element, chekli ayirma, usul, tamoyil, geometrik soha.

### 1. Kirish

Chekli elementlar usuli murakkab muhandislik muammolarini hal qilish uchun raqamli yondashuvdan foydalanadi. Bu murakkab geometrik tuzilmalar va materiallarni oddiyroq elementlarga bo'lish orqali ularni taxmin qilish imkonini beradi. Bu usul mexanika, issiqlik uzatish, elektromagnetizm va boshqalar kabi turli sohalarda keng qo'llaniladi. Biz chekli elementlar usulining asosiy tamoyillari, uning afzalliklari va kamchiliklari, shuningdek, uni qo'llash misollarini ko'rib chiqamiz.

Chekli elementlar usuli (CHEU) turli xil matematik modellashtirish va tahlil muammolarini hal qilish uchun ishlatiladigan raqamli usuldir. U murakkab geometrik sohani chekli elementlar deb ataladigan sodda kichik sohalarga ajratishga asoslangan. Har bir chekli element matematik modelni osongina aniqlash va analitik yoki raqamli yo'l bilan yechish mumkin bo'lgan sohaning kichik qismini ifodalaydi.

Chekli elementlar usuli mexanika, issiqlik uzatish, elektromagnetizm, suyuqlik dinamikasi va boshqalar kabi turli sohalarda keng qo'llaniladi. Bu mexanik tuzilmalar, elektr zanjirlari, issiqlik jarayonlari va boshqalar kabi murakkab tizimlarning xatti-harakatlarini modellashtirish va tahlil qilish imkonini beradi.[1]

Chekli elementlar usulining asosiy g'oyasi alohida chekli elementlar bo'yicha yechimlarni birlashtirish orqali muammoning yechimini butun soha bo'ylab yaqinlashtirishdir. Buning uchun har bir chekli element qaralayotgan element chegaralaridagi kerakli funksiya va uning hosilalari qiymatlarini bog'laydigan tenglamalar to'plami bilan tavsiflanadi.

### 2. Tadqiqot metodikasi

Sohani chekli elementlarga bo'lish va har bir element uchun tenglamalarni shakllantirishdan so'ng, butun tizimning harakatini tavsiflovchi tenglamalar tizimi yig'iladi. Tenglamalar tizimi keyinchalik muammoning taxminiy yechimini olish uchun Gauss usuli yoki yugurish (progonka) usuli kabi turli xil usullar yordamida sonli yechiladi.

Chekli elementlar usuli murakkab geometrik shakllarni modellashtirish, turli fizik hodisalarni hisobga olish, yaqinlashish funksiyalarini tanlashda moslashuvchanlik, noxiziq shartli masalalarni yechish kabi bir qator afzalliklarga ega. Biroq, u yuqori hisoblash murakkabligi va natijalarni tasdiqlash va moslashtirish zarurati kabi ba'zi kamchiliklarga ega.


Chekli elementlar usulining (CHEU) ishlash prinsipi murakkab geometrik sohani chekli elementlar deb ataladigan oddiy kichik sohalarga ajratishga asoslangan. Har bir chekli element matematik modelni osongina aniqlash va analitik yoki raqamli yo'l bilan yechish mumkin bo'lgan sohaning kichik qismini ifodalaydi.

Chekli elementlar usuli jarayoni quyidagi bosqichlarni o'z ichiga oladi:

Sohani chekli elementlarga bo'lish;

Murakkab geometrik soha chekli elementlar deb ataladigan sodda kichik sohalarga bo'linadi. Chekli elementlar turli shakllarga ega bo'lishi mumkin, masalan, uchburchaklar, to'rtburchaklar, tetraedrlar yoki geksaedrlar. Sohani chekli elementlarga bo'lish matematik modelni soddalashtirish va uni sonli yechish imkonini beradi.

<sup>a</sup> <https://orcid.org/0000-0001-8404-3013>

<sup>b</sup> <https://orcid.org/0009-0007-2900-0046>



Har bir chekli element uchun element chegaralarida kerakli funksiya va uning hosilalari qiymatlarini bog'laydigan tenglamalar tuziladi. Bu tenglamalar massaning saqlanish qonuni, energiyaning saqlanish qonuni yoki harakat tenglamalari kabi fizik qonunlardan kelib chiqadi.

Har bir chekli element uchun tenglamalar tuzilgandan so'ng, butun tizimning xatti-harakatlarini tavsiflovchi tenglamalar tizimi yig'iladi. Bunga har bir chekli element uchun tenglamalarni birlashtirish va chegara shartlarini hisobga olgan holda erishiladi.

Hosil bo'lgan tenglamalar tizimi turli usullar, masalan, Gauss usuli yoki yugurish (progonka) usuli yordamida sonli yechiladi. Maqsad - tenglamalar va chegara shartlarini qondiradigan butun soha bo'ylab kerakli funksiyaning qiymatlarini topish.

Raqamli yechim olingandan so'ng, uning to'g'riligi tekshiriladi va kerak bo'lganda moslashtiriladi. Bu yechimning yaqinlashuvini tekshirish, xatolarni tahlil qilish va sohani chekli elementlarga bo'linishini yaxshilashni o'z ichiga olishi mumkin.

Shunday qilib, chekli elementlar usulining ishlash prinsipi alohida chekli elementlar bo'yicha yechimlarni birlashtirish orqali butun soha bo'yicha muammoning yechimini taxmin qilishdir. Bu murakkab tizimlarning harakatini raqamli usullar yordamida modellashtirish va tahlil qilish imkonini beradi.

#### **Chekli elementlar usulining afzalliklari:**

1. **Ko'p qirralilik:** Chekli elementlar usuli (CHEU) mexanika, issiqlik uzatish, elektromagnetizm va boshqalar kabi turli sohalarda keng ko'lamli muammolarni hal qilish uchun qo'llanilishi mumkin. Bu uni turli tizimlar va jarayonlarni modellashtirish va tahlil qilish uchun universal vositaga aylantiradi.

2. **Moslashuvchanlik:** CHEU murakkab geometrik shakllar va tuzilmalarni, jumladan, birjinsli bo'lmagan va nochiziqli materiallarni modellashtirish imkonini beradi. Bu muammoni hal qilishda materiallarning real sharoitlari va xususiyatlarini hisobga olish imkonini beradi.

3. **Yuqori aniqlik:** CHEU muammoni hal qilishda yuqori aniqlikni ta'minlaydi, ayniqsa sohani nisbatan kichik chekli elementlarga bo'linishidan foydalanganda. Bu analitik usullar yoki boshqa raqamli usullarni qo'llashdan ko'ra aniqroq natijalarni olish imkonini beradi.

4. **Chegaraviy shartlarni hisobga olish qobiliyati:** CHEU turli xil chegara sharoitlarini, masalan, yuklarni, mahkamlash va harorat sharoitlarini hisobga olish imkonini beradi. Bu sizga real vaziyatlarni modellashtirish va turli xil tashqi ta'sirlar ostida tizimning xatti-harakatlarini tahlil qilish imkonini beradi.[3]

5. **Optimallashtirish qobiliyati:** CHEU konstruksiyalarni va jarayonlarni optimallashtirish uchun ishlatilishi mumkin. Geometriyani, materiallarni yoki boshqa parametrlarni o'zgartirish orqali berilgan talab va cheklolarni qondiradigan optimal yechimni topish mumkin.

#### **Chekli elementlar usulining kamchiliklari:**

1. Yuqori hisoblash xarajatlari: CHEU muhim hisoblash resurslarini talab qiladi, ayniqsa ko'p sonli sonli elementlarga ega murakkab tizimlarni modellashtirishda. Bu uzoq vaqt xarajatlarga va yuqori unumdor kompyuterlarga bo'lgan talablarga olib kelishi mumkin.

2. Tajriba va maxsus dasturiy ta'minotga bo'lgan talab: CHEU ni muvaffaqiyatli qo'llash raqamli modellashtirish sohasida tajriba va bilimlarni talab qiladi. Bundan tashqari, qimmat bo'lishi mumkin va ta'lim talab qiladigan maxsus dasturlardan foydalanishingiz kerak.

3. Taxminiy yechim: CHEU sonli usul bo'lib, uning natijalari har doim taxminiy bo'ladi. Yechimning aniqligi sohaning chekli elementlarga bo'linishi va boshqa modellashtirish parametrlariga bog'liq. Noto'g'ri bo'linish yoki parametrlarni noto'g'ri tanlash noto'g'ri natijalarga olib kelishi mumkin.[8]

4. Murakkab fizik hodisalar bo'yicha cheklolvar: CHEU chiziqli bo'lmagan materiallar, katta deformatsiyalar yoki dinamik jarayonlar kabi ba'zi murakkab fizik hodisalarni modellashtirishda cheklolvar ega bo'lishi mumkin. Bunday hollarda murakkabroq usullardan foydalanish yoki modelni takomillashtirish kerak bo'lishi mumkin.

5. To'r sifatiga bog'liqlik: sohani chekli elementlarga bo'lish sifati yechimning aniqligi va ishonchligiga sezilarli ta'sir ko'rsatishi mumkin. Noto'g'ri to'r yoki to'rdagi nomuvofiqliklar natijalardagi xatolar va noaniqliklarga olib kelishi mumkin.[2]

Ba'zi kamchiliklarga qaramay, chekli elementlar usuli turli tizimlar va jarayonlarni modellashtirish va tahlil qilish uchun eng keng tarqalgan va samarali raqamli usullardan biri bo'lib qolmoqda.

#### **Chekli elementlar usulini turli sohalarda qo'llash**

**Mexanika.** Chekli elementlar usuli (CHEU) mexanikada qattiq jismlar va tuzilmalarning harakatlarini tahlil qilish va modellashtirish uchun keng qo'llaniladi. Bu sizga deformatsiyalanuvchi jismlar mexanikasi bilan bog'liq muammolarni hal qilish imkonini beradi, masalan, konstruksiyalardagi kuchlanish va deformatsiyalarni aniqlash, mustahkamlik va qattqlikni hisoblash, dinamik jarayonlarni tahlil qilish va boshqalar. CHEU geometriya, materiallar, chegara sharoitlari va yuklar kabi turli omillarni hisobga olishi mumkin, bu uni mexanik muammolarni hal qilish uchun kuchli vositaga aylantiradi.

**Issiqlik uzatish.** Issiqlik uzatish sohasida CHEU turli tizimlarda issiqlik uzatish jarayonlarini modellashtirish va tahlil qilish uchun ishlatiladi. Bu materiallar va inshootlardagi harorat, issiqlik oqimi va temperatura o'tishlarining taqsimlanishini aniqlash bilan bog'liq muammolarni hal qilishga imkon beradi. CHEU materiallarning issiqlik o'tkazuvchanligi, issiqlik manbalari va chegara sharoitlari kabi turli omillarni hisobga olishi mumkin, bu uni issiqlik uzatish tahlili uchun samarali vositaga aylantiradi.

**Elektromagnetizm.** CHEU elektromagnit maydonlar va jarayonlarni modellashtirish va tahlil qilish uchun elektromagnetizm sohasida ham qo'llaniladi. U elektr va magnit maydonlarining taqsimlanishi, elektr va magnit potentsiallarni aniqlash, muhitning elektromagnit to'lqinlar bilan o'zaro ta'sirini tahlil qilish va boshqa elektromagnit hodisalar bilan bog'liq muammolarni hal qilish imkonini beradi. CHEU elektr o'tkazuvchanligi, magnit o'tkazuvchanligi va chegara sharoitlari kabi turli omillarni hisobga olishi mumkin, bu esa uni elektromagnit hodisalarni tahlil qilish uchun foydali vositaga aylantiradi.[7]

**Gidrodinamika.** Suyuqlik dinamikasida CHEU suyuqlik va gazlarning harakatini modellashtirish va tahlil qilish uchun ishlatiladi. Bu suyuqlik yoki gazning bosimi, tezligi va oqimining taqsimlanishini aniqlash, gidrodinamik kuchlar va boshqa parametrlarni tahlil qilish bilan bog'liq muammolarni hal qilish imkonini beradi. CHEU yopishqoqlik, zichlik va chegara sharoitlari kabi turli omillarni hisobga olishi mumkin, bu uni gidrodinamik jarayonlarni tahlil qilish uchun foydali vositaga aylantiradi.[4]

**Akustika.** Akustika sohasida CHEU turli muhit va tuzilmalarda tovush va tebranishlarning tarqalishini modellashtirish va tahlil qilish uchun ishlatiladi. Bu tovush



bosimi, tovush tezligi va chastotasining taqsimlanishini aniqlash, rezonans hodisalarini va boshqa parametrlarni tahlil qilish bilan bog'liq muammolarni hal qilish imkonini beradi. CHEU akustik impedans, yutilish va chegara sharoitlari kabi turli omillarni hisobga olishi mumkin, bu uni akustik hodisalarini tahlil qilish uchun foydali vositaga aylantiradi.

Bular chekli elementlar usuli qo'llaniladigan sohalarning faqat bir qismidir. Shuningdek, u aerodinamika, geotexnika muhandisligi, biomexanika, kimyo muhandisligi va murakkab tizimlar va jarayonlarni modellashtirish va tahlil qilishni talab qiladigan boshqa sohalarda qo'llanishni topadi.

#### **Chekli elementlar usulidan foydalanishga misollar**

**1-misol: Mexanika.** Chekli elementlar usulini mexanikada qo'llashga misollardan biri metall konstruksiyadagi kuchlanish va deformatsiyalarni tahlil qilishdir. Tasavvur qilaylik, yuklangan po'lat balka bor. Biz balka ichidagi kuchlanish va kuchlanish taqsimotini aniqlash uchun CHEU dan foydalanishimiz mumkin. Buning uchun biz balkani chekli elementlar deb ataladigan ko'plab kichik elementlarga ajratamiz va matematik modellar yordamida har bir elementning xatti-harakatlarini taxmin qilamiz. Keyin har bir elementdagi va umuman tuzulmadagi kuchlanish va deformatsiyalarni olish uchun tenglamalar tizimini yechamiz. Bu bizga tuzulmaning mustahkamligi va bikirligini baholash va uni mustahkamlash yoki optimallashtirish uchun tegishli choralarni ko'rish imkonini beradi.

**2-misol: Issiqlik uzatish.** Chekli elementlar usulini qo'llashning yana bir misoli tizimda issiqlik uzatishni modellashtirishdir. Tasavvur qilaylik, bizda issiqlik bir muhitdan ikkinchisiga o'tkaziladigan issiqlik almashtirgich bor. Issiqlik almashtirgich ichidagi harorat taqsimoti va issiqlik oqimini aniqlash uchun biz CHEU dan foydalanishimiz mumkin. Buning uchun biz issiqlik almashtirgichni cheklini elementlarga ajratamiz va matematik modellar yordamida har bir elementning xatti-harakatlarini taxmin qilamiz. Keyin har bir elementda va butun tizimda harorat va issiqlik oqimini olish uchun tenglamalar tizimini yechamiz. Bu bizga issiqlik uzatish samaradorligini baholash va uni yaxshilash yoki optimallashtirish choralarni ko'rish imkonini beradi.

**3-misol: Elektromagnetizm.** Chekli elementlar usulini qo'llashning uchinchi misoli elektromagnit maydonlar va jarayonlarni modellashtirish bilan bog'liq. Tasavvur qilaylik, bizda elektr yoki magnit maydonni o'lchash uchun ishlatiladigan elektromagnit sensori bor. Sensor ichidagi elektr yoki magnit maydon taqsimotini aniqlash uchun CHEU dan foydalanishimiz mumkin. Buning uchun biz sensorni chekli elementlarga ajratamiz va matematik modellar yordamida har bir elementning xatti-harakatlarini taxmin qilamiz. Keyin har bir elementda va umuman sensorida elektr yoki magnit maydon qiymatlarini olish uchun tenglamalar tizimini hal qilamiz. Bu bizga sensorning sezgirligi va aniqligini baholash va uni yaxshilash yoki optimallashtirish choralarni ko'rish imkonini beradi.[5]

Bular chekli elementlar usulidan foydalanishga misollardir. Shuningdek, u aerodinamika, geotexnika muhandisligi, biomexanika, kimyo muhandisligi va murakkab tizimlar va jarayonlarni modellashtirish va tahlil qilishni talab qiladigan boshqa sohalarda tatbiqlarni topadi.

**Chekli elementlar usulini qo'llashning asosiy bosqichlari**

**1-qadam: Muammoning bayoni.** Chekli elementlar usulini qo'llashning birinchi bosqichi muammoni shakllantirishdir. Bu bosqichda tizimning geometriyasi va chegaraviy shartlari, shuningdek, hal qilinadigan masala aniqlanadi. Masalan, bu mexanik tuzulmadagi kuchlanish va kuchlanishni yoki issiqlik uzatish tizimidagi haroratni taqsimlashni aniqlash bo'lishi mumkin.

**2-qadam: Chekli elementlarga bo'linishi.** Muammoni qo'ygandan so'ng, keyingi qadam tizimni chekli elementlarga bo'lishdir. Cheklangan elementlar - bu tizimning kichik qismlari bo'lib, ularning xatti-harakatlarini matematik modellar yordamida yaqinlashtirish mumkin. Muammoning geometriyasi va xususiyatlariga qarab, cheklangan elementlarga bo'linish ixtiyoriy yoki tuzulmali bo'lishi mumkin.

**3-bosqich: Matematik modelni shakllantirish.** Chekli elementlarga bo'lingandan so'ng, har bir element uchun matematik modelni shakllantirish kerak. Matematik model elementning harakatini va uning tugunlari orasidagi bog'lanishlarni tavsiflaydi. Buning uchun mexanika tenglamalari, issiqlik o'tkazuvchanligi yoki elektromagnetizm kabi turli xil tenglamalar va qonunlar qo'llaniladi.[6]

**4-qadam: Bikirlik matritsasini yig'ish va jamlash.** Har bir element uchun matematik modelni shakllantirgandan so'ng, bikirlik matritsasi yig'iladi va jamlanadi. Bikirlik matritsasi to'plami har bir element uchun mahalliy bikirlik matritsalarini hisoblash va tizimning global bikirlik matritsasini olish uchun ularni jamlashdan iborat. Bikirlik matritsasi tizim tugunlari orasidagi bog'lanishlarni aks ettiradi va noma'lum qiymatlarni aniqlash uchun tenglamalar tizimini yechishga imkon beradi.

**5-bosqich: Tenglamalar tizimini yechish.** Qattiqlik matritsasi yig'ilgandan so'ng, kuchlanish, deformatsiya, harorat yoki elektr maydoni kabi noma'lum qiymatlarni aniqlash uchun tenglamalar tizimi yechiladi. Tenglamalar tizimini yechish Gauss usuli yoki yugurish (progonka) usuli kabi turli usullar yordamida amalga oshirilishi mumkin.

**6-qadam: Natijalarni tahlil qilish.** Chekli elementlar usulini qo'llashning oxirgi bosqichi olingan natijalarni tahlil qilishdir. Bu deformatsiya, kuchlanish, harorat yoki elektr maydon kabi qiziqish parametrlari uchun olingan qiymatlarni baholash va sharhlashni o'z ichiga oladi. Natijalarni tahlil qilish tizimning xatti-harakatlari va tizimni takomillashtirish yoki optimallashtirish bo'yicha tegishli qarorlar yoki chora-tadbirlar to'g'risida xulosalar chiqarish imkonini beradi.[9]

Shunday qilib, chekli elementlar usulini qo'llashning asosiy bosqichlari masalani shakllantirish, chekli elementlarning parchalanishi, matematik modelni shakllantirish, bikirlik matritsasini yig'ish va jamlash, tenglamalar tizimini yechish va natijalarni tahlil qilishdan iborat. Bu jarayon fan va texnikaning turli sohalaridagi murakkab tizim va jarayonlarni modellashtirish va tahlil qilish imkonini beradi.



## Sonli usullar tahlili

Tafsifi	Chekli elementlar usuli	Chekli ayirma usuli	Chekli hajm usuli
Ta'rifi	Murakkab geometrik obyektlarini oddiyroq obyektlarga (chekli elementlar) bo'lishga asoslangan usul, bunda yechim asosiy funksiyalarning chiziqli birikmasi bilan yaqinlashadi.	Tugunlar tarmog'idagi ayirma munosabatlari bo'yicha hosilalarni yaqinlashtirishga asoslangan usul..	Obyektzni cheklangan hajmlarga bo'lishga asoslangan usul, bunda yechim har bir hajmdagi o'rtacha qiymatga yaqinlashtiriladi.
Ishlash tamoyili	Har bir chekli element bo'yicha tenglamalarni yeching va natijalarni butun obyekt uchun yechim olish uchun birlashtiradi.	Har bir to'r tugunida tenglamalarni yechish va hosilalarni yaqinlashda ayirma munosabatlaridan foydalaniladi	Har bir chekli hajm bo'yicha tenglamalarni yechish va o'rtacha qiymatdan foydalanib, yechimga yaqinlashish.
Ustivorligi	Murakkab geometrik obyektlarni modellashtirishda moslashuvchanlik, turli xil chegara sharoitlarini hisobga olish qobiliyati, juda oz sonli elementlar bilan yuqori aniqlik.	Amalga oshirish qulayligi, hisoblash resurslariga past talablar, murakkab to'r bilan yaxshi yaqinlashish.	Tuzulmasi bo'lmagan to'rlarni modellashtirishda qulaylik, massa va energiyani tejashni hisobga olgan holda qo'pol to'r bilan yaxshi yaqinlashish.
Kamchiliklar	Ko'p sonli elementlarga ega yuqori hisoblash murakkabligi, har bir element bo'yicha chegara shartlarini hisobga olish zarurati.	Murakkab geometrik maydonlar uchun cheklangan qo'llanilishi cheklanganligi, qo'pol to'rda yaqinlashish aniqligini pastligi.	Tuzulmali to'rlar uchun qo'llanilishi murakkabligi, murakkab geometrik sohalarda uchun cheklangan qo'llanishligi.
Tatbig'i	Mexanika, issiqlik uzatish, elektromagnetizm, gidrodinamika, akustika va fan va texnikaning boshqa sohalari.	Issiqlik uzatish, elektromagnetizm, gidrodinamika, akustika va fan va texnikaning boshqa sohalari.	Suyuqlik dinamikasi, issiqlik uzatish, neft va gaz sanoati va fan va texnikaning boshqa sohalari.

### 3. Xulosa

Chekli elementlar usuli turli fizik hodisalar va jarayonlarni modellashtirish va tahlil qilish uchun kuchli vositadir. U analitik tarzda yechilmaydigan murakkab muammolarni hal qilishga imkon beradi va tizimning xatti-harakatlari haqida batafsil ma'lumot beradi.

Chekli elementlar usulini mexanika, issiqlik uzatish, elektromagnetizm va boshqa shu kabi turli sohalarda qo'llash konstruksiyalarni loyihalash va optimallashtirishdan tortib fizik jarayonlarni modellashtirishgacha bo'lgan keng ko'lamli muammolarni hal qilish imkonini beradi.

Shu bilan birga, chekli elementlar usulining ayrim cheklovlari va kamchiliklarini hisobga olish kerak, masalan, yaqinlashish va diskretlashtirish zarurati, raqamli xatolar ehtimoli va natijalarni tasdiqlashning qiyinligi.

Umuman olganda, chekli elementlar usuli muhandislar va olimlar uchun turli tizimlar va jarayonlarni tahlil qilish va optimallashtirish uchun muhim vositadir.

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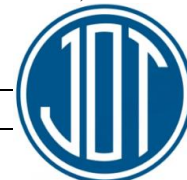
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## Mualliflar haqida ma'lumot / Information about the authors

Rasulmuhamedov Muxamadaziz Muxamadaminovich / Rasulmuhamedov Mukhamadaziz Mukhamadaminovich	Toshkent davlat transport universiteti “Transportda axborot tizimlari va texnologiyalari” kafedrası dotsenti. (PhD), E-mail: prof.rasulmukhamedov@gmail.com Tel.:+998901205980 <a href="https://orcid.org/0000-0001-8404-3013">https://orcid.org/0000-0001-8404-3013</a>
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Shukurova Shohsanam Bahridin qizi / Shukurova Shohsanam Bahridin qizi	Toshkent davlat transport universiteti “Transportda axborot tizimlari va texnologiyalari” kafedrası doktoranti. E- mail: shohsanamm2896@gmail.com Tel.:+998909607728 <a href="https://orcid.org/0009-0007-2900-0046">https://orcid.org/0009-0007-2900-0046</a>
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# Development of the button relay scheme and algorithm of the dial group microprocessor blocks controlling two combined shunting traffic lights of the railway automation and telemechanics system

J. F. Jo'rayev <sup>1</sup><sup>a</sup>, E.K. Ametova <sup>1</sup><sup>b</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

Abstract:

Today, in all developing countries, one of the urgent problems of development of not only railway transport, but also other sectors, the economy as a whole, is the introduction of energy and resource-saving technologies and determining the ways of their effective use. This article analyzes the centralization systems in railway automation and telemechanics and considers the issue of improving the dialing group blocks (NM2P and NM2AP) controlling two unified shunting traffic lights of the BMRM system, i.e. creating their microprocessor representation, developing algorithms for each working chain. There are several electric switching systems in the road automation and telemechanics system, and among them, the block route relay switching system has been actively used for many years, and this system is much faster than other systems because it is installed in a large number of railway stations. improved.

Keywords:

relay, relay system, route, shunting traffic light, electromechanical, microprocessor system, microelectronic, microcontroller, optocoupler.

## 1. Introduction

Currently, a number of microprocessor centralization systems, which are developing rapidly, have been developed based on the block-routed relay centralization (BMRM below) system. Because in the BMRM system, the safety and reliability requirements of devices are implemented at a high level and have been tested in the production process for a long time. Therefore, the use of the BMRM system architecture and performance algorithm in creating modern centralization systems is one of the most alternative solutions. In this regard, it is also worth noting that the introduction of new and modern microprocessor centralization systems does not always increase economic efficiency, because the cost of such systems requires many years to pay for themselves. In addition, it is much easier and more cost-effective to upgrade parts of an existing system in sequence than to completely upgrade it.

## 2. Methodology and empirical analysis

In order to develop a modern microprocessor version of the dial group block NM2P, which controls two combined maneuvering traffic lights in the BMRM system, we analyze the button relay circuit (Fig. 1) and the operation algorithm in the block.

The button relay serves to fix the pressing of the route button on the control panel of the station attendant.

A pushbutton relay is normally de-energized and can be energized in two ways:

- by pressing the buttons on the station attendant's control panel;
- through automatic button relay (AKN) contacts;

Push-button relays receive power through the first chain of interconnections of the dial group blocks and are de-energized only when the PU and MU controlling the arrow switches or the signal relay is energized.

The push-button KN relay in the dial group unit NM2P, which controls two combined maneuvering traffic lights, can be energized when one of the following conditions is met.

Condition 1. There should be a supply at the THM point, the K relay contacts should provide a common forward connection, and there should be a connection with the 1-1 point. This situation can be expressed by the following formula (1)

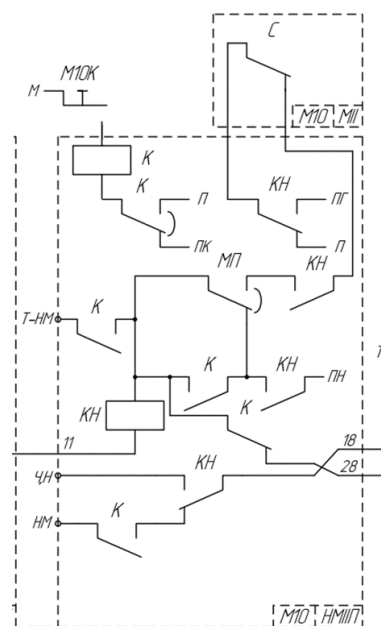



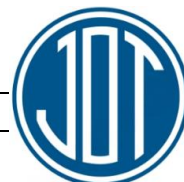
Figure 1. Button relay circuit in the NM2P block

$$[T-HM \cap K \cap (1-1) = 1] [KH = 1] \quad (1)$$

Condition 2. In the next case, the presence of supply at the input of the block (2-8), the connection of the contacts of the relay K and the connection with the point 1-1 will bring

<sup>a</sup> <https://orcid.org/0009-0007-7852-6554>

<sup>b</sup> <https://orcid.org/0000-0003-0872-3599>



the relay KN to the current state. This situation can be expressed by the following formula (2)

$$[(2-8) \cap \bar{K} \cap (1-1)=1][KH=1] \quad (2)$$

Condition 3. Supply is available at PN input, common and forward contacts of relay KH are connected in energized state, common and forward contacts of relay K are connected and there is a 1-1 point connection KN relay is energized through self-locking circuit causes. This can be expressed as (3)

$$[IH \cap KH \cap K \cap (1-1)=1][KH=1] \quad (3)$$

Condition 4. The presence of supply at the PN input, the common and forward contacts of the KH relay are connected in the live state, the MP relay is de-energized, i.e. the common back contacts are connected, and there is a connection with 1-1 point, the second self of the KN relay through the locking circuit to the live state. This can be expressed as (4)

$$[IH \cap KH \cap \bar{M} \cap (1-1)=1][KH=1] \quad (4)$$

Condition 5. (1-9) if there is a supply at the input, the common and front contacts of the KH relay are connected in the current state, the common and front contacts of the MP relay are connected and there is a connection with point 1-1, the KN relay is turned on by itself. through the locking circuit to the live state. This can be expressed as (5)

$$[(1-9) \cap KH \cap M \cap (1-1)=1][KH=1] \quad (5)$$

Based on the mentioned conditions, the working algorithm of the KN relay (Fig. 2) is as follows.

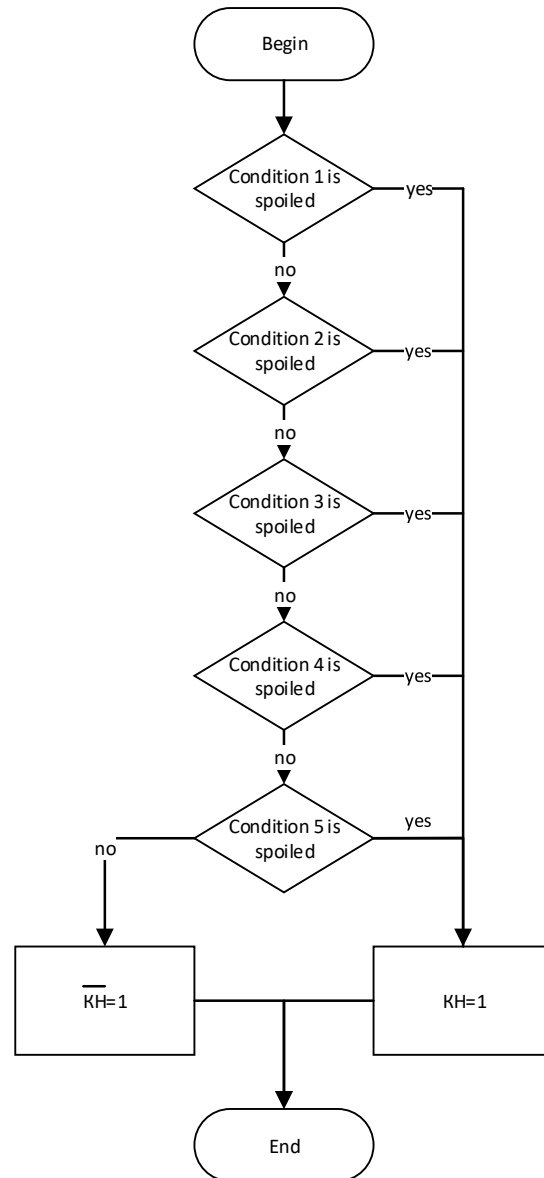
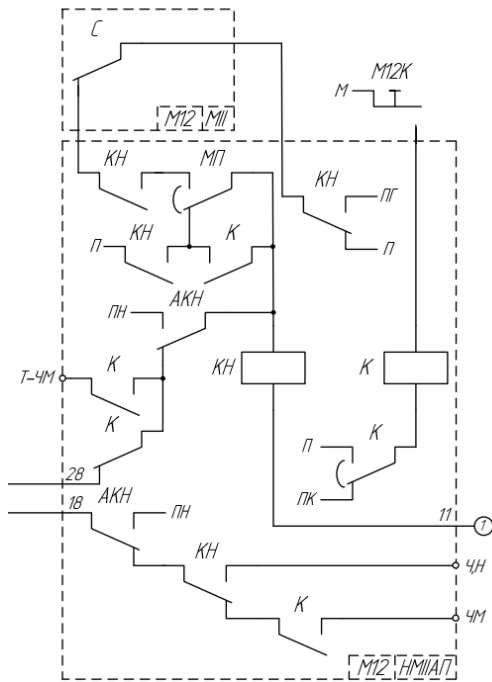


Figure 2. Working algorithm of the KN relay

Next, we will analyze the operation algorithm of the button relay circuit (Fig. 3) in the NM2AP block, which controls two combined maneuvering traffic lights in the BMRM system.





**Figure 3. Button relay circuit in the NM2AP block**

The pushbutton KN relay in the NM2AP dial group unit can be energized when one of the following conditions is met.

Condition 1. There should be a power supply at point THM, contacts of relay K should provide a common forward circuit, contacts of relay AKH should be de-energized, i.e. in a common reverse circuit, and there should be a connection with point 1-1. This situation can be expressed by the following formula (6)

$$[T-HM \cap K \cap \overline{AKH} \cap (1-1)=1][KH=1] \quad (6)$$

Condition 2. In the next case, there is a supply at the input of the block (2-8), the contacts of the relay K are connected to the common back contact, the contacts of the relay AKH are in the common back, and there is a connection with point 1-1, the KN relay is energized. This situation can be expressed by the following formula (7)

$$[(2-8) \cap \overline{K} \cap \overline{AKH} \cap (1-1)=1][KH=1] \quad (7)$$

Condition 3. The presence of supply at the PN input, the common and front contacts of the AKH relay in the current state, and the connection with the 1-1 point will bring the KN relay to the current state. This can be expressed as (8)

$$[PH \cap AKH \cap (1-1)=1][KH=1] \quad (8)$$

Condition 4. There should be a supply at the PN input, the common and front contacts of the KH relay are energized, the MP relay is de-energized, i.e. the common back contacts are connected and there should be a connection with 1-1 point, self-locking of the KN relay. through the chain to the current state. This can be expressed as (9)

$$[PH \cap KH \cap \overline{MP} \cap (1-1)=1][KH=1] \quad (9)$$

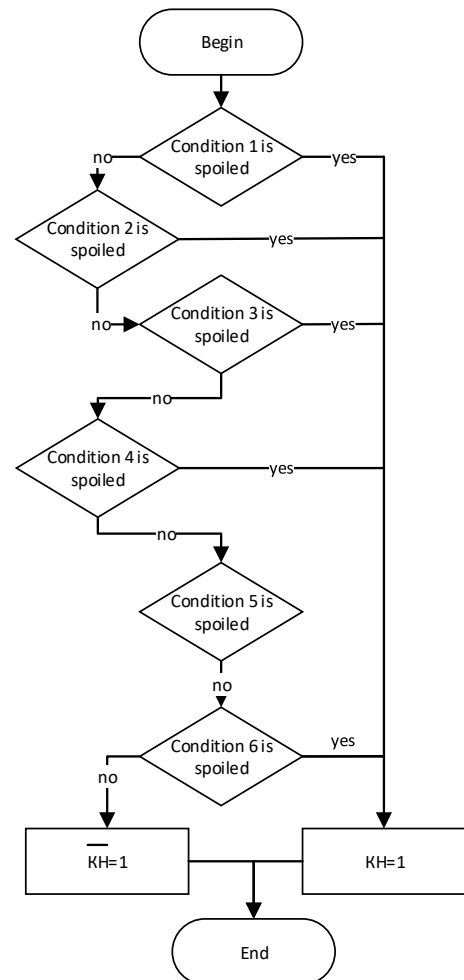
Condition 5. The presence of supply at the PN input, the common and front contacts of the KH relay energized, the K relay energized, and the 1-1 point connection causes the KN relay to be energized through the second self-locking circuit. This can be expressed as (10)

$$[PH \cap KH \cap K \cap (1-1)=1][KH=1] \quad (10)$$

Condition 6. (1-9) there is a supply at the input, the common and front contacts of the KH relay are connected in the energized state, the common and front contacts of the MP relay are connected and there is a connection with point 1-1, the third self-off of the KN relay zi is energized through the locking circuit. This can be expressed as (11)

$$[(1-9) \cap KH \cap MP \cap (1-1)=1][KH=1] \quad (11)$$

Based on the mentioned conditions, the working algorithm of the KN relay in the NM2AP block (Fig. 4) is as follows.



**Figure 4. KN relay operation algorithm in the NM2AP block**

In addition to KN button relay, NM2AP block also has AKH automatic button relay. The AKH relay switches to the ON state when the following conditions are met.

Condition 1. There should be a supply at the 2-2 access point, the connection of the common back contacts of the KH relay and the connection with the 1-2 access point should be available. It can be expressed as follows.



$$[(2-2) \cap \overline{KH} \cap (2-1)=1] [AKH=1] \quad (12)$$

In addition, the following two expressions ensure that the AKH relay with 13-14 arcs is switched to the current state through a self-locking circuit.

$$[(1-22) \cap AKH \cap AKH \cap K \cap (2-1)=1] [AKH=1] \quad (13)$$

$$[(1-22) \cap AKH \cap K \cap (1-1)=1] [KH=1] \quad (14)$$

The working algorithm of the AKN relay in the NM2AP block is as shown in Figure 5 below.

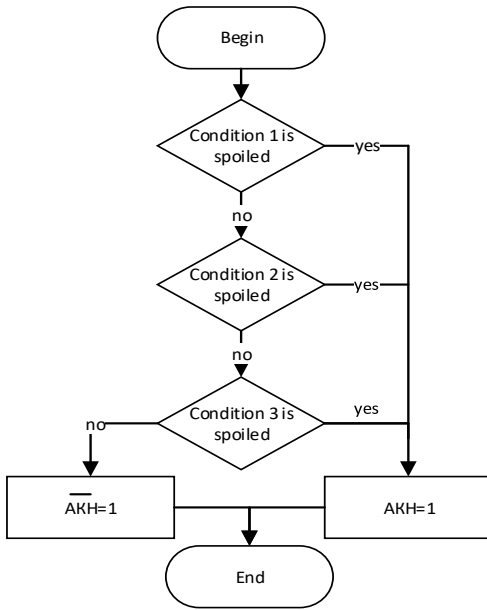


Figure 5. AKN relay operation algorithm in the NM2AP block

### 3. Results

In the NM2P dial group unit controlling two combined maneuvering traffic lights, we will develop a functional circuit and replace the electromagnetic relay and its contacts with microelectronic devices in the KN relay circuits. In this case, using PS-817 instead of the electromagnetic relay, and PVG-612 S-type optocouplers instead of the relay contacts, the KN relay switches to the current state based on the 1st condition, the functional scheme is as follows Fig. 6.

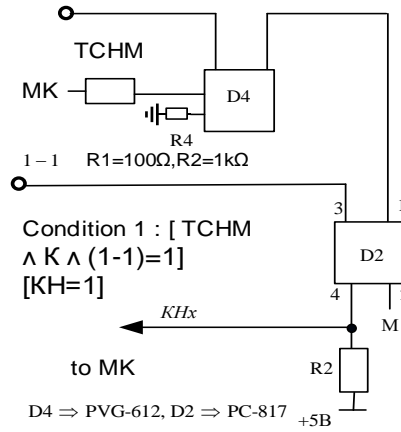


Figure 6. Functional scheme of the KN relay supply chain based on condition 1

### 4. Conclusion

The improved modern microprocessor block of dialing group blocks controlling two combined shunting traffic lights of the proposed railway automation and telemechanics system has advantages over electromagnetic relay blocks with energy efficiency, compactness and compactness. Another major advantage is that the production of this type of microprocessor units is done locally and is cost-effective. This, in turn, eliminates dependence on foreign enterprises in the sector. Microelectronic optocouplers and semiconductors are used instead of electromagnetic relays to create an improved version of the dial group block controlling two combined shunting traffic lights in the centralization system with a block route relay. The operating algorithms of the electromagnetic relay block are analyzed, and software is written for the microcontroller based on these algorithms.

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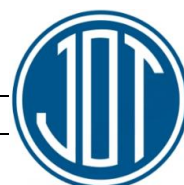
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### Information about the authors

Jo'rayev Javoxirjon Tashkent State Transport  
Farhodjon o'g'li University, doctoral student,  
Tashkent, Uzbekistan  
<https://orcid.org/0009-0007-7852-6554>

Ametova Elnara Tashkent State Transport  
Kuandikovna University, Phd Assoc. Tashkent,  
Uzbekistan Department of  
automation and telemechanics  
<https://orcid.org/0000-0003-0872-3599>



## Determination of service quality parameters and their weight in passenger transport

B.I. Abdullaev<sup>1</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** The researchers expressed the assessment of the quality of transport services to passengers with different parameters, and also different parameters (groups) were taken into account in the normative documents of different countries. The article is devoted to determining the parameters (group) determining the quality of passenger transport service for Uzbekistan and their severity, and improving the method of assessing the quality of passenger transport service based on the most severe parameter (group). For this reason, the article examines the researches of world researchers on the assessment of the quality of transport services to passengers, as well as analyzes the normative documents of foreign countries. Based on the results of the analysis, a group of parameters determining the quality of passenger transport services for Uzbekistan and its organizers were determined and its hierarchy was created. The group of parameters determining the quality of transport service is divided into a group of parameters that can be taken into account in the main and necessary cases based on the methods of analysis and expert survey. It was also determined that the most difficult parameter (group) is "Security" using the expert survey method. The method of evaluating the quality of passenger transport service according to the "safety" parameter (group) has been.

**Keywords:** Quality of passenger transport service, service availability, service availability, informativeness, time, comfort, safety, luggage storage, staff service, environmental impact, economy.

## Yo'lovchi transportida xizmat ko'rsatish sifat parametrlari va ularning og'irligini aniqlash

B.I.Abdullaev<sup>1</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Tashkent, O'zbekiston

**Annotatsiya:** Yo'lovchilarga transport xizmati ko'rsatish sifatini baholashni tadqiqotchilar turli parametrlar bilan ifodalaganlar, shuningdek turli davlatlarning me'yoriy xujjatlarida ham turli parametrlar (guruhi) hisobga olingan. Maqola O'zbekiston uchun yo'lovchi transporti xizmati sifatini belgilovchi parametrlarni (guruhi) va ularning og'irligini aniqlash hamda aniqlangan eng og'ir parametr (guruhi) bo'yicha yo'lovchi transporti xizmati sifatini baholash usulini takomillashtirishga bag'ishlangan. Shu sababdan, maqolada yo'lovchilarga transport xizmati ko'rsatish sifatini baholash bo'yicha dunyo tadqiqotchilari tadqiqotlari o'rganilgan, shuningdek xorij davlatlarining me'yoriy xujjatlari tahlil qilingan. Tahlil natijalari asosida O'zbekiston uchun yo'lovchilarga transport xizmati ko'rsatish sifatini belgilovchi parametrlar guruhi hamda uni tashkil etuvchilari aniqlangan va uning iyerarxiyasi tuzilgan. Transport xizmati ko'rsatish sifatini belgilovchi parametrlar guruhi tahlil va ekspert so'rovi usullari asosida asosiy va zarur hollarda hisobga olinishi mumkin bo'lgan parametrlar guruhiga ajratilgan. Shuningdek, ekspert so'rovi usuli yordamida eng og'ir "Xavfsizlik" parametri (guruhi) ekanligi aniqlangan. "Xavfsizlik" parametri (guruhi) bo'yicha yo'lovchi transporti xizmati sifatini baholash usuli takomillashtirilgan.

**Kalit so'zlar:** Yo'lovchilarga transport xizmati ko'rsatish sifati, xizmatning mavjudligi, xizmatdan foydalanish imkoniyati, axborotchanlik, vaqt, komfortlik, xavfsizlik, bagajlarni saqlash, xodimlar xizmati, atrof-muhitga ta'sir, iqtisodchanlik.

### 1. Kirish

Dunyo miqyosida yirik shaharlarda aholiga transport xizmati ko'rsatish sifatini oshirish, jumladan, yo'lovchilarni manzillariga xavfsiz, ishonchli, o'z vaqtida, komfort sharoitda, arzon narxda yetkazib qo'yish masalalari, mavjud muammolarning zamonaviy yechimlari muhim ahamiyat kasb etmoqda. Bu borada AQSh, Germaniya, Yaponiya,

Janubiy Koreya, Singapur kabi rivojlangan xorij mamlakatlarida yo'lovchi transportlarida xizmat ko'rsatish sifatini oshirishning yangi ilmiy-texnikaviy yechimlarini ishlab chiqishga alohida e'tibor qaratilmoqda. Mamlakatimizda aholiga transport xizmati ko'rsatish sifatini oshirishga qaratilgan, shahar yo'lovchi transporti ishini ilmiy yondashuvlarga asoslangan holda takomillashtirish masalalariga yo'naltirilgan ilmiy-tadqiqot ishlari ustuvor

 <https://orcid.org/0009-0006-3150-5601>



xususiyatga ega bo'lmoqda. Jumladan, O'zbekiston Respublikasi Prezidentining 16.02.2023 yildagi "Jamoat transporti tizimini isloh qilish chora-tadbirlari to'g'risida"gi PQ №59-sonli Qarorida avtobusda yo'lovchi tashish xizmatlarini ko'rsatuvchi tashuvchilar bilan hisob-kitoblarni "bosib o'tilgan yo'l" va "sifat" mezonlari asosida vakolatli davlat organi tomonidan amalga oshirilishi belgilab berilgan<sup>a</sup>. Ammo, jamoat transportlarida yo'lovchilarni tashishda xizmat ko'rsatish sifatini baholovchi mukammal mexanizm mavjud emasligi, tashish xizmati sifatini oshirish yoki baholashda turlicha yondashuvlar kelib chiqishiga sabab bo'lmoqda.

Mazkur maqolaning maqsadi shu muammoning yechimiga yo'naltirilgan bo'lib, quyidagi vazifalarni qamrab oladi:

- mamlakatimizda yo'lovchi transporti xizmati sifatini belgilovchi parametrlarni (guruhi) aniqlash;
- yo'lovchi transporti xizmati sifatini belgilovchi parametrlarning (guruhi) og'irligini aniqlash;
- eng og'ir parametrlarni (guruhi) baholash usulini takomillashtirish.

Sifat deganda ISO 9000-2000 "Quality management systems – Fundamentals and vocabulary"ga muvofiq o'ziga xos xususiyatlarning umumiy talablarga javob berish darajasi tushuniladi [1]. Yo'lovchi transporti xizmatiga iste'molchi sifatida yo'lovchilar tomonidan qisqa vaqtda manzilga yetkazish, maksimal xavfsizlik, yo'nalishda transport vositasining ish vaqti va tashuvning kafolatlanganligi, harakatning muntazam bo'lishi, komfort sharoit va qulaylik, qo'shimcha xizmatlar mavjudligi kabi turlicha talablar qo'yiladi. Transport xizmati sifatini ana shu talablarni maksimal darajada qanoatlantirish uchun amalga oshirilgan tadbirlar natijalarining majmuidan iborat bo'ladi. Demakki, transport xizmati sifatini uning yagona emas, balki, ko'plab parametrlari bilan bog'liq bo'ladi. Mazkur sohada dunyo tadqiqotchilari tomonidan ko'plab tadqiqotlar olib borilgan bo'lib, transport xizmati sifatiga turlicha tariflar berilib, uni baholashga turlicha yondashilgan holda turli ko'rsatkichlar bilan bog'langan [2-19]. Yo'lovchilarga transport xizmati ko'rsatish sifatini baholash bo'yicha ishlab chiqilgan mezonlarning tahlili, aholiga transport xizmatini ko'rsatish sifatini baholash bo'yicha ko'plab tadqiqotlar olib borilganligi va tadqiqotchilar turli parametrlardan foydalanishganligini ko'rsatadi.

## 2. Metodologiya

Yo'lovchilarga transport xizmati ko'rsatish sifatini baholovchi parametrlari (guruhi) va ularning og'irligini aniqlashda tahlil va ekspert so'rovi usullaridan foydalanish maqsadga muvofiq.

Quyida AQSh, Yevropa va Rossiya davlatlarining yo'lovchi transportida xizmat ko'rsatish sifatini aniqlashda hisobga olinadigan parametrlar guruhi (va parametrlar) ko'rib chiqiladi.

AQShda yo'lovchi transporti xizmati sifatini aniqlashda quyidagi parametrlar guruhi va parametrlar hisobga olinadi [20].

1. Muntazamlik – ishning doimiyliigi va o'zaro barqarorligi.

2. Javobgarlik – xizmat ko'rsatuvchining xizmatni o'z vaqtida bajarishga tayyorligi va unga qodirligi.

3. Malakaviylik – tashishni amalga oshirishda zarur malaka va bilimga ega bo'lish.

4. Kirishuvchanlik – aloqaning osonligi (yengilligi).

5. Xushmuomalalik – muloqotda xushmuomalalik va do'stona munosabat.

6. Muloqotga kirishuvchanlik – istemolchilarni ular tushinadigan tilda axborot bilan taminlash.

7. Ishonchlilik – haqiqatgoylik va ishonchlilik, shuningdek, istemolchilarga chin dildan xizmat ko'rsatish.

8. Xavfsizlik – shubha, tavakkalchilik va xavfdan holi bo'lish.

9. Iste'molchilarni bilish/tushunish – istemolchilar ehtiyojlarini tushunish uchun qayg'urish.

10. Moddiylik – jismoniy muhit va xizmatlarni namoyish qilish.

Yevropada yo'lovchi transporti xizmati sifati 40 dan ortiq davlatlar uchun yagona standart asosida 8 ta parametrlar guruhi bilan aniqlanadi. [21]:

1- va 2-guruhlar yo'lovchi transporti xizmati sifatini umumiy holda 3-, 4-, 5-, 6- va 7-guruhlar esa, batafsil tavsiflaydi.

1. "Xizmat ko'rsatish imkoniyati" guruhi geografiya, vaqt, transport harakati chastotasi va rejimi bo'yicha taqdim etiladigan xizmatlar darajasini o'z ichiga oladi.

2. "Kirishuvchanlik" guruhi esa, jamoat transporti tizimiga kirish, shu jumladan boshqa transport turlari bilan o'zaro ishlay olishini hisobga oladi.

3. "Axborotchanlik" guruhi transport xizmatlari haqida ma'lumot olishning, transport qanchalik yaxshi ishlashini bilishning, muammo tug'ilganida muqobil yo'nalish topishning osonligi parametrlaridan tashkil topadi.

4. "Vaqt" guruhi o'z vaqtida manzilga yetkaza olish bilan xarakterlanadi.

5. "Mijozlarga xizmat ko'rsatish" guruhi xodimlarning kiyinishi, xizmatining foydaliligi va muammo yoki shikoyatlarni hal etilish darajasi parametrlarini o'z ichiga oladi.

6. "Komfortlik" parametrlar guruhi o'rindiqlarning komfortligi va yetarliligi, transport vositasi harakati va qatnov komfortligi, me'yorga mos keluvchi tinchlik (osoyishtalik), yoritilganlik, ventilyatsiya va haroratlarini qamrab oladi.

7. "Xavfsizlik" parametrlar guruhi tashish jarayonida yo'lovchi uchun xavfsiz bo'lishini nazarda tutadi.

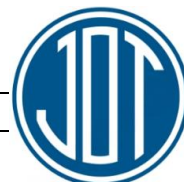
8. "Atrof muhitga ta'siri" parametrlar guruhi atrof-muhitga chiqaradigan zaharli gazlarni hisobga oladi.

Rossiyaning «Номенклатура показателей качества»ga muvofiq yo'lovchi transporti xizmati sifatini quyidagi 6 ta parametrlar guruhlarini belgilaydi [22]:

1. Xizmat ko'rsatish axboroti parametrlari guruhi axborotlarni uzatish chastotasini, transport vositalarini jo'nashi va yetib kelishi, yo'lovchilarga ko'rsatiladigan xizmatlar va ularning narxlarini, zarur binolar, aloqa vositalari, umumta'minot ob'yektlarining joylashuvi haqida va boshqa axborotlarni o'z ichiga oladi.

2. Komfortlik parametrlari guruhi bir yo'lovchiga to'g'ri keluvchi maydon, transport vositasi va binoni tozalash chastotasi, chexol-g'illoflarni almashtirish chastotasi, transport vositasi va binoda havoning harorati, transport vositasi va binodagi yoritilganlik, shovqin miqdori, vibratsiya va namlikning ruxsat etilgan darajasi, transport vositasi saloni va binoning o'rtacha (ruxsat etilgan) to'lganlik parametrlarini o'z ichiga oladi.

<sup>a</sup> O'zbekiston Respublikasi Prezidentining 2023 yil 17-fevraldagi "Jamoat transporti tizimini isloh qilish chora-tadbirlari to'g'risida"gi PQ №59-sonli Qarori



3. Tezlik parametrlari guruhi qatnovda bo'lish davomiyligi, transport vositasining o'rtacha harakat tezligi, transport vositasi bekatlari chastotasi parametrlarini o'z ichiga oladi.

4. O'z vaqtida bajarilish parametrlari guruhi: jadval bo'yicha jo'natilgan transport vositalari ulushi; jadval bo'yicha qabul qilingan transport vositalari ulushi; transport vositalari harakatining o'rtacha intervali; transport vositalari harakatining maksimal intervali parametrlarini o'z ichiga oladi.

5. Bagajni saqlash parametrlari guruhi jo'natilgan va buzilish bilan qabul qilingan bagajlarning foizi, bagajlarning buzilishidan olingan yo'qotishning o'rtacha narxi, bagajlarning buzilishi o'rni qoplash narxi ko'rsatkichlarini o'z ichiga oladi.

6. Xavfsizlik parametrlari guruhi transport vositalarining harakatda bo'lishi ishonchligi, transport xizmati ko'rsatuvchilarning kasbiy mutanosibligi, transport vositalarining muayyan tashishni amalga oshirishga tayyorliklarini o'z ichiga oladi.

Mamlakatimizda yo'lovchi transportida xizmat ko'rsatish sifatini belgilovchi mezonlar qanday bo'lishi lozimligi quyida ko'rib chiqiladi. Yo'lovchilarga transport xizmati ko'rsatish sifatini belgilovchi mezonlarni jamoat transporti bilan cheklab qo'yish kerak emas, balki, yo'lovchi transportiga nisbatan tatbiq etish maqsadga muvofiq hisoblanadi. Shu sababli, yo'lovchi transportida xizmat ko'rsatish sifati deb yuritimiz va xizmat ko'rsatish sifatini tizim deb qaralsa, parametrlar guruhi tagtizimlarni tashkil etadi va ular yana tagtizimlar va parametrlardan tashkil topadi. Yo'lovchilarga transport xizmati ko'rsatish sifatini aniqlovchi parametrlar guruhini (va parametrlar) asoslash tahlil natijalari va ekspertlar fikri asosida amalga oshiriladi.

Tahlil natijalaridan aniqlangan parametrlarning og'irligi quyidagi ifoda orqali aniqlanadi [23],

$$M_{ij} = \frac{R_{ij}}{\sum_{i=1}^n R_{ij}} \quad (1)$$

bu yerda:  $R_{ij}$  – 10 ballik shkala asosida  $i$ -parameter guruhi bo'yicha  $j$ -ekspert bahosining absolyut qiymati;  $n$  – parametrlar guruhi soni.

So'ngra (1) ifoda natijasi asosida aniqlangan eng og'ir parametrlar guruhi bo'yicha yo'lovchi transporti xizmati sifatini baholash usuli takomillashtiriladi.

### 3. Natijalar

Olib borilgan tadqiqotlar natijasida mamlakatimizda yo'lovchi transporti xizmati sifatini belgilovchi 6 ta asosiy va 4 ta zarur hollarda hisobga olinishi mumkin bo'lgan quyidagi parametrlar guruhidan (va parametrlar) iborat bo'lishi lozimligi aniqlandi.

Asosiy parametrlar guruhi (va parametrlar). Jahon tajribasidan kelib chiqib, birinchi navbatda yo'lovchi transportining xizmati mavjud bo'lishi va u harakat chastotasi, transport turi, transport vositasining xizmat ko'rsatish hududi, transport vositasining xizmat ko'rsatish muddati kabi parametrlarni qarab olgan bo'lishi va **“Xizmatning mavjudligi”** deb nomlanishi maqsadga muvofiq.

Ikkinchidan xizmatdan foydalanish imkoniyati mavjud bo'lishi lozim va mazkur tagtizim transport vositasiga yo'lovchilarning chiqishi va undan tushishning qulayligi,

transport vositasi salonida harakatlanish qulayligi, zarur muddatlarda zarur turdagi chiptalar mavjudligi, yo'l haqi to'lashning imkoniyati, imkoniyati cheklangan yo'lovchilarning foydalana olish darajasi ko'rsatkichlari kabilarni nazarda tutishi lozim va **“Xizmatdan foydalanish imkoniyati”** deyish lozim deb nomlanishi maqsadga muvofiq.

**“Axborotchanlik”** parametrlar guruhi. Hozirgi kunda dunyo bo'ylab axborot almashish juda rivojlanib ketdi. Shu bois **“Axborotchanlik”** jamoat transporti xizmati sifatini belgilovchi asosiy guruhlardan hisoblanadi va transport xizmatlari haqida ma'lumot olish imkoniyati, transport qay darajada ishlashini bilish imkoniyati, muammo tug'ilganda muqobil yo'nalish topish osonligi parametrlari bilan tavsiflanadi.

**“Vaqt”** parametrlar guruhi. Jamoat transportiga chiqqan yo'lovchi uchun svetoforlar, oraliq bekatlar, transport tirbandliklarida ushlanib qolishlar yo'lovchi uchun qiziq bo'lmaydi va uning uchun manziliga tezda yetib olishi muhim hisoblanadi. Mazkur guruhga o'z vaqtida manzilga yetkaza olishi, qatnovda bo'lish davomiyligi, transport vositasining o'rtacha harakat tezligi, transport vositalari harakatining o'rtacha intervali, transport vositalari harakatining maksimal intervali kabi parametrlarni kiritish lozim.

**“Komfortlik”** parametrlar guruhi transport vositasi o'rindiqdarining komfortligi va yetariligi, transport vositasi salonida maxsus o'rindiq mavjudligi, transport vositasi salonining o'rtacha (ruxsat etilgan) to'lganlik darajasi, transport vositasi harakati (qatnovi) komfortligi, transport vositasiga chiqish, undan tushish uchun bekatlarning qulayligi, transport vositasining tozaligi, transport vositasi salonining yoritilganligi, transport vositasi salonida havo harorati, transport vositasi saloni ichki qismining quyosh nuridan himoya qilinganlik darajasi, transport vositasi salonida namlik darajasi, transport vositasi salonida vibratsiya darajasi, bekatlardan imkoniyati cheklangan yo'lovchilarning foydalana olish darajasi parametrlarini qamrab oladi.

**“Xavfsizlik”** parametrlar guruhi. Jahon tajribasi ko'rsatishicha jamoat transportida xavfsizlik yo'l harakati bilan bog'liq bo'lmagan va bog'liq bo'lgan guruhlariga bo'linishi lozim. Yo'l harakati bilan bog'liq bo'lmagan xavfsizliklar jarayonida turli ko'rinishdagi terroristik hujumlar, bosqinchiliklar, yong'inlar va boshqa turdagi baxtsiz hodisalardan yo'lovchilarni himoyalanganlik darajasini hamda qutqaruv xizmatlari bilan bog'lanish, ular xizmatidan foydalanishning osonligi kabilarni bilan tavsiflanadi.

Yo'l harakati bilan bog'liq bo'lgan xavfsizliklar yo'llarda yo'l-transport hodisalarini vujudga kelishi natijasidagi yo'lovchilar hayoti xavfsizligini nazarda tutadi va quyidagilarni o'z ichiga oladi: xizmat ko'rsatuvchilarning (haydovchilarning) kasbiga mutanosibligi (ish staji, malaka oshirganligi va shu kabilarni), transport vositalarining tashishni amalga oshirishga tayyorligi (qutqaruv vositalari bilan ta'minlanganligi, me'yoriy xujjatlar bilan ta'minlanganligi va shu kabilarni), transport vositasining o'z ishini bajarish ishonchligi, ya'ni yo'nalishda buzilmasdan ishlashi (resurs, ishlash muddati, buzilmasdan ishlash ehtimolligi va shu kabilarni). Zarur hollarda hisobga olinishi mumkin bo'lgan parametrlar guruhi (va parametrlar). **“Bagajlarni saqlash”** parametrlar guruhi quyidagilarni nazarda tutadi: jo'natilgan va buzilish bilan qabul qilingan bagajlarning foizi, bagajlarning buzilishidan olingan



yo'qotishlarning o'rtacha narxi, bagajlarning buzilishi o'rni qoplash narxi ko'rsatkichi.

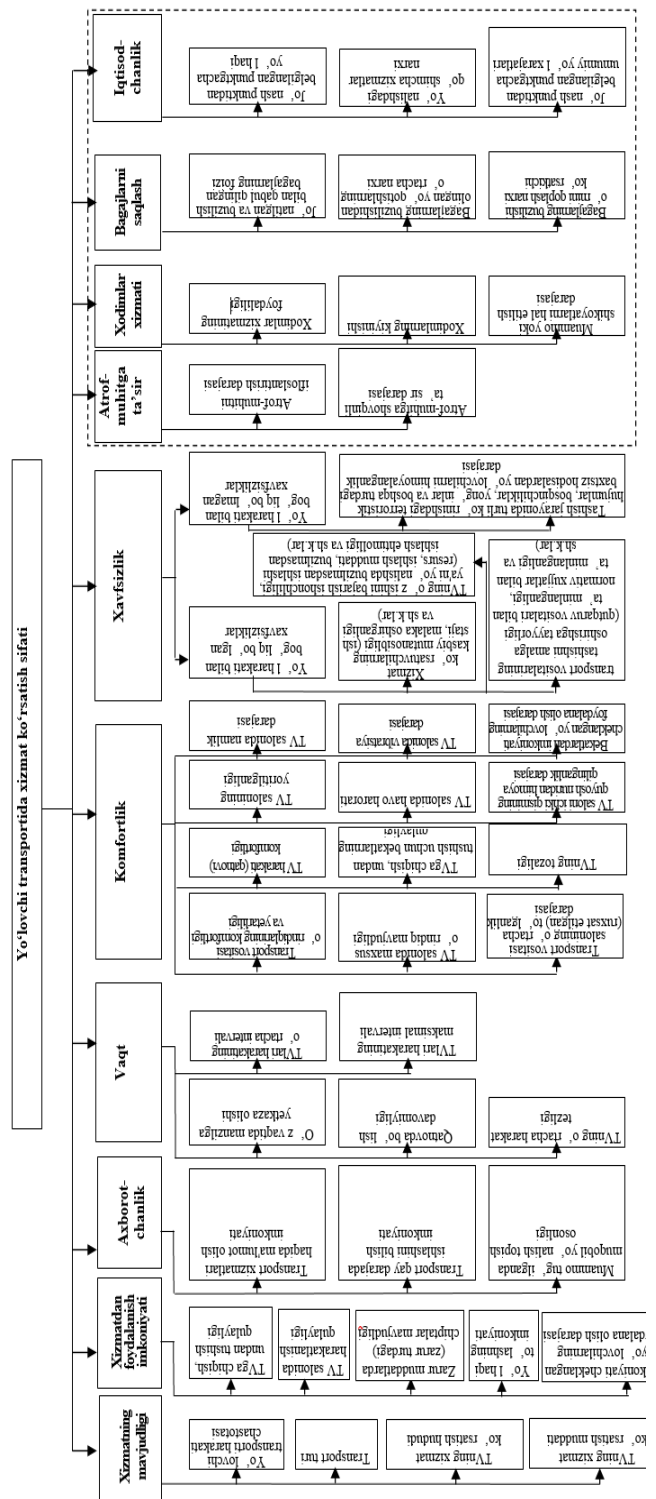
“Xodimlar xizmati” parametrlar guruhi xodimlar xizmatining foydaliligi, xodimlarning kiyinishi, muammo yoki shikoyatlarni hal etilish darajasi kabilarni nazarda tutadi.

“Atrof-muhitga ta'sir”ni hisobga oluvchi parametrlar guruhini atrof-muhitni ifloslantirish darajasi, atrof-muhitga shovqinli ta'sir darajasi kabilarni tashkil etadi.

“Iqtisodchanlik” parametrlar guruhi jo'nash punktidan belgilangan punktga yo'l haqi, yo'nalishdagi qo'shimcha xizmatlar narxi, jo'nash punktidan belgilangan punktga umumiy yo'l xarajatlari kabilarni o'z ichiga oladi.

Olib borilgan tadqiqotlar natijasida yo'lovchi transport xizmati sifatini belgilovchi tagtizimlar va ularning parametrlarining iyerarxik tuzilmasi 1-rasmda keltirilgan.

Yo'lovchilarga transport xizmati ko'rsatish sifat parametrlari guruhlarining og'irligi bo'yicha hisob natijalari 2-rasmda keltirilgan.



1-rasm. Yo'lovchi transportida xizmat ko'rsatish sifatining iyerarxik tuzilmasi







2-rasm. Yo'lovchi transporti xizmati sifatini belgilovchi parametrlar guruhlarining og'irlik ko'rsatkichlari

#### 4. Olingan natijalar muhokamasi

Amalda yo'lovchi transporti xizmati sifatini baholash mezonlarida harakat xavfsizligi parametri sifatida yo'l-transport hodisalari dinamik darajasi va unda yo'lovchining yo'qotadigan vaqti hisobga olingan.

$$K = \frac{1}{1 + \alpha B_0} \quad (2)$$

bu yerda:  $\alpha$  – yo'lovchining yo'l-transport hodisasi natijasida nisbiy yo'qotgan vaqti;  $B_0$  – yo'l-transport hodisasining dinamik darajasi ko'rsatkichi.

(2) ifodadan o'tgan davr uchungina foydalanish mumkin. Ammo, yangi ochilgan yo'nalishlarda qisqa davr ichida (masalan, 1 sutka) YTH sodir etilish ehtimolligi kamligi, shuningdek, yo'nalishlarda harakat sxemasi o'zgarishi, qolaversa, jamoat transporti yo'nalishida harakat xavfsizligiga ta'sir etuvchi parametrlarning o'zgaruvchanligi, ya'ni, (ko'rilayotgan davr ichida) yo'nalish sxemasi hududida yo'lovchilar ko'plab yig'iladigan ob'ekt hosil bo'lishi (yoki aksincha), oraliq bekatlarning soni o'zgarishi, yo'llarning kesishmalarida yoki peregona uchastkalarida yo'l harakatini tashkil etish texnologiyasining o'zgarishi (2) ifoda bo'yicha mukammal natija (ishonchli) olib bo'lmasligiga asos bo'ladi.

Jamoat transportining yo'nalish bo'yicha harakati xavfsizligini quyidagi ifoda yordamida aniqlash muallif tomonidan tavsiya etiladi,

$$K_{x_{ym}} = \sum_{i=1}^n K_i \quad (3)$$

bu yerda:  $K_i$  – kesishmalar, peregona va bekatlarning xavfsizlik koeffitsiyentlari.

$K_i$  har bir ob'ekt uchun alohida hisoblanib, tegishli ob'ektlarning umumiy koeffitsiyentini shakllantiradi,

masalan yo'nalishdagi barcha kesishmalarning yakuniy harakat xavfsizligi koeffitsiyenti quyidagiga teng bo'ladi.

$$K_{x_{ym}} = \sum_{j=1}^m K_j \quad (4)$$

Avtomobil yo'llarining bir sathli kesishmalari xavfliligi quyidagi ifoda orqali aniqlanadi,

$$K_a = \frac{10^7 G K_{\bar{a}}}{25(M+N)} \quad (5)$$

bu yerda:  $G$  – 1 yilda;  $M, N$  – asosiy va ikkinchi darajali yo'llardagi transport vositalari harakati jadalligi, avt./sutka;  $K_{\bar{a}}$  – ziddiyatli nuqtalarning nisbiy halokatlilik; 25 – kunlarning o'rtacha sonini yilga ta'sirini hisobga oluvchi koeffitsiyent.

(5) ifodada sodir etilishining nazariy ehtimoligida faqat transport vositalari nazarda tutulgan, vaholangki yo'l-transport hodisalari piyodalar, velosipedchilar hamda aravalar ishtirokida ham sodir etilishi mumkin. ishtirokida ham sodir etilishi mumkin. Shu nuqtai-nazardan mavjud (5) ifoda muallif tomonidan quyidagicha takomillashtirildi,

$$K = \frac{10G_{TB}K_{\bar{TB}}}{\alpha(M_{TB}+N_{TB})} + \frac{m_{\pi}K_{\pi}G_{TB\pi}K_{\bar{\pi}}}{\alpha(M_{\pi}+N_{\pi})} + \frac{m_{B}K_{B}G_{TB\pi}K_{\bar{B}}}{\alpha(M_{B}+N_{B})} + \frac{m_{a}K_{a}G_{TBa}K_{\bar{a}}}{\alpha(M_{a}+N_{a})} \quad (6)$$

bu yerda:  $G_{TB}$  – 1 yilda transport vositalarining o'zaro ziddiyatli nuqtalarida yo'l-transport hodisalari sodir etilishining nazariy ehtimolligi;  $G_{TB\pi}$  – 1 yilda transport vositalari va piyodalarning o'zaro ziddiyatli nuqtalarida yo'l-transport hodisalari sodir etilishining nazariy ehtimolligi;  $G_{TB\pi}$  – 1 yilda transport vositalari va velosipedchilarning o'zaro ziddiyatli nuqtalarida yo'l-transport hodisalari sodir etilishining nazariy ehtimolligi;  $G_{TBa}$  – 1 yilda transport vositalari va aravalarining o'zaro ziddiyatli nuqtalarida yo'l-transport hodisalari sodir etilishining nazariy ehtimolligi;  $K_{\bar{TB}}$  – transport vositalari harakatining yillik notekislik koeffitsiyenti;  $K_{\bar{\pi}}$  – piyodalar harakatining yillik notekislik koeffitsiyenti;  $K_{\bar{B}}$  – velosipedchilar harakatining yillik notekislik koeffitsiyenti;  $K_{\bar{a}}$  – aravalar harakatining yillik notekislik koeffitsiyenti;  $M_{TB}, N_{TB}$  – asosiy va ikkinchi darajali yo'llardagi transport vositalari harakati jadalligi;  $M_{\pi}, N_{\pi}$  – asosiy va ikkinchi darajali yo'llardan chorrahani kesib o'tuvchi piyodalar harakati jadalligi;  $M_{B}, N_{B}$  – asosiy va ikkinchi darajali yo'llardan chorrahani kesib o'tuvchi velosipedchilar harakati jadalligi;  $M_a, N_a$  – asosiy va ikkinchi darajali yo'llardan (kesib) o'tuvchi aravalar harakati jadalligi;  $m_{\pi}$  – chorrahadan 10 mln. transport vositasi o'tgunga qadar, undan o'tadigan piyodalar harakati jadalligi;  $m_{B}$  – chorrahadan 10 mln. transport vositasi o'tgunga qadar, undan o'tadigan velosipedchilar harakati jadalligi;  $m_a$  – chorrahadan 10 mln. transport vositasi o'tgunga qadar, undan o'tadigan aravalar harakati jadalligi;  $K_{n,\pi}$  – chorrahadan 10 mln. transport vositasi o'tgunga qadar, undan o'tadigan piyodalar harakati jadalligini tekislovchi koeffitsiyent;  $K_{n,B}$  – chorrahadan 10 mln. transport vositasi o'tgunga qadar, undan o'tadigan velosipedchilar harakati jadalligini tekislovchi koeffitsiyent;  $K_{n,a}$  – chorrahadan 10 mln. transport vositasi o'tgunga qadar, undan o'tadigan aravalar harakati jadalligini tekislovchi koeffitsiyent.

#### 5. Xulosa

Mamlakatimizda yo'lovchilarga transport xizmati ko'rsatish sifatini aniqlashda 1-rasmda keltirilgan



parametrlar guruhi (va parametrlar) asos qilib olinishi lozim.

Yo'lovchi transporti xizmati sifatini aniqlovchi parametrlar guruhlari og'irlik koeffitsiyentlari aniqlanganda barcha asosiy parametrlar guruhlari qiymatlari zarur hollarda hisobga olinishi mumkin bo'lgan parametrlar guruhlari qiymatlaridan yuqori ekanligi aniqlandi.

Avtomobil yo'llarining bir sathli kesishmalari xavfliligini baholash piyodalar, velosipedchilar va aravalar ishtirokida sodir etilishi mumkin bo'lgan yo'l-transport hodisalarining nazariy ehtimolligini hisobga olish evaziga takomillashtirildi.

Keyingi tadqiqotlar transport vositalari, piyodalar, velosipedchilar va aravalar harakatining yillik notekislik koeffitsiyenti, chorrahadan 10 mln. transport vositasi o'tgunga qadar, undan o'tadigan piyodalar, velosipedchilar harakati jadalligini tekislovchi koeffitsiyentlarni ishlab chiqish hamda chorrahaning xavfliligiga ta'sir etuvchi ko'rsatkichlarning bog'liqligini aniqlashga, shuningdek, oraliq bekatlar va peregon uchastkalar xavfsizligini baholash usulini ishlab chiqishga yo'naltiriladi.

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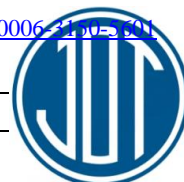
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## Mualliflar to'g'risida ma'lumot/ Information about the authors

Abdullaev Botir PhD, доцент, Ташкентский  
Inatovich государственный транспортный  
университет  
[mrabotir@mail.ru](mailto:mrabotir@mail.ru),  
+998946994152  
<https://orcid.org/0009-0006-4107-9201>



# Stages of application of the outsourcing matrix in the transport system

N.Sulaymonov<sup>1</sup><sup>a</sup>, M. Ikromov<sup>1</sup><sup>b</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** This article discussed the sequence of steps of using the outsourcing matrix in the transport system. Outsourcing is a popular strategy in the transportation system, as it seeks to determine the processing and efficiency of companies. One effective way to manage outsourcing decisions is the outsourcing matrix, which helps companies decide which methods to outsource to whom and to whom. The use of the outsourcing matrix in the transport system is analyzed, scientific-methodical and practical suggestions and recommendations are given.

**Keywords:** outsourcing matrix, transport system, cost reduction, efficiency, decision-making outsourcing.

## 1. Introduction

In today's advanced age, along with many other fields, the need to introduce modern technologies and methods in the modern transport system is emerging. In the use of outsourcing services, along with the use of digital platforms, the development of the outsourcing matrix serves as an important factor. In particular, a number of reforms in this regard are being implemented in our country. Republic of Uzbekistan. Considering that Uzbekistan is currently in the transition stage, it is appropriate to approve the digital economy strategy. Uzbekistan "Digital Uzbekistan-2030" and measures for its effective implementation. Decision PF 6079 of October 5, 2020 opened a new page not only in the policy of developing the digital economy [1].

Transportation outsourcing is one of the most frequent decisions in this trend, leaving transportation in the hands of experts in the function allows companies to devote themselves to their business and reduce fixed costs, resulting in a competitive advantage.

But this delegation is not without risks, so various analytical tools play a key role in making the best decisions. Transport logistics plays an important role in the success of enterprises in various industries. Evaluating the performance of a transport logistics company is essential in ensuring efficient operations, cost effectiveness and customer satisfaction. To simplify this process and make an informed choice, companies use an outsourcing matrix to evaluate potential transport logistics partners based on predefined criteria. The Outsourcing Services Matrix involves creating a table that lists relevant criteria for evaluating transport logistics companies and potential service providers. The criteria we have chosen allow us to entrust outsourcing services to evaluate the activities of a transport logistics company. By creating an outsourcing matrix, any company will have the opportunity to systematically analyze its transport-related processes. Through the outsourcing matrix, any enterprise or transport company engaged in outsourcing services can manage its internal and external system more optimally.

## 2. Literature review

Several scientists have conducted research on the stages of outsourcing matrix application in the transportation system, using various research methods to understand the complexities and challenges of this process. One of the key researchers in this field is Dr. Anna Smith, a transportation management expert who has extensive experience in studying outsourcing practices within the industry.

Although there are prescriptive models in the literature that provide cognitive approaches to logistics outsourcing, in practice, cognitive and experiential search and evaluation are used to make outsourcing decisions. International scholars Mello J. E, Esper T. L and Stank T. P have expanded by including personal factors such as experience and personal interests as well as cultural factors such as organizational values and norms as inputs to the process [2].


In addition, Asian scientists Scientists Li Y., Liu X., Chen Y. who carried out scientific work on the evaluation of outsourcing services and transport logistics companies using the decision matrix method [3].

In addition, in their articles, international scientists Fu S., Yu Y., Xu M. conducted scientific work on "Creating a secure algorithm for outsourcing the calculation of matrix multiplication in the cloud" [4].

## 3. Research methods and the Received results

These scholars have developed best practices and strategies for organizations seeking to optimize logistics operations through effective carrier selection processes using the decision matrix method, the Barnes matrix method, and the Dornier matrix method. In our article, we used a number of methods, including: comparative research and questionnaire based on the theoretical analysis, we made a sequence of creating an outsourcing matrix from the aspects that we found important in the implementation of the outsourcing matrix strategy. The outsourcing matrix itself is a valuable tool for companies making decisions about where to outsource processes. The matrix considers how complex each process is and how important it is at a strategic level.

<sup>a</sup> <https://orcid.org/0009-0001-8201-0944>

<sup>b</sup> <https://orcid.org/0009-0009-6282-7111>



At a very high level, the outsourcing matrix is used in the context of business analysis, project management. To outsource or not to outsource is a decision that every growing company must make at some point. An impact matrix can help. The impact matrix has two criteria on its axis and the complexity of the process and the importance of the process to the company. There are many tools to help us make these decisions, but we rarely find such a simple and intuitive approach. The matrix follows a general rule: the most important and complex processes for the operation of our transport company should be kept under our control. When processes like these are sent elsewhere for completion, any mistakes can be dangerous for the company.

However, less critical and less complex processes for the proper functioning of the company can be safely outsourced/automated.

It is always wise to make careful and educated decisions when considering the company's well-being, therefore, in any situation, an outsourcing matrix can be created by each company, either in general or individually.

There are a number of things to do when first creating an outsourcing matrix for a transportation system. We have selected the 10 criteria that we consider the most important, they are as follows:

1. Identify key functions or activities in the transportation system that can be outsourced, such as maintenance, logistics, fleet management, or customer service;

2. Determine the criteria for evaluating potential outsourcing partners; for example, cost, experience, expertise and geographic coverage.

3. Create a matrix with identified functions or activities on one axis and evaluation criteria on the other;

4. Research and gather information about potential outsourcing partners who provide services related to the specified functions or activities;

5. Evaluate each potential outsourcing partner according to the criteria in the matrix, assigning a score or rating for each criterion;

6. Rank potential outsourcing partners based on their overall score or rating;

7. Choose an outsourcing partner that best meets the criteria and requirements of the transport system;

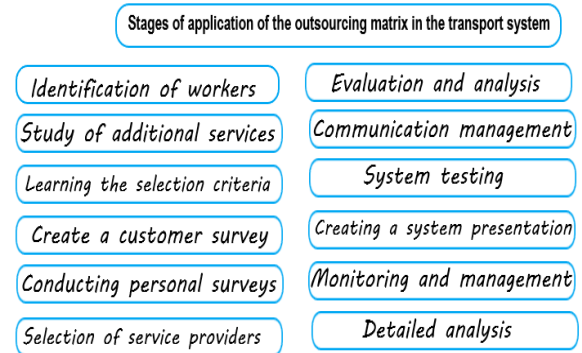
8. Negotiating an outsourcing contract with the selected partner that specifies the scope, terms and conditions and performance indicators;

9. Regularly monitor and evaluate the outsourcing partner's performance to ensure compliance with agreed standards and expectations;

10. Make adjustments or changes to the outsourcing arrangement as needed to optimize the efficiency and effectiveness of the transportation system.

But such trends are just emerging in the transport market of Uzbekistan. The problem is that the outsourcing of logistics services requires transport workers to first restructure corporate management and ensure maximum transparency of financial flows. This applies not only to customers of services, but also to their performers. Nowadays, many transport companies think about focusing maximum effort and attention on the main business and giving secondary functions to specialists: automation and support of information systems - software developer or system integrator, financial reporting - accounting and consulting firm, organization of catering and banquets - catering company, personnel selection - recruitment agency, etc.

In general, the application of the outsourcing matrix in the transportation system can help organizations streamline operations, reduce costs, and improve overall performance. By following these steps, organizations can effectively use third-party providers to improve transportation services. Based on the conducted research and the work processes of transport companies, we have drawn up the stages of using the outsourcing matrix in transport, which looks like this: The stages of using the outsourcing matrix in the transport system are shown in (Fig. 1)



**Fig.1. Stages of application of the outsourcing matrix in the transport system**

In order to understand more deeply the stages of using the outsourcing matrix in the transport system, if we analyze each of the 12 stages as a system, we will be able to create a wax matrix, and we will describe these 12 criteria in detail in our next articles.

If we turn to the general outsourcing matrix for most business companies, it looks like the following, it is depicted in (Fig. 2)



**Fig. 2. Outsourcing matrix**

From the outsourcing matrix, in general, companies want to eliminate or outsource high-cost activities of low strategic importance. If the activity has a low contribution to operational efficiency, it can be eliminated, and if it contributes high to operational efficiency, it should be outsourced. wants to control the activities that have. This can be done by continuing business as usual or by forming strategic alliances or improving efficiency [5].

In most cases, the way to do this is to reduce costs as much as possible. Common cost reduction methods include:

1. Procurement: consolidation of purchases or revision of supply contracts;

2. HR management: reduce labor costs through salary, training, overtime, benefits and health, employee stock ownership and downsizing;

3. Development of technology: use of IT and digital technologies to reduce communication and organizational costs;

Use advanced production technology;





4. Logistics: cooperate with distribution companies (such as FedEx).

5. Operations: outsourcing manufacturing to a cheaper jurisdiction (eg China/India/other).

Increase the level of use of fixed assets;

Move the headquarters to a cheaper city, region or country.

6. Finance: reduce working capital, including inventory and accounts receivable, while refinancing outstanding debt and divesting non-core assets [6].

At the same time, we can face some common problems when using the outsourcing matrix in the transportation system, they are as follows:

1. Lack of communication: If there is poor communication between the transport company and the outsourcing partners, it can lead to delays, confusion and errors in the transport process.

2. Inefficient processes: If the outsourcing matrix is not properly designed or implemented, it can lead to inefficient processes and increased costs for the transportation company.

3. Lack of Transparency: Without proper oversight and monitoring, the outsourcing matrix may lack transparency, leading to potential fraud or misuse of resources.

4. Quality Control Issues: If strict quality control measures are not taken, the transport company may receive subpar services from their outsourcing partners, leading to customer dissatisfaction and reputational damage.

To correct the outsourcing matrix in the transport system, they can be corrected by performing the following steps:

1. Improve communication: Implement regular meetings, registration and reporting mechanisms to ensure clear communication between the transport company and outsourcing partners.

2. Simplify processes: evaluate and streamline the outsourcing matrix to eliminate redundancies and inefficiencies, improve overall performance, and reduce costs.

3. Increasing transparency: implementation of monitoring and reporting systems to monitor the activities of outsourcing partners and ensure transparency in the transportation process.

4. Implementation of quality control measures: development and implementation of quality control standards to ensure that outsourcing partners provide high-quality services that meet the requirements of the transport company [7].

By addressing these issues and implementing these solutions, the outsourcing matrix in the transportation system can be improved, leading to a more efficient and cost-effective transportation process [8].

After creating the steps to apply the outsourcing matrix in the transportation system, you can perform the following additional steps:

1. Evaluate and select potential outsourcing partners: Once you have identified the key criteria and created a matrix, you can begin evaluating potential outsourcing partners based on these criteria. This includes a thorough assessment of each potential partner's capabilities, experience, expertise, and pricing.

2. Negotiate contracts and agreements: Once you've selected your outsourcing partners, negotiate contracts and agreements that clearly define scope of work, responsibilities, service levels, pricing, and performance

metrics. negotiation is important. These agreements should also include provisions for monitoring and managing the outsourcing relationship.

3. Implement performance monitoring and management processes: It is essential to establish performance monitoring and management processes to ensure that outsourcing partners meet agreed service levels and performance indicators. Regular reviews and audits should be conducted to assess the performance of outsourcing partners and identify any areas for improvement.

4. Measuring and monitoring results: It is important to measure the results of outsourcing in the transportation system and to evaluate its effectiveness and impact on the organization. Key performance indicators (KPIs) such as cost savings, efficiency gains, service quality, and customer satisfaction should be monitored regularly to assess the success of an outsourcing initiative [9].

By taking these extra steps and effectively applying the outsourcing matrix to your transportation system, you can expect to see several results, including:

- Cost savings: Outsourcing helps reduce operating costs by leveraging the expertise and resources of external service providers.

- Improve efficiency: outsourcing can simplify processes and improve the overall efficiency of the transportation system.

- Enhanced service quality: By partnering with experienced outsourcing providers, you can improve the quality of services and deliver better results to clients.

- Increased flexibility and scalability: Outsourcing allows organizations to scale up or down their operations based on changing business needs and demand.

- Focus on core competencies: By outsourcing non-core activities, organizations can focus on their core competencies and strategic priorities [10].

Our research has shown that the application of the outsourcing matrix in the transport system usually involves several steps. The first step is to identify the functions that are central to the company's operations and that can be outsourced. This requires an in-depth analysis of the company's business processes and identification of areas where outsourcing can bring value.

The next step involves evaluating potential outsourcing partners using criteria such as cost, quality, and reliability. Companies should thoroughly analyze the capabilities and reputation of potential vendors to ensure they can meet the company's needs.

Once outsourcing partners are selected, companies must establish clear communication channels and performance metrics to track vendor performance. Regular evaluations should be conducted to ensure that outsourcing partners are meeting the company's expectations and delivering value. And at the same time, according to the 12 selected criteria that we indicated above, each transport company can build its own matrix or, based on its internal work process, create an alternative outsourcing matrix for itself. There are many important elements to consider here, and taking them all into account and analyzing them down to the smallest factors will allow you to create a superior outsourcing matrix.





## 4. Conclusion

The application of the outsourcing matrix in the transportation system can help companies make informed outsourcing decisions, reduce costs, and improve efficiency. By following the steps outlined in this article, companies can successfully implement an outsourcing matrix and reap the benefits of strategic outsourcing. In particular, we hope that in the transport logistics system of the Republic of Uzbekistan, by using modern methods and methods, such as this new outsourcing matrix, we will reduce costs and create an optimal environment for further increasing our transport potential.

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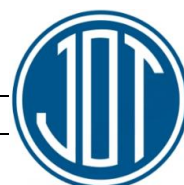
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## Information about the authors

Sulaymonov Nazar Normurod o'g'li / Suaymonov Nazar Normurod o'g'li	Toshkent davlat transport universiteti "Transport logistikasi" kafedrası doktoranti, E-mail: tipratikann1808@gmail.com Tel.:+998930470044 <a href="https://orcid.org/0009-0001-8201-0944">https://orcid.org/0009-0001-8201-0944</a>
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Ikromov Muzaffar Dilmurod o'g'li /Ikromov Muzaffar Dilmurod o'g'li	Toshkent davlat transport universiteti "Transport logistikasi" kafedrası doktoranti. E-mail: muzaffarikromov1997@gmail.com Tel.:+998911190105 <a href="https://orcid.org/0009-0009-6282-7111">https://orcid.org/0009-0009-6282-7111</a>
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## Study of mechanical properties of modified sulfur polymer composite

U.A. Ziyamukhamedova<sup>1</sup><sup>a</sup>, J.H. Nafasov<sup>1</sup><sup>b</sup>, G.B. Miradullaeva<sup>1</sup><sup>c</sup>, M.U. Rustamov<sup>2</sup><sup>d</sup>,  
N.F. Maxamadiyeva<sup>1</sup><sup>e</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

<sup>2</sup>Worker at "Industrial Energy Group" LLC, Mubarak, Uzbekistan

**Abstract:** In this article, the effect of modified dispersed and fibrous fillers on the mechanical and operational properties of sulfur-based concrete is studied, and the optimal time and method of modification are determined. The obtained results were compared with M450 heavy concrete, which is currently used in the production of reinforced concrete sleepers for railway transport.

**Keywords:** Sulfur concrete, modification, glass fiber, dispersed filler.

## Modifikatsiyalangan oltingugurt polimer kompozitning mexanik xossalarini tadqiqotlash

Ziyamuxamedova U.A.<sup>1</sup><sup>a</sup>, Nafasov J.H.<sup>1</sup><sup>b</sup>, Miradullaeva G.B.<sup>1</sup><sup>c</sup>, Rustamov M.U.<sup>2</sup><sup>d</sup>,  
Maxamadiyeva N.F.<sup>1</sup><sup>e</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Toshkent, O'zbekiston

<sup>2</sup>Sanoat Energetika Guruhi MChJ XK Muborak XChK, Muborak, O'zbekiston

**Annotatsiya:** Ushbu maqolada oltingugurt asosli betonning mexanik va ekplutatsion xossalarini ta'minlashda modifikatsiyalangan dispers va tolali to'ldiruvchilarning ta'siri o'rganilgan, hamda modifikatsiyalashning optimal vaqti va usuli aniqlangan. Olingan natijalar bugungi kunda temir yo'l transporti temir-beton shpalalarini ishlab chiqarishda qo'llanilib kelinayotgan M450 markali og'ir beton bilan solishtirilgan.

**Keywords:** Oltingugurt beton, modifikatsiyalash, shisha tola, dispers to'ldiruvchi.

### 1. Kirish

Xozirgi kunda, chet elda va mamlakatimizda xar xil sharoitda va soxalarda ishlovchi kompozit materiallarni yangi tarkiblarini va ularni mexanik xossalarini oshirish uchun kimyoviy, fizik va mexanik modifikatsiyalash usullari bo'yicha tadqiqotlar olib borilmoqda. Bunda termoplast materiallarning molekulyar tuzilishi va qatlamlararo strukturaning shakllanishi o'ziga xos xususiyatlariga mos ravishda modifikatsiyalash usullari tarkibiy komponentlarga, olish texnologiyasiga va shu kabi boshqa omillarga bog'likligini tadqiqotlash bilan energiya tejamkor, ekologik toza, mustaxkam, ekspluatatsion sharoitlarni inobatga olgan xolda mustaxkam yangi materiallar yaratish va ularni amalda qo'llash uchun real ekspluatatsion sharoitda sinash orqali uni chidamliligini, dinamik yuklanishlarni materialning mexanik mustahkamligi va ishonchligiga ta'sirini aniqlash dolzarb muammo bo'lib kelmoqda.

Qariyb o'n asrdan beri insonlar tomonidan foydalanib kelinayotgan beton – shag'al, qum, maydalangan toshlar, Portland sement, suv kabi materiallar aralashmasi hisoblanadi. Beton ishlab chiqarish sanoati yillar o'tgan sayin rivojlanib bormoqda.

Bugungi kunda betonning bir qancha modifikatsiyalangan turlari yaratilgan bo'lib, polimer-beton, sement-beton, temir-beton, qo'rg'oshin-beton va oltingugurt-beton shular jumlasidandir. Yuqorida keltirilgan turlardan oltingugurt-beton boshqa beton turlaridan o'zining agressiv muhitlardagi ekspluatatsion, mexanik va fizik xossalari bilan ajralib turadi.

Oltingugurt beton – zamonaviy kompozitsion material bo'lib, u inert agregatlar va konstruktiv mustahkamlash funksiyalarini bajaradigan to'ldiruvchi moddalarni o'z ichiga oladi. Oltingugurt asosida tayyorlangan kompozitlar, shu jumladan oltingugurt beton ham termoplast material hisoblanadi. Oltingugurtning bunday xossalari vareaksiyon xossalarini inobatga olib undan polimerlanish jarayonida

<sup>a</sup>  <https://orcid.org/0000-0001-5005-0477>

<sup>b</sup>  <https://orcid.org/0000-0002-0415-2584>

<sup>c</sup>  <https://orcid.org/0009-0006-6959-8153>

<sup>d</sup>  <https://orcid.org/0009-0008-1440-5988>

<sup>e</sup>  <https://orcid.org/0009-0004-7984-7403>



struktura shakllanishida to'ldiruvchi va bog'lovchi orasidagi fizik kimyoviy jarayonlarni tadqiqotlash asosida bu materialdan yuqori mustahkamlikka ega bo'lgan konstruksiyalar, issiqlik izolyatsiya xususiyatli materiallar va yuqori agressiv muhitlarga bardoshli materiallar olish mumkin.

Oltinugurt elementining funksional imkoniyatlarining yuqoriligiga qaramay hozirgi kunda materiallar olish imkoniyatlari olimlar tomonidan to'liq o'rganilib chiqilmagan. Yevropa olimlari olib borgan ilmiy izlanishlar natijasiga ko'ra oddiy oltinugurt betonga nisbatan modifikatsiyalangan oltinugurt beton xossalari bir qator afzalliklarga ega. Bunga ko'ra oltinugurt polimer beton modifikatori portland sementga qaraganda ishqalanishga qarshilik, bosim, egilish kabi xususiyatlari yuqori. Oddiy betonga nisbatan charchoqqa chidamli bo'lib, takroriy yuklarga bardoshli hisoblanadi. Oltinugurt polimer beton modifikatori qariyb 50 yildan beri qishloq xo'jaligi va oziq ovqatni qayta ishlash zavodlarida, qoplamlar sifatida, quvur liniyalarini ushlab turuvchi vosita sifatida, sanoatda keng ko'lamda foydalanib kelinmoqda [1].

O'zbek olimlari tomonidan olib borilgan tadqiqotlarda neft gaz korxonalarida ikkilamchi xom ashyo sifatida hosil bo'ladigan oltinugurdan oltinugurt beton ishlab chiqarishda bog'lovchi sifatida foydalanilgan hamda portlandsement asosli beton bilan solishtirilgan. Natijada olingan yangi tarkibli oltinugurt betonning o'rtacha zichligi portlandsement asosli betonning zichligidan 4-5% ga, hamda siqilishdagi mustahkamligi 2-2,5 martaga, egilishdagi mustahkamligi esa 1,5-2 barobarga yuqorroq ekanligi aniqlangan. Oltinugurt tutgan beton portlandsement bog'lovchisi asosidagi betonlardan kam bo'lmagan arzon va yuqori samarali betonlar va mahsulotlarni olish imkonini bergan [2].

Ushbu ilmiy izlanishlarda modifikatsiyalangan oltinugurtdan asos sifatida foydalanish materialning mexanik xossalari yaxshilaganligi keltirib o'tilgan. Ammo modifikatsiyalashning turi va madifikatsiyalash parametrlarining material xossalari va struktura hosil bo'lish jarayonlariga ta'siri o'rganilmagan.

Adabiyot manbalarini ko'rib chiqish shuni ko'rsatadiki, gazni qayta ishlash chiqindilari (oltinugurt) asosida mexanik xossalari yaxshilangan materiallar turli sohalarida keng qo'llaniladi. Bunday materiallarga talablarning ortib borishi, ayniqsa, ularning ishlashi, turli xil agressiv muhitlarga qarshilik, shuningdek, suv o'tkazmasligi bilan bog'liq soxalarda istiqbolli bo'lib qolmoqda. Bunday materiallar gazni qayta ishlash va gaz-kimyos korxonalarida gazni tozalash davrida ko'plab miqdorda ajralib chiqayotgan oltinugurt asosida olinishi mumkin bo'lgan oltinugurtli organomineral polimer kompozit materialdan foydalanish bir nechta muhim muammolarni hal qilishi mumkin [3]:

- mamlakat qurilish bozorini yuqori mustahkamlikka ega bo'lgan mahsulotlar bilan ta'minlash;
- ekspluatatsion ishonchlilikni oshirib, buyumning dizaynini ta'minlovchi materiallar tannarxini kamaytirish;
- mexanik yuklanishlarga va agressiv kimyoviy muhitlarga bardoshlilikni oshirish hisobiga konstruksiyalarning tannarxini kamaytirish;
- texnik oltinugurti utilizatsiya qilish hisobiga atrof-muhitga zararli ta'sirlarini kamaytirish.

Organomineral kompozit polimer materiallardan konstruksiyalarini ishlab chiqarish an'anaviy keramik kompozit materiallardan konstruksiyalar ishlab chiqarish bilan solishtirganda CO<sub>2</sub> emissiyasini 40% ga kamaytirishga olib keladi. Bu katta miqdorda karbonat angidrid gazi ajraladigan, mineral oxaktoshlarni sementga aylantirishda

sarf bo'ladigan energiyani, boshqa maqsadlarga yo'naltirish imkonini beradi. Bundan tashqari organomineral kompozit materiallarni olish uchun 140 °C harorat yetarli bo'ladi. Sement ishlab chiqarishda esa 1400 °C harorat talab etiladi.

## 2. Tadqiqot metodikasi

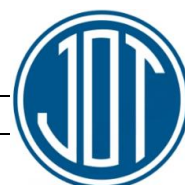
Tadqiqotlar natijasida olingan modifikatsiyalangan to'ldiruvchilar bilan boyitilgan oltinugurt beton namunalari mexanik va ekspluatatsion x<sup>os</sup>salari bugungi kunda qo'llanilib kelinayotgan M450 markali og'ir beton turlari bilan solishtirildi.

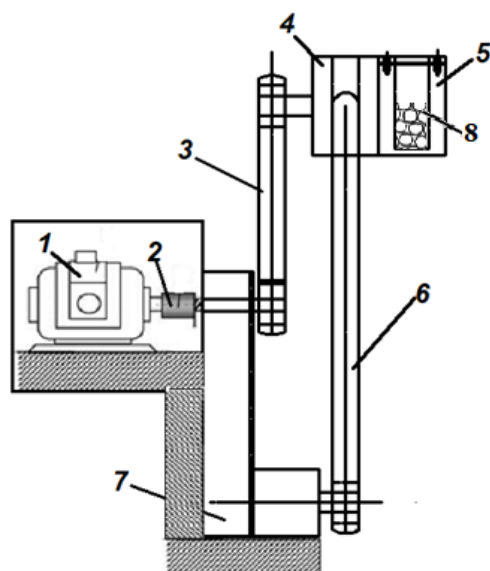
Namunalar tayyorlashda foydalanilgan dispers to'ldiruvchilarning sirt yuzalari faolligini oshirish uchun vibroplanetar faollashtirgichdan foydalanildi (1-rasm). Vibroplanetar faollashtirgichning mavjud analoglaridan farqi shundaki, ushbu faollashtirgichda to'ldiruvchi zarrachalariga bir vaqtning o'zida turli yo'nalishlarda koriolis kuchini ta'sir ettirib sirt yuzalarini yaxshiroq faollashtirish imkoniyati mavjud. To'ldiruvchi sifatida material tarkibiga kiritilgan faol dispers zarrachalar mexanik faollashtirish jarayonida ikkilamchi Van-der Vaals va vodorod bog'larini hosil qilib, geterosistemadagi strukturaviy bog'lanishlarni yaxshilaydi.

Mexanik faollashtirilgan to'ldiruvchilar va qum-shag'al aralashmasini oltinugurt bilan birganlikda 140 – 160 °C haroratda qizdirib aralashtirish uchun "IN-test" MLA-20 markali aralashtirish qurilmasidan foydalanildi. MLA-20 laboratoriya aralashtirgichining texnik ko'rsatgichlari 1-jadvalda keltirilgan.

1-jadval  
MLA-20 laboratoriya aralashtirgichining texnik ko'rsatgichlari

№	Nomlanishi	Miqdori
1	Aralashtirish kamerasi sig'imi	10 l
2	Haroratni nazorat qilish aniqligi	± 3 °C
3	Aralashtirish vaqti	1 - 9999 sekund
4	Aralashtirgich tezligi	48 ayl/min.
5	Harorat	10°C ÷ 400°C
6	Nasby namlik	< 80%





1 – rasm. Vibroplanetar mexanik faollashtirgich sxemasi

1 – elektrodvigatel; 2 – bog‘lovchi mufta;  
3- aylantiruvchi richag; 4- tosh; 5 – mexanik faollashtirgich; 6 – yo‘naltiruvchi richag; 7 – korpus;  
8 – maydalovchi jism.

MLA-20 aralashtirgichda 160 °C haroratda 15 daqiqa davomida aralashirilgan oquvchan holatdagi aralashma,

### 3. Natijalar va muhokamalar

Tadqiqodlar uchun mayda va yirik qumning mos ravishda 1:3 nisbatdagi aralashmasi, O‘z DSt 127.1-93 bo‘yicha granulalangan texnik oltingugurt hamda tarkibida 60,68% [4] kremnizem saqllovchi “Olmaliq kon



a



b



c

3-rasm. Namunalar tayyorlash uchun xom ashyo materiallari:

a) qum-shag‘al; b) oltingugurt; c) kremnizem

Qum-shag‘al aralashmasi 170 °C haroratda 15 daqiqa davomida qizdirilib aralashma tarkibidagi namliklar yo‘qotildi, so‘ng modifikatsiyalovchi kremnizem qo‘shilib hajm bo‘ylab bir xilda taqsimlangunga qadar aralashtirildi. Haroratni 150°C gacha tushirib, aralashmaga oltingugurt qo‘shildi va suyaq faza hosil bo‘lgunga qadar aralashtirildi. Aralashma to‘liq oquvchan

o‘lchamlari 100×100×100 mm bo‘lgan qoliplrga qo‘yilib, 24 soat davomida havoda quritildi. Olingan namunalarning mexanik yuklanishlarga bardoshlilik xossalari pressda (2 - rasm) aniqlandi.



2 - rasm. E160PN181 Markali gidravlik pressing umumiy ko‘rinishi

metallurgiya kombinati”da mis ishlab chiqarish jarayonida hosil bo‘ladigan chiqindidan modifikator sifatida foydalanildi (3-rasm).





4-rasm. Kub shaklidagi namunalarni siqilishga sinash

2 - jadval.

Oltिंगugurt beton namunalarni laboratoriya sharoitida fizik-mexanik sinovlari natijalari

Namuna raqami	Shixta tarkibi, mas. %				Zichlik, g/sm <sup>3</sup>	Suv shimishi, mas. %	Yuklanish, MPa
	Oltिंगugurt	Qum	Shag'al	Kremnezim			
№1	30	60	10	2	0,792	0,0006	22,006
№2	50	10	35	5	0,493	0,0004	18,953
№3	30	15	50	5	0,634	0,0006	32,679
№4	30	20	45	5	0,704	0,0006	43,087
M450 markali beton (GOST 26633-2012)					2,5	< 0,038	44,95

Tadqiqotlar shuni ko'rsatdiki organomineral oltिंगugurt polimeri kompozit material olish jarayonida to'ldiruvchilarni sirt yuzalaridagi namlikni yo'qotish maqsadida ularni 150-170 °C gacha qizdirib unga vibro planetar aktivatorida faollashtirilgan oltिंगugurt kukuni qo'shilganda, dastlab oltिंगugurt suyuq holatga o'tadi. Komponentlarni aralashtirish jarayonida harorat 170°C dan oshgandan oltिंगugurtning polimerizatsiya jarayoni yuz berib, aralashma quyulish holati kuzatildi. 2-jadvalda keltirilgan 1 va 2 namunalar kompozitsiyada polimerlanish jarayoni boshlanishidan oldin suyuq holatda quyilgan namunalardir. 3 va 4 namunalar esa 180 °C haroratgacha qizdirilib kompozitsiya quyulish holatga o'tgandan so'ng qoliplarga quyib olingan.

Kompozitsiya tarkibiga to'ldiruvchi sifatida 5% miqdorda kremnezimning qo'shilishi, to'ldiruvchi zarrachalarining o'ziga xos sirt maydoni tufayli tarkibni yuqori darajadagi to'ldirishga, bundan tashqari modifikatsiyalangan kompozitsiyalarining reologik xususiyatlarini yaxshilashga, yuqori elektr izolyatsiyasiga (kam ifloslik tufayli) va modifikatsiyalangan kompozitsiyalarni yuqori mexanik xususiyatlarga erishish imkonini beradi [5-8].

Materialning suv singish xususiyati uning tarkibidagi bog'lovchining miqdoriga bog'liq bo'lib, unga teskari proporsional ravmda o'zgarishini ko'rishimiz mumkin.

#### 4. Xulosa

Olingan natijalar va eksperimental tadqiqotlarning chuqur ilmiy tahlili asosida xulosa qilish mumkinki, tarkibida 30% miqdorda oltिंगugurt bog'lovchi, 20% qum, 45% sheben va 5% miqdorda kremnezim bo'lgan kompozitsion materialning siquvchi kuchlanishga mustahkamligi M450 markali sement mustahkamligiga yaqin. Demak oltिंगugurt asosli kompozit material olishda harorat muhim ahamiyatga ega bo'lib, aralashmada polimerizatsiya boshlangandan keyin olingan materiallar nisbatan mustahkamligi yuqori bo'ladi

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**Mualliflar haqida ma'lumot /  
Information about the authors**

Ziyamuxamedova Umida Alijonovna/  
Umida Ziyamukhamedova  
Toshkent davlat transport universiteti  
"Materialshunoslik va mashinasozlik"  
kafedrası professori. t.f.f.d., professor  
E-mail: [z.umida1973@yandex.ru](mailto:z.umida1973@yandex.ru)  
Tel.: +998911915665  
<https://orcid.org/0000-0001-5005-0477>

---

Nafasov Jasurbek Himmat o'g'li/  
Jasurbek Nafasov  
Toshkent davlat transport universiteti  
"Materialshunoslik va mashinasozlik"  
kafedrası katta o'qutuvchisi. t.f.f.d.  
(PhD)  
E-mail: [nafasovz@mail.ru](mailto:nafasovz@mail.ru)  
Tel.: +99897 710 66 93  
<https://orcid.org/0000-0002-0415-2584>

Miradullayeva Gavhar  
Bakpulatovna/  
Gavkhar Miradullaeva

Toshkent davlat transport universiteti  
"Materialshunoslik va mashinasozlik"  
kafedrası dotsenti. t.f.f.d. (PhD),  
dotsent  
E-mail:  
[gavharmiradullaeva@gmail.com](mailto:gavharmiradullaeva@gmail.com)  
<https://orcid.org/0009-0006-6959-8153>

Rustamov Mirshohid Ulug'bek  
o'g'li/  
Mirshohid Rustamov

Sanoat Energetika Guruhi MChJ XK  
Muborak XICHK si yetakchi  
muxandisi, mustaqil izlanivchi  
Tel.: +998 99 953 92 52  
<https://orcid.org/0009-0008-1440-5988>

Maxammadiyeva Nilufar Farmon  
qizi/  
Nilufar Maxammadiyeva

Toshkent davlat transport universiteti  
"Materialshunoslik va mashinasozlik"  
kafedrası 2-kurs talabasi  
Tel.: +99893 599 23 25  
<https://orcid.org/0009-0004-7984-7403>



## Porosity properties and some properties of cement-concretes with complex modifiers

U.X. Abdullayev<sup>1</sup>, S.I. Kandakharov<sup>1</sup>, D.T. Sharipova<sup>1</sup>, N.B. Rakhimova<sup>1</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** This article shows the methods of studying the porosity of cement stone modified by the combined effect of construction additives of various nature and hydration active mineral additives, as well as the production of products based on them.

**Keywords:** modifier, complex additives, cement-concrete, porosity, hydration active mineral additives.

## Kompleks modifikatorli syement-betonlarining g'ovaklilik xossalari va ba'zi xususiyatlari

Abdullayev U.X.<sup>1</sup>, Kandakharov S.I.<sup>1</sup>, Sharipova D.T.<sup>1</sup>, Rakhimova N.B.<sup>1</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Toshkent, O'zbekiston

**Annotatsiya:** Ushbu maqolada turli xil tabiatdagi qurilish qo'shimchalari va gidratsion faol mineral qo'shimchalarning birgalikdagi ta'siri bilan o'zgartirilgan syement toshining g'ovaklilikini o'rganish usullarini hamda ular asosidagi mahsulotlarni ishlab chiqarish ko'rsatilgan.

**Keywords:** Modifikator, kompleks qo'shimchalar, syement-beton, g'ovaklik, gidrasion faol mineral qo'shimchalar.

### 1. Kirish

Turli xil tabiatdagi qurilish qo'shimchalari va gidratsion faol mineral qo'shimchalarning birgalikdagi ta'siri bilan o'zgartirilgan syement toshining g'ovaklilikini o'rganish alohida qiziqish uyg'otadi. Bu kombinatsiya gidratsiya jarayoniga ham ta'sir ko'rsatishga imkon beradi va gidratsiya mahsulotlari orasidagi nisbatning yo'naltirilgan o'zgarishiga hissa qo'shishi va syement toshining zichligini oshirishga sezilarli ta'sir ko'rsatadi.

Yeksperimental tadqiqotlarda Oxangaron syement zavodining M400 D0 markali portlandsyementidan foydalanilgan. Mineral to'ldiruvchi sifatida Yangi Angren IYeS dan uchuvchi kul (UK) va Toshkent quyuv-mexanika zavodining (TQMZ) po'lat eritish chiqindilari (PECH) ishlatilgan. Sirtli faol modda sifatida, polikarboksilat

superplastiklashtiruvchi (SP) POLIMIKS ishlatilgan.

Zamonaviy qurilishda yangi avlod betonlarining yuqori fizik-mexanik va ishlash xossalari kuchaytirishda kimyoviy qo'shimchalardan qo'shib foydalanmasdan tasavvur qilish mumkin emas. Qurilishda bunday kompozitsiyalar va ular asosidagi mahsulotlarni ishlab chiqarish uchun reologik xususiyatlarga ta'sir qilish, strukturaning shakllanishi va havo kirish jarayonlarini nazorat qilish imkonini beradigan keng turdagi qo'shimchalar qo'llaniladi [1-6].

### 2. Tadqiqot metodikasi

Tadqiqot o'tkazish uchun uchta turdagi kompozitsiyalarning bir qator namunalar tayyorlandi: nazorat va kompleks qo'shimchali (1-jadval).

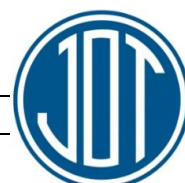
1-jadval

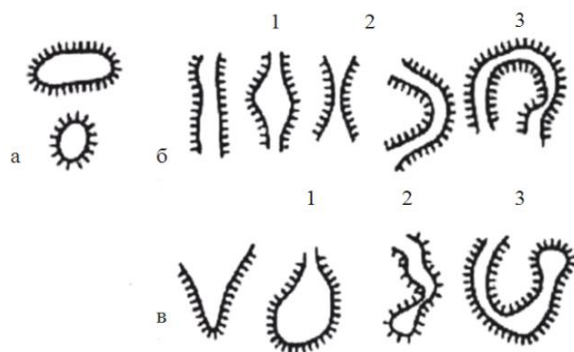
Beton qarishmasining o'rganilganlik tarkibi

Beton sinfi	Konus cho'kishi, sm	Syement, kg	Maydalangan tosh, kg fr. 5-20	Qum, kg M <sub>cr</sub> =2,7	Suv, l	Zolo-umos, kg	Po'lat ishlab chiqarish chiqindilari, kg	Superplastifikator POLIMIKS, kg
B15	1-2	236	1220	715	190	-	-	-
B15	1-2	201	1220	792	133	35	-	1.89
B15	1-2	201	1220	792	133	-	35	1.89

Shakliga ko'ra syement toshidagi g'ovaklar (1-rasm) yopiq (g'ovaklari yumaloq va boshqa g'ovaklardan

ajratilgan), kanal hosil qiluvchi (g'ovaklarning ikkala uchi ochiq va to'g'ri yoki chuvalchangsimon bo'lishi mumkin) turlarga bo'linadi [10-11].



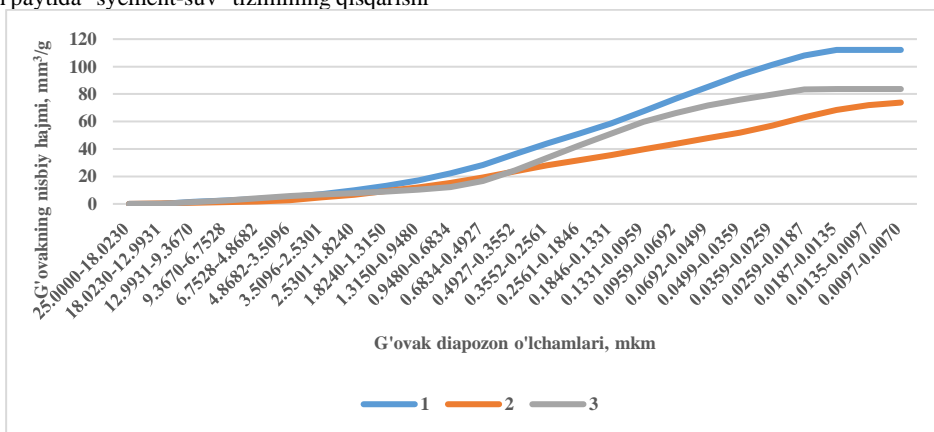


**1-rasm. G'ovaklarning asosiy shakllari (A.S.Berkman va I.G.Melnikova bo'yicha):**  
**a-yopiq yoki chegaralangan g'ovaklar; b-ochiq kanal hosil qiluvchi g'ovaklarlar;**  
**v-berk g'ovaklar; 1-tekis; 2- qurtga o'xshash; 3- halqa shaklida**

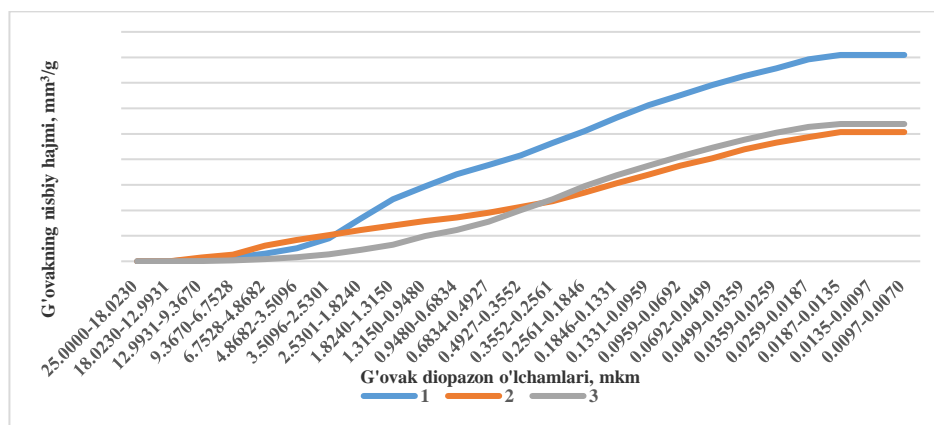
Kelib chiqishi bo'yicha syement toshidagi g'ovaklar havo, cho'kindi (kapillyar, cho'kindi) va qisqarish g'ovaklariga bo'linadi. Havo g'ovaklari texnologik omillar, suvning tashqi va ichki ajralishi natijasida cho'kish natijasida hosil bo'ladi. Siqilish g'ovaklari syement toshining qotish paytida "syement-suv" tizimining qisqarishi

tufayli hosil bo'ladi[1-7], qisqarish g'ovaklari kapillyarlarga xos o'lchamlarga ega degan taxmin mavjud.

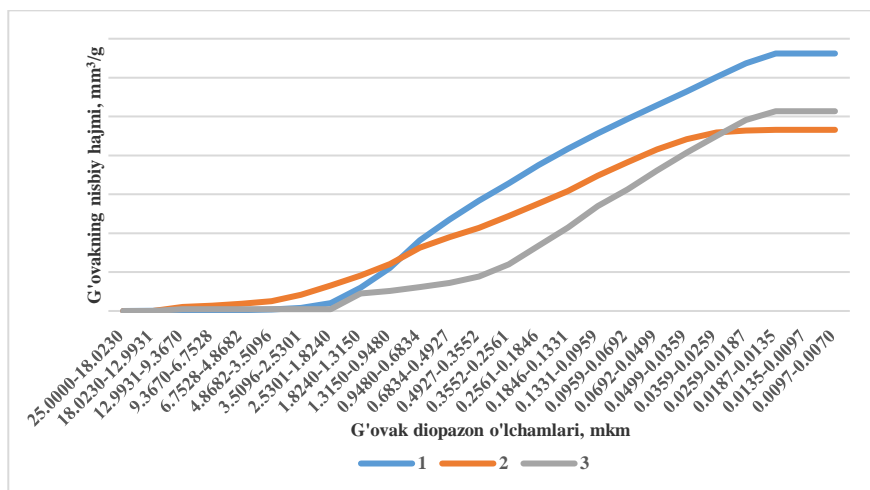
G'ovaklar parametrlarini o'rganish 2-4-rasmlarda ko'rsatilgan.



**Rasm-2. 3 sutkali muddatda tadbiq qilinayotgan tarkib g'ovaklarining nisbiy hajmi:**  
**1-nazorat; 2-ZU+SP; 3-SP+PECH**



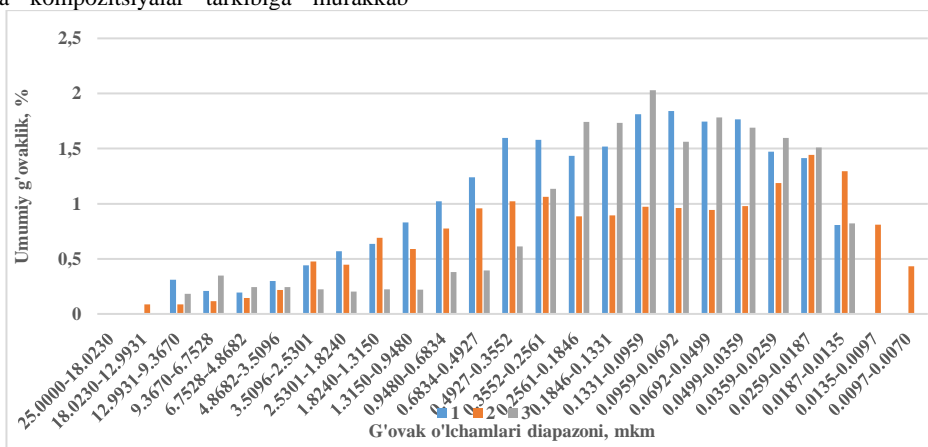
**3-Rasm. 14 sutkali muddatda tadbiq qilinayotgan tarkib g'ovaklarining nisbiy hajmi:**  
**1-nazorat; 2-ZU+SP; 3-SP+PECH**



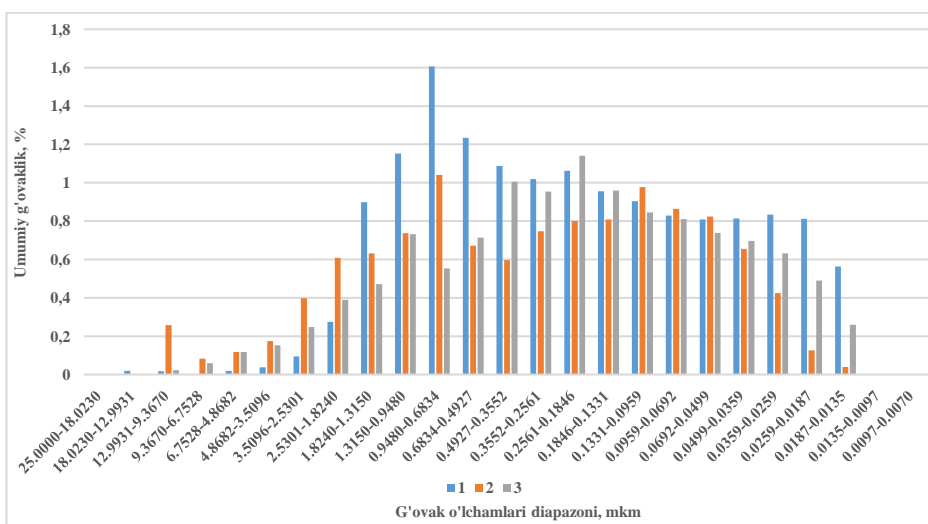
4-Rasm. 28 sutkali muddatda tadbiq qilinayotgan tarkib g'ovaklarining nisbiy hajmi: 1-nazorat; 2-ZU+SP; 3-SP+PECH

G'ovaklarning o'lchamlari bo'yicha taqsimlanishini tahlil qilish (5-7-rasm) mos yozuvlar tarkibi texnologik va kapillyar teshiklarning katta mavjudligi bilan klassik tuzilishga ega ekanligini ko'rsatdi. Integral g'ovaklikning o'xshash tabiatiga ega bo'lgan murakkab modifikatorli kompozitsiyalarda kompozitsiyalar tarkibiga murakkab

modifikatorni kiritish, nazorat namunaga nisbatan syement toshining umumiy g'ovakligining 15,23 % dan 26,41 % gacha pasayishiga olib keldi. Natijada gel g'ovaklar (0,007÷0,09 mkm), kapillyar (0,3÷10 mkm) va texnologik (≥10 mkm) g'ovaklarning muvozanati o'zgaradi.

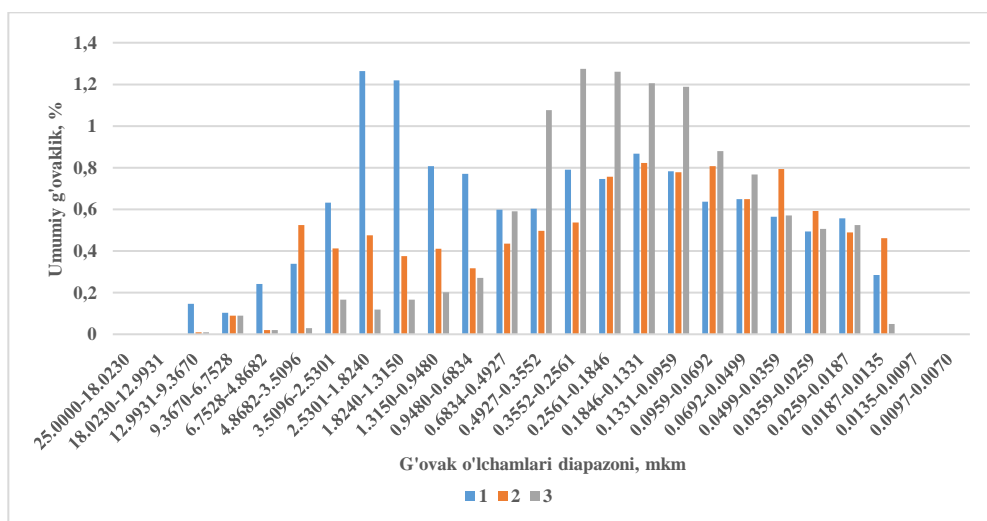


5-Rasm. 3 sutkali muddatda tadbiq qilinayotgan tarkib o'lchamlarining umumiy g'ovakligi: 1-nazorat; 2-ZU+SP; 3-SP+PECH



6-Rasm. sutkali muddatda tadbiq qilinayotgan tarkib o'lchamlarining umumiy g'ovakligi: 1-nazorat; 2-ZU+SP; 3-SP+PECH





7-Rasm. 28 sutkali muddatda tadbiq qilinayotgan tarkib o'lchamlarining umumiy g'ovakligi: 1-nazorat; 2-ZU+SP; 3-SP+PECH

### 3. Xulosa

Tadqiqot natijasida olingan natijalar SP+ZU va SP+PECH asosidagi tarkiblarning kompozit betonning talab etilgan xususiyatlariga yaxshi ta'sir o'tkazdi va natijalar gidratatsiya jarayonini borishida chuqur ahamiyat kasb etdi.

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### Mualliflar haqida ma'lumot / Information about the authors

Abdullayev  
Ulug'bek  
Hakimovich

Toshkent davlat transport universiteti  
"BSIQ" kafedrasida katta o'qituvchisi,  
texnika fanlari bo'yicha falsafa doktori  
(PhD); telefon: +998-71-299-03-02,  
e-pochta: [uabdullayev@mail.ru](mailto:uabdullayev@mail.ru)

Kandaxarov  
Sanjar  
Ishratovich

Toshkent davlat transport universiteti  
"BSIQ" kafedrasida dotsenti, texnika  
fanlari bo'yicha falsafa doktori (PhD);  
telefon: +998-71-299-03-02,  
e-pochta: [sanjar.kandaxarov@mail.ru](mailto:sanjar.kandaxarov@mail.ru)



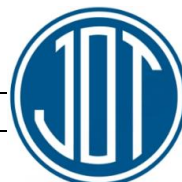


Sharipova  
Dilafuz  
Tofukovna

Toshkent davlat transport universiteti  
“BSIQ” kafedrası dotsenti v.b., texnika  
fanlari bo‘yicha falsafa doktori (PhD);  
telefon: +998-71-299-03-02, elektron  
pochta: [Dsharipova@mail.ru](mailto:Dsharipova@mail.ru)

Rahimova  
Nozima  
Baxtiyarovna

Toshkent davlat transport universiteti  
“BSIQ” kafedrası katta o‘qituvchisi,  
texnika fanlari bo‘yicha falsafa doktori  
(PhD); telefon: +998-71-299-03-02,  
e-pochta: [Nrahimova@mail.ru](mailto:Nrahimova@mail.ru)



## Disposal of concrete at the construction site during the renovation of urbanized areas

S.A. Ahmadov<sup>1</sup>, D.V. Khaydarova<sup>1</sup>, G.A. Suleymanova<sup>1</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** When renovating built-up areas, buildings are subject to demolition, the bearing and enclosing structures of which are made of reinforced concrete, concrete and brick. It is not advisable to take the disassembled structures to landfills, since it is possible to process concrete structures at stationary factories and mobile plants by crushing into crushed stone, sand and reuse these materials in construction. The article discusses the option of recycling concrete at a construction site using a set of construction machines on the example of the renovation of a residential area in Tashkent in order to assess the environmental and economic effect of the method of recycling reinforced concrete scrap.

**Keywords:** renovation, development of built-up areas, building, secondary crushed stone, recycling.

## Утилизация бетона на строительной площадке при реновации урбанизированных территорий

Ахмадов А.С.<sup>1</sup>, Хайдарова Д.В.<sup>1</sup>, Сулейманова Г.А.<sup>1</sup>

<sup>1</sup>Ташкентский государственный транспортный университет, Ташкент, Узбекистан

**Аннотация:** При реновации застроенных территорий, подлежат сносу здания, несущие и ограждающие конструкции которых выполнены из железобетона, бетона и кирпича. Свозить разобранные конструкции на полигоны не целесообразно, так как возможна переработка бетонных конструкций на стационарных заводах и мобильных установках дроблением в щебень, песок и вторичное использование этих материалов в строительстве. В статье рассмотрен вариант рециклинга бетона на строительной площадке с применением комплекта строительных машин на примере реновации жилого квартала в Ташкенте с целью оценки экологического и экономического эффекта способа утилизации железобетонного лома.

**Ключевые слова:** реновация, развитие застроенных территорий, строительство, вторичный щебень, рециклинг.

### 1. Введение

Реновация урбанизированных территорий, включающая снос старых зданий, становится неотъемлемой частью жизни современного города. При демонтаже конструкций образуется значительное количество строительных отходов, которые могут быть утилизированы. Из всех строительных отходов одним из самых распространённых является железобетон. Складирование бетонного лома на полигонах увеличивает их площадь и лишает промышленность материала, пригодного для вторичного использования [1-5]. Установки по переработке бетона могут размещаться в комплексе на полигонах, на мусороперерабатывающих заводах, а также в виде самостоятельных производств или мобильных установок на стройплощадках.

Использование вторичного щебня и песчано-гравийной смеси позволяет снизить затраты на новое

строительство и уменьшить нагрузку на полигоны. Вторичный щебень значительно дешевле природного, так как энергозатраты на его производство в 8 раз меньше, а себестоимость бетона ниже на 25 % [6]. Создание системы рециклинга строительных отходов является перспективным высокорентабельным производством. Использование мобильных дробильно-сортировочных установок (МДСУ) в ряде случаев, например, при реновации жилых кварталов, промышленных объектов, даёт возможность утилизации бетона, непосредственно на месте сноса, что ещё в большей степени упрощает схему переработки

### 2. Материалы и методы

Системный анализ научных источников. Изучение нормативов и правовых актов органов государственной власти г. Ташкент.

<sup>a</sup> <https://orcid.org/0009-0007-0925-0101>

<sup>b</sup> <https://orcid.org/0009-0000-9528-842X>

<sup>c</sup> <https://orcid.org/0009-0000-0992-9404>



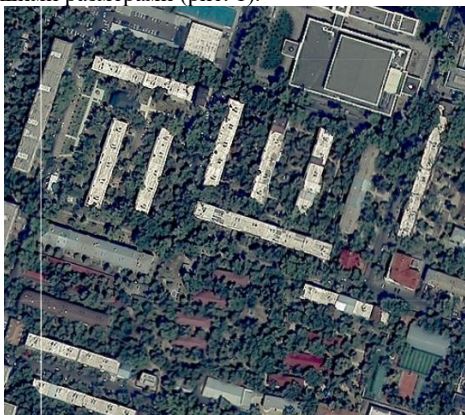
### 3. Результаты исследования

По результатам работы, экономия цемента в бетонах класса В15...В25 за счет введения микрокремнезема может составить от 41 до 183 кг/м<sup>3</sup> в зависимости от условий твердения и свойств бетонных смесей.

В рамках городской программы «Развитие застроенных территории Ташкента» по реновации города, закон о которой был принят, предполагается снос более чем 900 жилых зданий, 751 из которых средней этажности, построенные в 50-х годах прошлого столетия, остальные 219 - малой этажности. Несущие и ограждающие конструкции

этих зданий выполнены преимущественно из кирпича, бетона и железобетона. Дома сезонной постройки – деревянные [1-5].

Рассмотрим возможность применения МДСУ на примере одного из кварталов Яккасарайского района. Улица «Нурунийлар» обладает сравнительно небольшими размерами (рис. 1).



**Рисунок 1. Фрагмент квартала «Нурунийлар»:**

Масса железобетонных конструкций зданий, подлежащих сносу, рассчитывается на основе проектной документации серий. Объем бетона надземных конструкций пятиэтажных панельных 5–6 секционных зданий составляет 36482,9 тонны. Новым строительством будет возведена застройка квартала общей жилой площадью 145826 м<sup>2</sup> (рис. 2) [7].



**Рисунок 2. Концепт реновации квартала [7]**

Согласно исследованиям авторов, приведённым в статье [8], щебень, получаемый дроблением бетона, в своей массе содержит 20 % зерен фракций 20–40 мм и 40-50 % фракций 5-20 мм; имеет марку по дробимости 300-600, а его истираемость находится в пределах И4-И2. Оба показателя возрастают с увеличением крупности зерен. Вторичный щебень имеет развитую поверхность, приводящую к увеличению объема растворной части в бетонной смеси [9]. Вторичный щебень, может использоваться при строительстве автомобильных дорог и насыпей, а также в качестве

крупного заполнителя в составе бетонов класса В30 и ниже.

В случае переработки железобетонного лома, без учёта потерь, на выходе получится 15000–18300 т, вторичного щебня фракции 5–20 мм, в тоже время, для изготовления 1 м<sup>3</sup> бетона класса В25 с применением вторичного щебня требуется 960-1010 кг вторичного щебня данной фракции [10]. Таким образом, из имеющегося на строительной площадке вторичного щебня, возможно изготовить 14851–19063 м<sup>3</sup> бетона. При учёте, что общая площадь нового строительства значительно превосходит общую площадь старого жилого фонда, полученный бетон можно использовать без остатка и удовлетворить вплоть до 20% потребности в бетоне при строительстве (при расходе 0,5 м куб бетона на 1 м<sup>2</sup> площади жилых помещений).

Ведущей машиной в комплекте по переработки является дробилка, от технических характеристик которой (размер входного отверстия, объём загрузочного бункера, мощность привода, тип дробилки и пр.) зависит величина допустимого размера исходного вторсырья, производительность, а также количество и размер фракций готового продукта и возможность перерабатывать бетонный лом с металлическими включениями.

Современные машины обладают не только высокой производительностью, но и возможностью быстрой транспортировки, что позволяет осуществлять переработку в любом месте, которые выпускают установки на гусеничном и пневмоколесном ходу (рис. 3). Установки укомплектованы оборудованием широкого типоразмерного ряда.



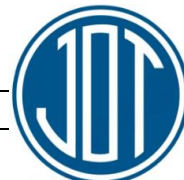
**Рисунок 3. Установка УМДС 250 (Союзгормаш), способная перерабатывать бетонные отходы, содержащие арматуру диаметром до 50 мм [11]**

Процесс переработки бетона с помощью МДСУ состоит из этапов (рис. 4) [12]:

- приёмка и первичная сортировка поступающих отходов в приёмный бункер;
- измельчение отходов в дробилке;
- извлечение металлических включений с помощью магнитного сепаратора;
- разделение полученной массы на фракции с помощью грохота.

Количество фракций зависит от ярусов грохота. Крупные обломки, не прошедшие грохот, возвращаются обратно в дробилку.

Переработка бетона осуществляется комплектом из 3–4 машин: дробильно- сортировочная установка (либо дробильная установка + грохот); самосвал, подвозящий бетонные отходы; экскаватор, осуществляющий подачу лома в дробилку.





**Рисунок 4. Переработка бетона [13]**

Анализ опыта переработки строительных отходов и вторичного использования бетона в строительстве показывает, что за счет внедрения рациональных схем переработки, использования новых поколений оборудования и улучшения качества вторичного щебня может быть обеспечена его конкурентоспособность с природными заполнителями.

Современные МДСУ обладают достаточно высокой производительностью (до 200 т/ч), поэтому при разработке ПОС и ППР целесообразно рассматривать их применение на месте демонтажа.

#### 4. Заключение

Учитывая результаты проведенных расчетов, можно рекомендовать использование мобильного комплекса переработки той или иной комплектации на стройплощадке при реновации квартала «Полуострово 43».

Применение МДСУ в построчных условиях целесообразно, потому что при высокой производительности потребная площадь для работы машин занимает 1 гектар. От данных мероприятий присутствуют экологический эффект: уменьшение количества отходов, размещаемых на полигонах, снижение количества земель, отводимых под устройство полигонов; экономический эффект: снижение транспортных расходов; снижение затрат на размещение ТБО на полигонах; снижение потребности в закупке материалов для нового строительства

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#### Информация о авторах/ Information about the authors

Ахмадов Суннатилло Абдуллоевич Ташкенский государственный транспортный университет “Строительство зданий и промышленных сооружений”, ассистент  
E-mail: [zakon.axmadov@gmail.com](mailto:zakon.axmadov@gmail.com)  
Tel.: +998974936611  
<https://orcid.org/my-orcid?orcid=0009-0007-0925-0101>



Хайдарова Дилфуза Васитовна Ташкенский архитектурно-строительный институт, студент 3 курса  
E-mail: [shakir777777@gmail.com](mailto:shakir777777@gmail.com)  
Tel.: +998998450185  
<https://orcid.org/my-orcid?orcid=0009-0000-9528-842X>

Сулейманова Гавхар Асатуллаевна Ташкенский архитектурно-строительный институт, студент 2 курса  
E-mail: [v0306924@gmail.com](mailto:v0306924@gmail.com)  
Tel.: +998935039735  
<https://orcid.org/my-orcid?orcid=0009-0000-0992-9404>





# Effective organization of train movement taking into account the costs of electrical energy

D. Butunov<sup>1</sup><sup>a</sup>, S. Abdukodirov<sup>1</sup><sup>b</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** The main goal of the work is to save the total cost of running trains. The standard of time and graphic times of the stay of trains at the stations were analyzed analytically and the total cost of their electric energy distribution was determined. As a result, a scheme for the zonal organization of train traffic in general expenditures and saving electricity consumption was created. It has been proposed to set graphical times when sending trains from stations, spending on electricity daily distribution, and zonal organization of train movement in TTG (train traffic graph).

**Keywords:** Electricity, railway section, train traffic graph, expenditure rate, zonal movement.

## 1. Introduction

The effective organization of the process of transportation of rail transport, including the movement of trains of various categories, determines the possibilities of saving the consumption of electric energy by sending freight trains taking into account the distribution of electricity expenditures during the day in terms of graphic times installed from railway stations. [1, 2, 6, 8].

The experience of organizing train traffic based on optimal options, including the movement of passenger trains at railway stations on an optimal train traffic graph (TTG), provides the opportunity to reduce electricity consumption by 5-6%. [3-5]. Therefore, the organization of the movement of freight trains on railway sections by the distribution of electricity expenditures is an urgent issue.

## 2. Literature analysis and methodology

Scientific research was carried out by many scientists and specialists on the identification, analysis and assessment of factors that negatively affect the movement of freight trains in various categories in their effective organization, and on the development of methods for organizing train traffic on an invariable graph and determining the cost of electricity [7-9, 11-14].

In particular, author Yan Xu in his scientific research [12] proposed a novel approach to electric energy-efficient integrated micro-macro to increase movement speeds in the

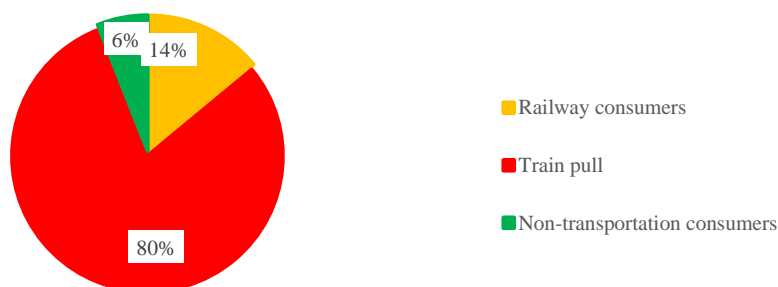
on TTG to save electricity through a programming model of optimizing the speed of movement.

Author Gerben M. Scheepmaker [13] has developed a method for determining electricity consumption, taking into account the factors affecting trains during their movement. The developed method provides an opportunity to save electricity consumption, taking into account the repair work in different parts of the TTG.

Nezewack W.L. [14] at railway stations, the indicators of TTG are optimized in accordance with the criterion for the consumption of electrical energy for braking and pulling the motion content in the conditions of slowing down and accelerating trains. Methods for determining the non-winding losses of electricity as a result of optimization are presented, and the indicators of their implementation in practice are analyzed.


In particular, it is currently analyzed that the cost of electricity consumption on the Railways of Uzbekistan is distributed to them for different situations (Figure 1). The results of the analysis showed that non-transport dependent consumers accounted for 6%, rail consumers for 14%, and train torts for 80%.

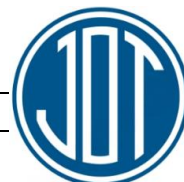
Train traffic in railway stations is carried out taking into account the technology of distribution of the cost efficiency associated with the standards of stopping time of freight trains at stations. It is necessary to assess the total spending, taking into account the graphical timing of the organization of train traffic on railway sections and the planning of their shipment from stations.



**Fig. 1. Diagram of the distribution of electricity consumption on the Railways of Uzbekistan** development of TTG. This method allows high-speed trains

<sup>a</sup> <https://orcid.org/0009-0009-4165-0257>

<sup>b</sup> <https://orcid.org/0000-0001-9457-255X>





When sending trains from the station, the total expenditures were determined using the following parameters. [2, 3]:

- a) expenditures associated with train stops at ( $P_{in}$ ) intermediate stations within the precinct include the following [2]:
  - ( $P_{L.br}$ ) total spending for the locomotive brigade's operation in terms of train stopping times;
  - acceleration and deceleration of trains costs for ( $P_{a/d}$ ) (electricity);
  - expenditures in the ( $P_{L.w}$ ) use of locomotives and wagons;
  - electricity ( $P_e$ ) spending costs for stopping trains.

The total spending on intermediate stations is determined by the following expression

$$P_{in} = P_{br} + P_{a/d} + P_{Lw} + P_e \quad (1)$$

$$P_{Lb} = (t_{in.av} + t_{ac} + t_{dec}) \cdot \frac{e_{br}}{60}, \quad (2)$$

- there
- $t_{in.av}$  – General stop time norms in intermediate stations by graph time;
  - $t_{ac}$  – acceleration time at possible stops at stations (3 minutes);
  - $t_{dec}$  – slowdown time (2 minutes) in possible stops at stations;
  - $e_{br}$  – expenditures rate 1 brigade-hour, som/hour.

$$P_{a/d} = 3,8 \cdot (Q_{loc} + Q_{br}) \cdot v_{run}^2 \cdot \alpha \cdot 10^{-6} \cdot N_{st}, \quad (3)$$

- there
- $Q_{loc}$  – the locomotive weighs, tons;
  - $Q_{br}$  – brutto weight of action content, tons;
  - $v_{run}$  – train running speed is, km / h;
  - $\alpha$  – in locomotive mechanical work, the energy consumption of 1 ton-km is equal to 3.6 kV/H;
  - $N_{st}$  – number of stops at intermediate stations by graph time.

$$P_{Lw} = (t_{in.av} + t_{ac} + t_{dec}) \cdot \frac{(e_{loc} + e_{wag} \cdot m_w)}{60}, \quad (4)$$

- there
- $e_{loc}$  – expenditures rate locomotive-hour, som/hour;
  - $e_{wag}$  – expenditures rate wagon-hour, som / hour;
  - $m_w$  – number of wagons in train traffic.

$$P_e = \varphi_e + t_{in.av} \cdot \frac{H_{st}}{60}, \quad (5)$$

- there
- $\varphi_e$  – cost of one  $kW \cdot hour$  electric power, som;
  - $H_{st}$  – The norm of electricity consumption to stay standing for 1 hour,  $kW \cdot hour$ .

- b) the following costs arise from the ( $P_{tech}$ ) expectation of direct graph times as a result of the increased standing of trains at technical stations [3]:
  - cost of ( $P_{Lw}$ ) use of locomotives and carriages (by train waiting time;

- ( $\sum P_{tech}$ ) costs to use other train wagons and locomotives in changing the graphical times of trains.
- ( $P_e$ ) electricity expenditure during train parking

$$P_{tech} = \sum P_{Lw} + P_e, \quad (6)$$

$$\sum P_{Lw} = \sum_{i=1}^k t_i \cdot \frac{(e_{loc} + e_{wag} \cdot m_w)}{60}, \quad (7)$$

- $k$  – there the number of trains exceeding the norm, or the number of first graph times used in order;
- $t_i$  – Stopping time of  $i$  train, minutes.

### 3. Results and conclusion

Sending a train from the station requires an analysis of compliance with the total cost based on the observance of graphic times. It is necessary to assess the compliance of the use of graph times with electrical energy costs using data describing the state of the train. Train traffic spending (8) is defined using the expression.

When sending trains from the station by chart times, the number of factors affecting them ( $P_{in}$ ) increases. However, in this case, the ( $t_{in}$ ) single variable intermediate stations, the sum of total time, take into account the times when the train remains standing, acceleration and deceleration. This variable again takes into account the weight of two-parameter trains (equal to the sum of  $Q_{loc}$  and  $Q_{loc.br}$ ) and the number of ( $N_{in.st}$ ) stays at intermediate stations with graph times. For the graphical time of trains, the train weight is chosen with a variation of 500 tons in the range from 2,500 tons to 6,500 tons. The number of stays at intermediate stations is accepted from 1 to 10 (train traffic is taken from TTG based on the train movement plan). The number of ( $N_{in.st}$ ) trains staying at intermediate stations is determined by the times of the regulatory train traffic graph (RTTG).

The total cost rate for the organization of freight train traffic on railway sections within Uzbekistan Railways is shown in Table 1. The electricity consumption for the movement of trains on railway sections is distributed differently during the day (Table 1).

**Table 1**  
Expenditures rate for freight trains on the Railways of Uzbekistan

No	Name of expenditures	Value, sum.
1	Wagon-hour	917
2	Locomotive-hour	114270
3	Brigade of the locomotive brigade-hour	157585
4	Elekrtovoz-hour	34760
Electricity consumption (1kWT · hour)		
5	Daytime rush hour from 06-00 to 09-00 and from 17-00 to 22-00	1350
6	The daytime time interval is from 09-00 to 17-00	900
7	Night time interval from 22-00 to 06-00	600

In order to plan the movement of trains on railway plots, the power consumption in the shipment from the technical



station according to the different distributed state of the shipment was increased to operation on the basis of RTTG.

The operating costs for each variant of train movement distribution ( $\sum P_e$ ) are determined by the following expression.

$$\sum P_e = \sum_{j=1}^p P_{st,j}, \tag{8}$$

there

$P_{st,j}$  – expenditures arising due to the fact that the train stops at the intermediate stations of the plot for the graphic time with the selected train;

$j$  – serial number of graphic time from the planning of sending trains.

The total spending determined by taking into account the number of station stays and time of stay to ship trains at the

railway stations according to the specified graphic time was expressed in Figure 2.

The results of the analysis of staying at intermediate stations for sending trains on railway plots according to the specified graphic time (Figure 2) electricity consumption is the most expensive during the day, respectively (Schedule 1) (daylight hours from 06-00 to 09-00 and from 17-00 to 22-00: 152437÷400806), average (daylight hours from 09-00 to 17-00: 14654÷384356 22-00 to 06-00: 143687÷376056) showed a change in total spending. According to the results of the analysis, as a result of the change in the time standards for staying at intermediate stations when sending a train by graphic time, electricity consumption was caused by different distribution during the day from 06-00 to 09-00, during the day from 09-00 to 17-00, and between 22-00 and 06-00 at night.

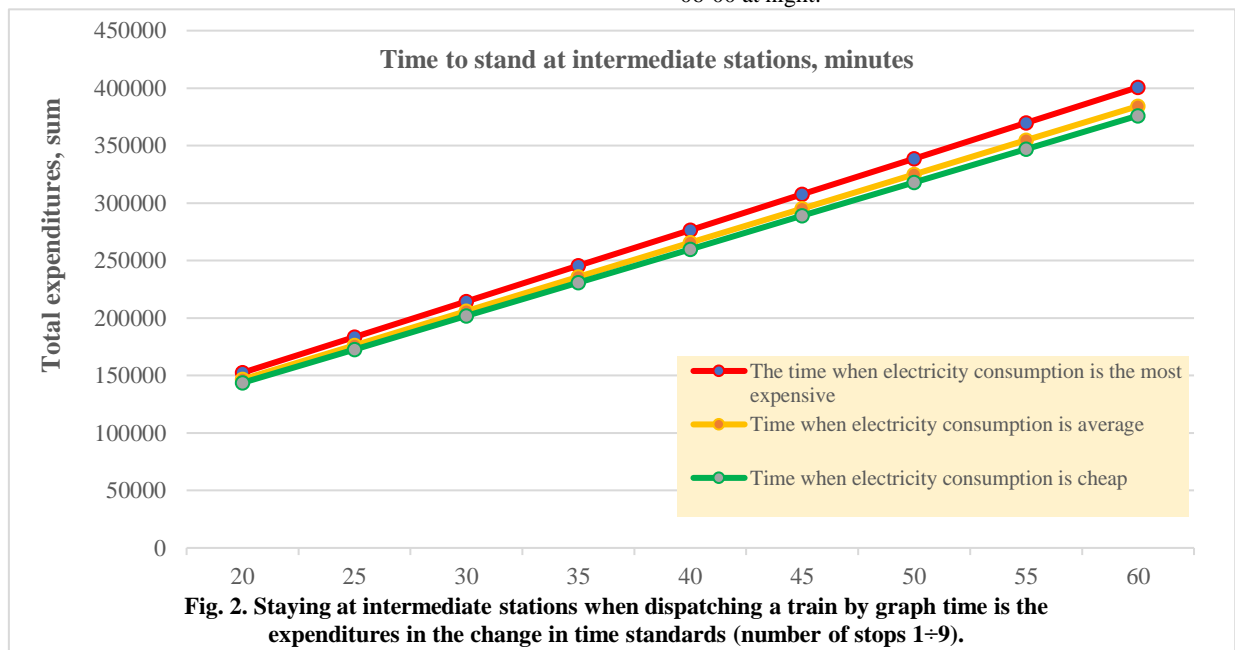


Fig. 2. Staying at intermediate stations when dispatching a train by graph time is the expenditures in the change in time standards (number of stops 1÷9).

Trains scheduled to be shipped from the technical station will cause graphics times to wait. Therefore, the determination of the total cost of using locomotives and wagons at the technical station is calculated according to the following expression.

$$t_{tech} = \sum_{i=1}^d t_i. \tag{9}$$

At the technical station, the cost of ( $P_{lw}$ ) use of locomotives and carriages to ship trains in graphic times (by train waiting time), the total cost (9) taking into account the cost of ( $P_e$ ) electricity at the time of stopping trains-was determined by expression, and the result was given in Figure 3.

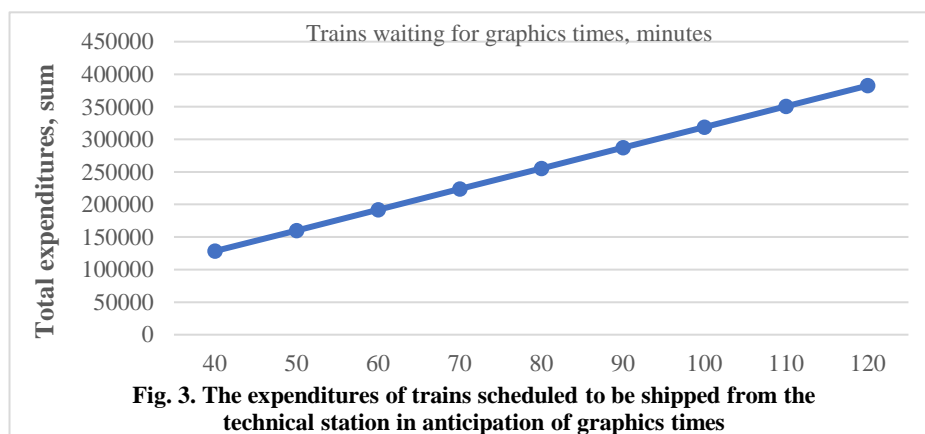


Fig. 3. The expenditures of trains scheduled to be shipped from the technical station in anticipation of graphics times

Based on the results of the analysis, the cost of using locomotives and wagons (in terms of train waiting time), taking into account the expenditure of electricity at the time of stopping the trains at the technical station in terms of the change in the expectation of the specified graphic times, the

total spending averaged 128376÷414184 rubles, respectively. So, when planning the departure of trains from the technical station, it was found that it is advisable to send trains by comparing the costs of using locomotives and cars (in terms of train waiting time), the costs of using trains at



the technical station according to the number of stops at the intermediate stations and the time standards of staying.

At the Uzbekistan-Khovos-Jizzakh railway station, which is owned by Uzbekistan railways, passenger train traffic runs from 06<sup>00</sup> to 09<sup>30</sup> in the morning and from 17<sup>00</sup> to 22<sup>00</sup> in the evening at times when electricity consumption is expensive. Freight train traffic was analyzed in the “Uzbekistan-Khovos-Jizzakh” railway section on the double and odd lines from 09<sup>30</sup> to 17<sup>00</sup> am with an average electricity

value in December 2023 and at intervals of 22<sup>00</sup> to 06<sup>00</sup> pm with low electricity value (Table 1) (4 and 5<sup>th</sup> pictures).

From Figure 4, it can be concluded that freight trains are changing to 4÷9 trains from 10<sup>00</sup> to 17<sup>00</sup> in the morning and 5÷10 trains from 22<sup>30</sup> to 06<sup>00</sup> in the evening, respectively. So, in this section, the movement of passenger trains in the time intervals from 10<sup>00</sup> to 17<sup>00</sup> in the morning and from 22<sup>30</sup> to 06<sup>00</sup> in the evening in both directions is considered to be a less organized period.

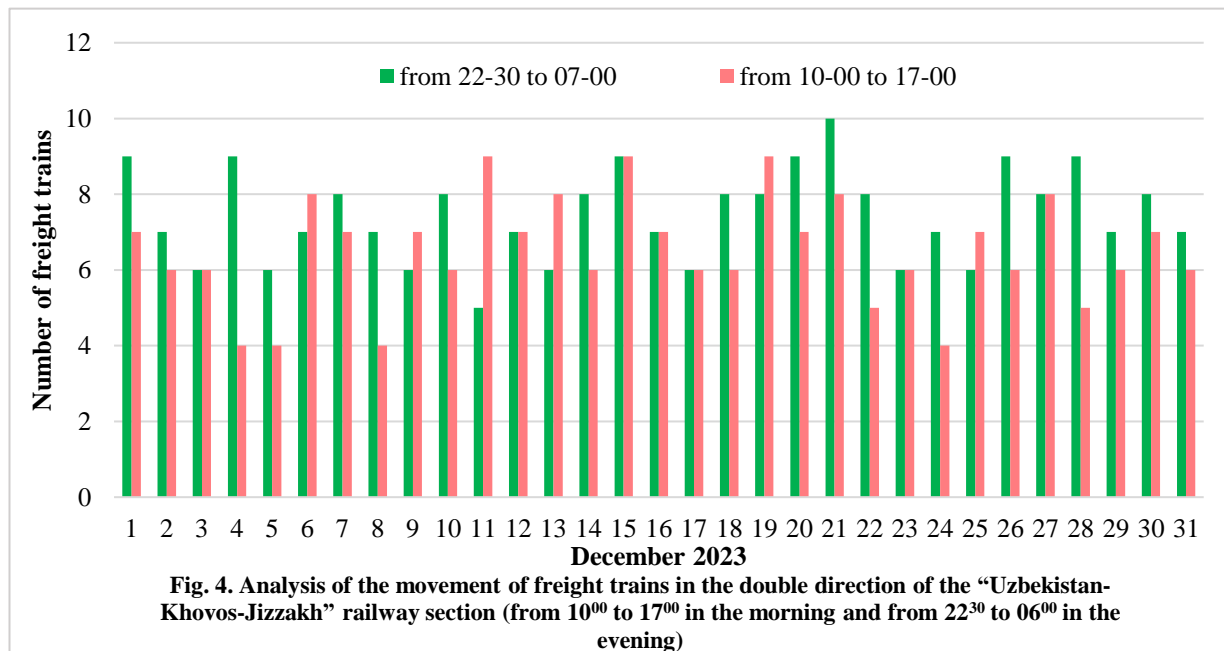


Fig. 4. Analysis of the movement of freight trains in the double direction of the “Uzbekistan-Khovos-Jizzakh” railway section (from 10<sup>00</sup> to 17<sup>00</sup> in the morning and from 22<sup>30</sup> to 06<sup>00</sup> in the evening)

According to the results of the analysis in Figure 5, freight trains are changing to 4÷7 trains from 08<sup>00</sup> to 18<sup>00</sup> in the morning and 5÷8 trains from 23<sup>30</sup> to 04<sup>00</sup> in the evening. So, it was found that the movement of passenger trains is not

planned for the time intervals from 10<sup>00</sup> to 17<sup>00</sup> in the morning and from 22<sup>30</sup> to 06<sup>00</sup> in the evening even on the odd direction.

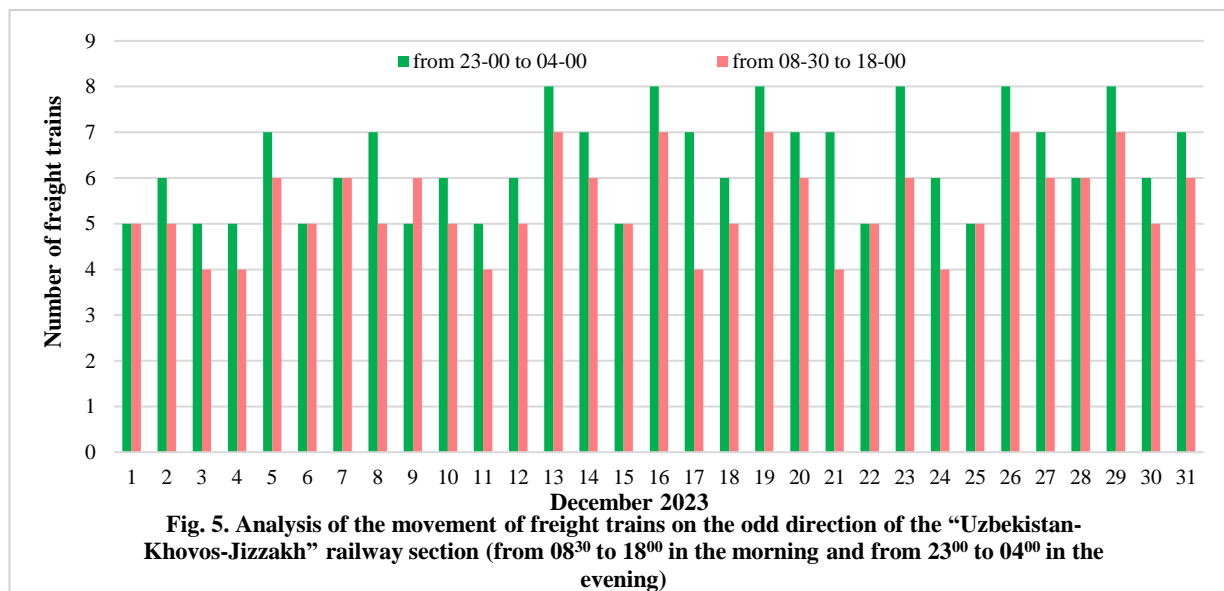


Fig. 5. Analysis of the movement of freight trains on the odd direction of the “Uzbekistan-Khovos-Jizzakh” railway section (from 08<sup>30</sup> to 18<sup>00</sup> in the morning and from 23<sup>00</sup> to 04<sup>00</sup> in the evening)

It is advisable to organize the movement of freight trains on the pair and odd lines of the Uzbekistan-Khovos-Jizzakh railway section under the ownership of the Railways of Uzbekistan during periods when electricity consumption is

moderate and cheap. In addition, increasing the flow of freight trains during periods when electricity consumption is moderate and affordable determines the possibility of assessing the operational and economic indicators of the



railway site.

In order to effectively organize the movement of trains on railway plots from the experiences of developed foreign countries, it is necessary to develop flexible options for the

consumption rate in the TTG during the day varies. Therefore, a schematic outline of the zonal organization of the movement of trains taking into account the consumption of electricity in the organization of train traffic on the

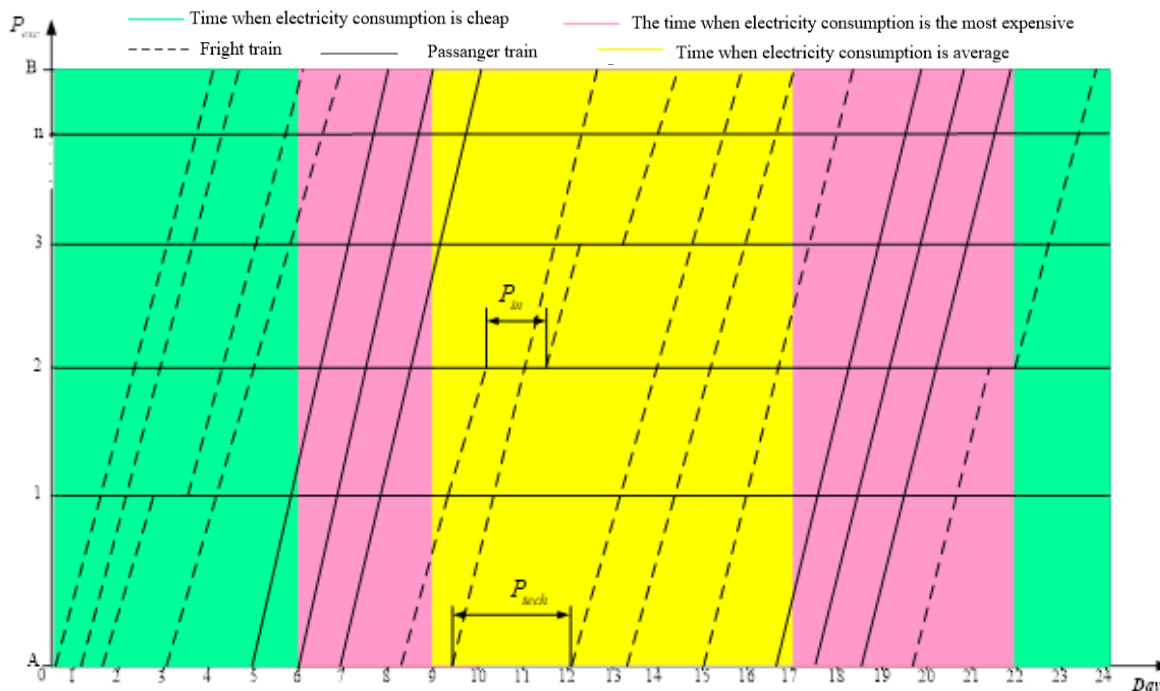


Fig. 6. Scheme of zonal organization of the movement of trains on the distribution of electricity consumption in the organization of train traffic in TTG

zonal organization of train traffic and the plan for the formation of trains, since the distribution of the electricity

The proposed approach (Figure 6) provides opportunities for zonal Organization of train traffic taking into account the distribution of the electricity consumption rate during the day, development of flexible options for a train layout plan, sending trains from the station by graphic time, and most importantly, saving overhead costs.

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Railways of Uzbekistan was developed (Figure 6).

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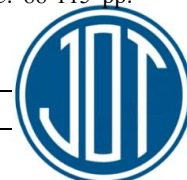
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### Information about the authors

Butunov Dilmurod Baxodirovich	Temir yo'ldan foydalanish ishlarini boshqarish kafedrası professori v.b., PhD, dotsent, <a href="mailto:dilmurodpgups@mail.ru">dilmurodpgups@mail.ru</a> <a href="https://orcid.org/0009-0009-4165-0257">https://orcid.org/0009-0009-4165-0257</a>
Abduqodirov Sardor Asqar o'g'li	Temir yo'ldan foydalanish ishlarini boshqarish kafedrası dotsenti v.b., PhD, <a href="mailto:sardor_abduqodirov@bk.ru">sardor_abduqodirov@bk.ru</a> <a href="https://orcid.org/0000-0001-9457-255X">https://orcid.org/0000-0001-9457-255X</a>





# Relationship of rheological properties bitumen with empirical Ring and Ball softening point test

E.B. Joldasbaev<sup>1</sup><sup>a</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

Abstract:

It was reported that for most unmodified bitumens, the R&B softening point equated to a needle penetration of about  $800 \times 0,1 \text{ mm}^2$  (Heukelom, 1969). R&B softening point is used as the elevated temperature performance of binders. However, the R&B softening point relevance is questionable for modified bitumens so that Dynamic viscosity is used as the elevated service temperature performance. A good correlation is reported with  $G^*/\sin\delta$  at a frequency of 10rad/s and 60°C before and after rolling thin-rolling oven (RTFO)-aging. The correlation the dynamic viscosity with R&B softening point was good after RTFO-aging, but not before (Alexander, 2000). No relationships have been demonstrated for modified bitumen using dynamic viscosity with R&B softening point. (Balaidi, 2001). There are some relationships, but no correlation has been found in the papers between R&B softening point and other bitumen tests.

Keywords:

Ring and Ball Test, Softening Point of Bitumen, Rheological properties.

## 1. Introduction

Bitumen is one of the oldest known engineering materials. It is known that 6000BC there was a thriving shipbuilding industry in Sumeria that produced and used natural bitumen. Also, bitumen was used in the mummification process as long ago as 1200 BC during the Ptolemaic period. In the 1900s, refined bitumen was first produced by refining crude oil in the USA. Bitumen consumption has increased rapidly, especially in road construction. (Jiqing Zu 2014) Bitumen is a dark viscous mixture made of hydrocarbons. Bitumen is manufactured from crude oil. Nearly all bitumens present a more or less pronounced visco-elastic behavior, their resistance to deformation depends on the temperature and time during which a force is applied. Under normal temperature conditions, viscous and elastic behavior play their part. Tests are necessary for characterizing different bitumen grades. Examples of such methods of characterization and their appropriate consistency are:

Fraass breaking point – brittleness

Penetration- semi solid range Softening point- beginning of fluidity

Viscosity – fluidity range

Penetration Index- temperature susceptibility.

The two tests used most frequently to characterize bitumens are penetration and softening point. From these two tests can be obtained important engineering properties namely, high temperature viscosity and low temperature stiffness. As the penetration and softening point tests are empirically derived it is essential that they are always carried out under exactly the same conditions.

The softening point of a bitumen is used as an indication of the temperature at which the bitumens start showing fluidity. The European standard for R&B softening test is EN1427. Until 1999, most countries had their own test version which were similar to the harmonized test. In (EN1427) this test a steel ball 3.5 gram is placed on a sample of bitumen contained in a brass ring which is suspended in a water or glycerine bath. Water is used for bitumen with a softening point of 80 C or below, glycerine is used for softening points greater than 80 C. The bath temperature is raised at 5C per

minute, the bitumen softens and eventually deforms slowly as the ball falls through the ring. When the steel ball touch a base plate ( $25 \pm 0.4$ ) mm below the ring, the temperature of the water is recorded. After the test the mean of the two measured temperatures is reported. If the difference between the two results more than 1 C, the test must be repeated. The reported temperature is designated the softening point of the bitumen, and represents an equi-viscous temperature. (EN1427)

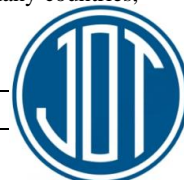
There are no universally accepted specifications for bitumen, cutback bitumen or bitumen emulsions. British Standards are used in the UK, in Europe, the national specifications for bitumen are in the process which is being consolidated in a unified CEN specification, while in the world the ASTM specifications are commonly used. the principal difference was that including, the ASTM D36-95 version of the softening point test bath is not stirred, whereas in the EN1427 version the water is stirred, therefore the softening point determined by using these two methods differ. As a consequence the ASTM results are usually 1,5 C higher than for the EN1427 method. The procedure for performing the softening point test must be followed precisely to obtain accurate results. Sample preparation, rate of heating, and accuracy of temperature measurement are critical.(bitval,2006.).

## 2. Methodology

### 2.1. $G^*/\sin\delta$ parameter relationship with R&B softening point

A systematic approach to the development of new binder specifications was facilitated by the bitumen industries' efforts to define 'performance-related' requirements for paving binder formulations. In spite of the continuous development of new test methods, binder specifications are often based on and evolved from historic, empirical test methods that have been proven effective. R&B softening point is often used to obtain information about elevated temperature behavior of binders. However, its relevance to polymer-modified bitumen is contested. In many countries,

<sup>a</sup> <https://orcid.org/0009-0005-4959-0069>



especially those involved with PMB, a slow and gradual shift from the penetration-based bitumen specification to a performance related specification utilizing dynamic shear rheometer (DSR) is expected in the near future, especially, for PMBs. A good correlation is reported  $G^*/\sin\delta$  at a frequency of 10 rad/s and 60 °C before and after rolling thin-film oven (RTFO)-aging. The correlation of dynamic viscosity with the R&B softening point was good after RTFO-aging, but no relationships have been indicated for PMBs. (Khattak et al. 2001).  $G^*/\sin\delta$  parameter was the elevated service temperature property in the Superpave (Superior performing asphalt pavements) binder specification of this rheological parameter and was developed by strategic highway research program (SHRP). This value calculated from the complex shear modulus  $G^*$  divided by the sine of the phase lag(phase angle). Higher values of this parameter lead to a decreased tendency to permanent deformation.  $G^*/\sin\delta$  correlated well with the tendency for permanent deformation. However, this parameter is less useful for binders that contain polymers or other modified binders. (Claxton et al. 1996; Carswell et al. 2000).

## 2.2. Equi-viscous and equivalent modulus temperatures” based on a DSR relationship with R&B softening point of bitumen

A reliable quantitative relationship can be used to estimate the old empirical parameters from fundamental DSR results, which is more efficient and time-saving than running additional tests. Furthermore, it can lead to a better understanding of why the old empirical parameters were inadequate. It is important to know how DSR results relate to the R&B softening point of modified and unmodified bituminous binders. (J.Ziqing et al. 2020).

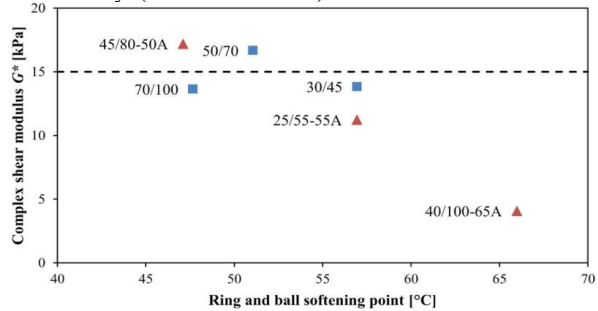
Some studies investigated the R&B softening point of bitumen to determine its equivalent softening point based on DSR test. It was reported the concept “equiviscous temperature” based on low shear viscosity (LSV) using a DSR in low frequency oscillation mode. This is temperature at which the complex shear modulus is 2kPa·s and it was demonstrated that it is a good approximation for unmodified bitumen but not for PMBs. (Zoorob et al. 2011)

Fan Liang (F. Liang et al. 2014) tested more than 30 different asphalt binders using a DSR test.

## 2.3. Binder-Fast-Characterisation-Test (BTSV Bitumen-Typisierung-Schnell-Verfahren) relationship with R&B softening point test

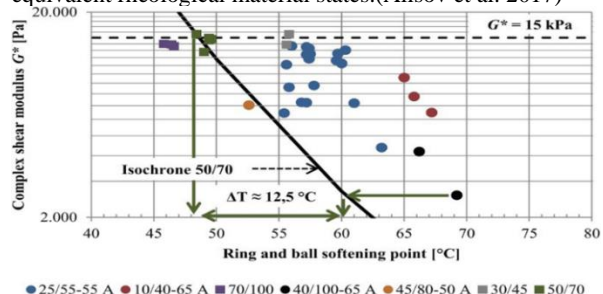
Whenever modified binders were investigated, there was no reliable correlation between rheological parameters and empirical softening point. Seven plain binders and polymer modified binders with different penetration grades were tested in the DSR at a frequency of 10 rad/s. Figure 2 shows the complex shear modulus  $G^*$  at the R&B softening point temperature with a different binders. (Alisov et al. 2020). According to Figure 2, some of the plain binders (70/100, 50/70, 30/45) have an approximate complex shear modulus of 15 kPa on average, while others show either much smaller values or much higher ones. Thus, the R&B softening point reflects equivalent rheological properties only for plain binders.  $G^*$  varies significantly for PMBs. This indicates that when polymer modified is used to enhance the material

property the R&B softening point does not behave consistently. (Alisov et al. 2020).



**Figure 1. the complex shear modulus  $G^*$ , measured at the R&B softening point temperature with a frequency of 10rad/s for different asphalt binders. (Alisov et al. 2020)**

In a logarithmic scale was used to describe binders tested at their R&B softening point temperature in the DSR (Figure 3). Figure 3 clearly shows how the temperature of R&B softening point for PMBs can lead to much lower values of the complex shear modulus ( $G^*=2563$ Pa), whereas the highest values were measured for plain binder ( $G^*=15682$ Pa). According to the exponential relationship between binder and material stiffness, a range of approximately 13 kPa corresponds to a difference of 12,5 °C. Softening point is relatively inaccurate at representing equivalent rheological material states. (Alisov et al. 2017)



**Figure 2. Complex shear modulus  $G^*$ , measured at the R&B softening point temperature, with a frequency of 10rad/s for different asphalt binders and an isochrones for 50/70. (Alisov et al. 2017)**

It is therefore possible to characterize the material behavior of binder at high temperatures by determining the isomodulus temperature corresponding to a complex shear modulus of 15 kPa. After the complex shear modulus reaches the threshold value of  $G^*=15$  kPa, the result of the test is obtained. At this point, the temperature  $T_{BTSV}$  which is related to the R&B softening point test and  $\delta_{BTSV}$  are determined as the two key parameters that describe the material. 164 different binders were selected for testing and some of the binders were aged with RTFO at the temperature of 163 °C (Alisov et al. 2018). BTSV is a test method that measures complex shear modulus and corresponding phase angle as a function of temperature.



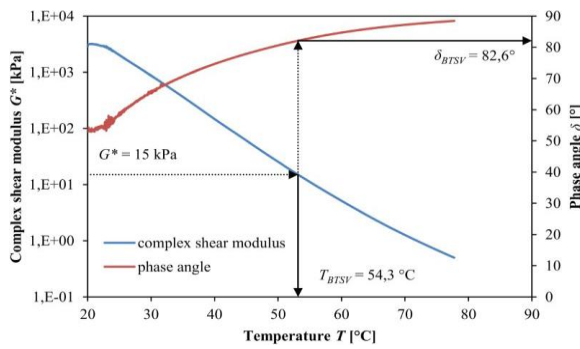


Figure 3. Example for determining  $T_{BTSV}$  and corresponding phase angle  $\delta_{BTSV}$  for a 50/70 pen-grade bitumen from BTSV results. (Alisov et al. 2018)

The master curves of the complex shear modulus and phase angle acquired from frequency and temperature sweep tests. The BTSV is obtained by first determining the reduced frequency that corresponds to a complex shear modulus of 15 kPa and then determination of phase angle that corresponds to that reduced frequency. From the reduced frequency, the temperature  $T_{BTSV}$  corresponding to a frequency of 1.59 Hz can be back-calculated using the William Landel Ferry equation.

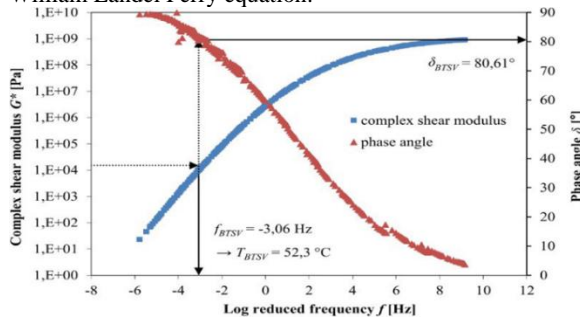


Figure 3. . Determination of phase angle from master curve of a 50/70 pen-grade binder. (Alexander Alisov et al. 2018)

Theoretical equation is used to obtain BTSV results. (1). (NCHRP, 2001)

$$G^* = G_e^* + \frac{G_g^* - G_e^*}{(1 - (f/f_c)^k)^{m_e/k}} \quad (1)$$

Where,  $G_e^*$  -  $G^*(f \rightarrow 0)$ , equilibrium complex modulus,  $G_e^* = 0$  for binders.  $G_g^* = G^*$  ( $f \rightarrow \infty$ ), glass complex modulus;  $f_c$  - location parameter with dimensions of frequency  $f'$ -reduced frequency, function of both temperature and strain;  $m_e, k$  - shape parameters, dimensionless.

Using William-Landeln-Ferry equation (2)  $T_{BTSV}$  temperature can be calculated. (William and Landeln, 1955)

$$\log a_T(T_{BTSV}) = -\frac{c_1(T_{BTSV} - T_0)}{c_2(T_{BTSV} - T_0)} \quad (2)$$

Last but not least, using the reduced frequency  $f'$  equals to 1.59 Hz multiplied for the temperature shift factor, determined in the previous step.

From (3) the value of  $\delta_{BTSV}$

$$\delta_{BTSV} = 90 \cdot I - (90 \cdot I - \delta_m) \cdot \left(1 + \left(\frac{f_d}{R_d}\right)^2\right)^{\frac{m_d}{2}} \quad (3)$$

Where,  $\delta_m$  - is the phase at the inflexion point,  $f_d$  - is the frequency at which  $\delta_m$  occurs.  $R_d$  and  $m_d$  - shape parameters.  $I = 0$  if  $f > f_d$  and 1 if  $f \leq f_d$   $T_{BTSV}$  which indicate hardness of the binder (R&B softening point) and  $\delta_{BTSV}$  shows the elastic ratio of viscoelastic behavior of asphalt binders. These parameters can be calculated empirical and theoretical way. After testing more than 164 different binders  $T_{BTSV}$  is a good estimation of R&B

softening point for unmodified bitumen, but not for PMBs. In figure 6 shows how  $T_{BTSV}$  and R&B softening point related to each other. (Jiqing Zhu et al. 2021)

### 3. Results and discussion

#### 3.1. $G^*/\sin\delta$ parameter relationship with R&B softening point

Higher values of this parameter lead to a decreased tendency to permanent deformation.  $G^*/\sin\delta$  correlated well with the tendency for permanent deformation. However, this parameter is less useful for binders that contain polymers or other modified binders. (Claxton et al. 1996; Carswell et al. 2000).

#### 3.2. "Equi-viscous and equivalent modulus temperatures" based on a DSR relationship with R&B softening point of bitumen

The equivalent modulus rule can be used to calculate the R&B softening point of neat asphalt binder. And between the calculated and the measured softening points a good relationship was found for unmodified binders. As for the complex shear modulus of bitumen was 13.034kPa.

#### 3.3. Binder-Fast-Characterisation-Test (BTSV Bitumen-Typisierung-Schnell-Verfahren) relationship with R&B softening point test

The BTSV method utilizes an iso-modulus approach ( $G^* = 15$  kPa at 10 rad/s) to evaluate bitumen, focusing on equivalent temperature ( $T_{BTSV}$ ) and phase angle ( $\delta_{BTSV}$ ) plots. For unmodified binders, lower penetration grades (harder bitumen) correspond to higher  $T_{BTSV}$  values, with  $\delta_{BTSV}$  values around  $82^\circ$ . After RTFOT ageing,  $T_{BTSV}$  increases and  $\delta_{BTSV}$  decreases to about  $80^\circ$ , a trend expected to continue with further ageing (Alisov et al., 2020). Modified bitumen with 3% SBS exhibits similar ageing trends, with lower  $\delta_{BTSV}$  values compared to unmodified binders. With 5% SBS,  $\delta_{BTSV}$  further decreases and remains stable post-RTFOT, while  $T_{BTSV}$  increases. The BTSV method offers an iso-modulus evaluation of bitumen, typically at a higher modulus than PMB at the Ring and Ball softening point. (Jiqing Zhu et al.)

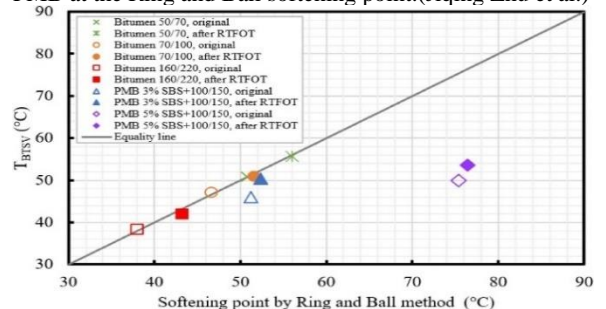


Figure 4.  $T_{BTSV}$  results of bitumen versus the R&B softening point. (Jiqing et al. 2021)

### 4. Conclusion

After conducting a comprehensive review of the state-of-the-art literature on the relationship between the rheological properties of bitumen and the Softening Point Ring and Ball test, several key insights can be drawn.

The development of new binder specifications is moving





towards performance-related requirements, particularly for polymer-modified bitumen (PMB). Despite advancements in test methods, traditional empirical tests like the R&B softening point remain common. There is a gradual shift towards using the dynamic shear rheometer (DSR) for performance specifications. The parameter  $G^*/\sin\delta$ , used in the Superpave binder specification, shows good correlation with permanent deformation tendencies, although it is less effective for polymer-modified binders.

A quantitative relationship derived from dynamic shear rheometer (DSR) results can estimate old empirical parameters efficiently, saving time and providing insight into their limitations. Understanding how DSR results relate to the R&B softening point is crucial, particularly for modified and unmodified bituminous binders. Studies have shown that while the concept of "equiviscous temperature" works well for unmodified bitumen, it is less effective for polymer-modified bitumen (PMB). Testing has also demonstrated a strong correlation between calculated and measured softening points for unmodified binders using the equivalent modulus rule. When investigating modified binders, no reliable correlation was found between rheological parameters and the empirical R&B softening point. Testing showed that while the R&B softening point is consistent for plain binders, it does not behave consistently for polymer-modified binders (PMBs). The complex shear modulus ( $G^*$ ) at the R&B softening point temperature varies significantly for PMBs, indicating the inadequacy of the softening point for representing their rheological properties. To better characterize binder behavior at high temperatures, the isomodulus temperature corresponding to a  $G^*$  of 15 kPa can be used. This approach, combined with the BTSV test method, provides more accurate parameters for describing binder materials.

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## Information about the authors


Er-Sultan  
Joldasbaev  
Baltabay uli

Tashkent State Transport University,  
chair of Automobile roads construction  
and maintenance, teacher-assistant.

<https://orcid.org/0009-0005-4959-0069>



## Comparative analysis of the spatial rigidity of a multi-storey reinforced concrete frame building with foam aerated concrete walls and new frame-sheathing envelope structures

A.A. Khodjaev<sup>1</sup>, I.S. Karimjonov<sup>2</sup>

<sup>1</sup>The Ministry of Higher education, science and innovations, Uzbekistan

<sup>2</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** A comparative analysis of the spatial rigidity of a multi-storey reinforced concrete frame building with foam aerated concrete walls and new frame-sheathing envelope structures (FSW) is presented based on dynamic calculation using the LIRA SOFT software package using the finite element method in the temperature, climatic and seismic conditions of Uzbekistan.

**Keywords:** Aerated concrete, wall, frame-sheathing wall (FSW), light steel thin-walled structures (LSTS), thermal profile, seismic resistance, energy saving, ecology, thermal insulation.

## Сравнительный анализ пространственной жесткости многоэтажного железобетонного каркасного здания с газобетонными стенами и новыми каркасно-обшивными ограждающими конструкциями

Ходжаев А.А.<sup>1</sup>, Каримжонов И.С.<sup>1</sup>

<sup>1</sup>Министерство Высшего образования, науки и инноваций, Узбекистан

<sup>2</sup>Ташкентский государственный транспортный университет, Ташкент, Узбекистан

**Аннотация:** Приведен сравнительный анализ пространственной жесткости многоэтажного железобетонного каркасного здания с газобетонными стенами и новыми каркасно-обшивными ограждающими конструкциями (КОС) на основе динамического расчета с помощью программного комплекса ЛИРА СОФТ методом конечных элементов в температурно-климатических и сейсмических условиях Узбекистана.

**Ключевые слова:** газобетон, стена, каркасно-обшивная стена (КОС), лёгкие стальные тонкостенные конструкции (ЛСТК), термопрофиль, сейсмостойкость, энергосбережение, экология, теплоизоляция.

### 1. Введение

Обеспечение надежности и долговечности зданий и сооружений в условиях повышенной сейсмичности и деструктивных воздействий температурно-влажностных условий резко-континентального сухого жаркого климата во многом обусловлено конструктивными решениями объектов, строящихся на таких территориях.

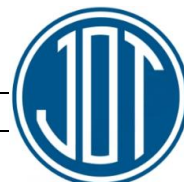
В настоящее время расчет зданий и сооружений на действие сейсмических нагрузок производится в соответствии с КМК 2.01.03-19 «Строительство в сейсмических районах», в основу которых заложено упругое деформирование конструкций с учетом податливости систем и образование пластических шарниров. Расчет прочности элементов производится по предельным усилиям, воспринимаемым элементом в нормальных, наклонных и пространственных сечениях. При этом вводятся специальные коэффициенты условий

работы, учитывающие особенности сейсмического воздействия. Расчет конструкций зданий и сооружений по указанному методу наглядно демонстрирует значение массы системы в общем контексте ее устойчивости при динамических воздействиях. Поэтому снижение массы здания является весьма актуальным для обеспечения его сейсмостойкости и наиболее правильного поведения здания при землетрясениях, обеспечивающего его лучшую надежность и в то же время экономичность проектных решений.

В условиях Узбекистана условие сейсмостойкости зданий обеспечивается на основе теории сейсмостойкого строительства и зависит от типа здания, территории застройки, внешней среды и других факторов. По мере увеличения высоты здания увеличивается и период его свободных (частных) колебаний. Обычно изменение периода свободных колебаний здания приводит к изменению реакции здания и соответствующих напряжений в верхних и нижних уровнях. Известно, что период доминирующей

<sup>a</sup> <https://orcid.org/0009-0000-5159-2972>

<sup>b</sup> <https://orcid.org/0009-0001-7326-6382>





вибрации землетрясения зависит от геологических условий местности вокруг очага и длится 0,1–2 секунды. Увеличение высоты здания (и, соответственно, периода колебаний) отдаляет его от доминирующего периода колебаний землетрясения, что обусловило принятие наиболее оптимальным для сейсмических районов зданий с высотой не более 15 этажей.

## 2. Основная часть

В настоящее время среди строящихся объектов городских территорий подавляющее большинство составляют многоэтажные железобетонные каркасные здания. Популярность такого типа зданий обусловлена прочностью и сейсмостойкостью их пространственной системы, возможностью практически безграничного проектирования и воплощения архитектурных решений, наличием сравнительных преимуществ по цене, отлаженностью технологий строительства и доступностью стройматериалов.

Как известно, несущая способность каркасных зданий обеспечивается пространственной работой железобетонного или металлического каркаса. При этом, в зависимости от заданных параметров и конструктивных решений здания, его пространственная жесткость обеспечивается соответствующими дополнительными связями, диафрагмами и сердечниками. В отдельных случаях диафрагмами жесткости служат также и ограждающие конструкции каркасных зданий, но все же их основная задача заключается в обеспечении функциональности архитектурной среды здания, создание условий для жизнедеятельности его инфраструктуры.

Сравнительный анализ многоэтажных железобетонных каркасных зданий со стенами различных конструкций с учетом их параметров дает возможность выявить наиболее оптимальные и приемлемые из них. С этой целью такой анализ проведен между традиционными, наиболее распространенными конструктивными решениями стен (кирпичные стены, стены из лёгких пористых ячеистых бетонов), а также новым предлагаемым конструктивным решением – каркасно-обшивные стеновые конструкции (КОС).

**Лёгкие пористые ячеистые бетонные блоки.** Ячеистые бетоны являются разновидностью легкого бетона. В процессе их производства образуется характерная "ячеистая" структура. Пористость ячеистого бетона можно регулировать, получая бетоны разной плотности и назначения. По назначению ячеистые бетоны делятся на три группы: конструкционные, конструкционно-теплоизоляционные, теплоизоляционные. Среди блоков из ячеистых бетонов наибольшее распространение получили пенобетонные и газобетонные блоки.

**Блоки из пенобетона.** Пенобетон изготавливается из цемента, песка, воды и пенообразователя. Изделия из пенобетона отличают хорошие звуко- и теплоизоляционные свойства, малый вес. Материал является негорючим и не разрушается от воздействия высокой температуры. На свойства пенобетона оказывает большое влияние качество пенообразователя. В настоящее время в основном применяются

синтетические пенообразователи на основе органических соединений как отечественного, так и импортного производства. Изменяя соотношение составляющих пенобетонной смеси, можно получать пенобетон различной плотности (400–1800 кг/м<sup>3</sup>). С увеличением плотности растет прочность пенобетона, но падает сопротивление теплопередаче. Пенобетонные блоки применяют в качестве ограждающих конструкций в каркасных зданиях, а также как термовкладыши ограждающих конструкций многоэтажных жилых домов. В малоэтажном домостроении в качестве несущих конструкций используют блоки из пенобетона марок от Д500 и выше. В качестве теплоизоляции, как правило, применяют блоки марки Д400 [1].

**Блоки из газобетона.** Газобетон получают из вяжущего (цемента, извести), кварцевого песка, воды, с добавлением газообразующих веществ (благодаря чему мелкие воздушные поры распределяются равномерно). Именно поэтому строительные элементы из газобетона имеют малый вес и хорошие теплоизоляционные свойства. Газобетон относится к конструкционно-теплоизоляционным строительным материалам. Его применение для возведения ограждающих конструкций позволяет значительно уменьшить массу и толщину стен, что не только сокращает сроки и объем строительных работ, но и снижает стоимость строительства в связи с понижением массы здания и экономией на возведении фундамента. Конструкции из газобетона имеют более высокие теплофизические показатели в сравнении с блоками из тяжелых бетонов, керамическими и силикатными штучными материалами. Например, для устройства наружной стены достаточными являются блоки из пористого бетона толщиной 375 мм (плотностью 400 кг/м<sup>3</sup>).

Газобетон является негорючим материалом и может быть использован для всех классов противопожарной безопасности. Он не разрушается от воздействия высокой температуры и препятствует распространению огня. Благодаря своей структуре газобетон является морозостойким строительным материалом. Кроме того, газобетонные блоки легко обрабатываются (пилятся, сверлятся, фрезеруются, шпательются, гвоздятся), а также не подвергаются коррозии и не гниют. При одинаковой плотности прочность газобетона больше почти в 2 раза, чем прочность без автоклавного пенобетона [1].

Особенностью газобетона как высокопористого материала являются высокая паропроницаемость и значительное водопоглощение. Поэтому в ограждающих конструкциях, выполненных из газобетонных блоков, необходимо обеспечить свободный транзит пара изнутри помещения наружу. Этого можно добиться устройством либо вентилируемого фасада, либо системы наружного утепления с применением финишного слоя с высокой паропроницаемостью. В случае невозможности устройства наружного утепления или высокой влажности внутри помещения, необходимо надежно защитить ограждающую конструкцию от проникновения пара изнутри (например, устройства с внутренней стороны пароизоляционной пленки) [1].

Преимуществами ячеистого бетона являются его низкая масса, сравнительная дешевизна (на 15–20 % дешевле обычного легкого бетона), доступность исходного сырья (песок и цемент), несложность механической обработки. К числу недостатков



относятся: значительное трещинообразование, пониженная морозостойкость, плохая связь с фактурными слоями, развитие коррозионных процессов в арматуре [2].

**Каркасно-обшивная стена (КОС)** — это многослойная комбинированная конструктивная система, состоящая из каркаса, материалов для утепления/звукоизоляции, заполняющих полость каркаса, обшивок стены (наружной и внутренней), крепежных элементов, пароизоляции и ветрозащиты, наружной облицовки (фасада), а также совокупности технических и технологических решений, определяющих правила и порядок установки этой системы в проектное положение.

**Наружные несущие КОС с каркасом из ЛСТК** — это ограждающие конструкции, воспринимающие нагрузку от собственного веса, ветровую и технологическую нагрузки и передающие их на несущие конструкции здания [3-5].

КОС — это перспективная, новая энергосберегающая технология, которая по праву может использоваться в жилом высотном домостроении. КОС позволит обеспечить энергосбережение за счет применения эффективного утеплителя и термопрофиля с прорезями, увеличивающими путь теплового потока и как следствие — сопротивление теплопередаче, а также снизит материальные, трудовые и стоимостные затраты в массовом строительстве при высоких качественных и эксплуатационных показателях и сократит сроки строительства за счет технологии сборки.

**Расчет многоэтажного железобетонного каркасного здания с различными ограждающими конструкциями.** В качестве объекта расчета выбрано пятиэтажное железобетонное каркасное здание с двумя вариантами ограждающих конструкций: первый вариант — газобетонные стены, второй вариант — каркасно-обшивные стены (КОС). Для технического сопоставительного анализа произведен также расчет каркаса без стен («этажерка»).

#### Характеристика строительной площадки:

- Район строительства — Республика Узбекистан, Ташкентская область;
- климатический район строительства - 4 по КМК 2.01.01-94;
- Нормативное значение снежного покрова на 1 м<sup>2</sup> горизонтальной поверхности земли — 50 кг/м<sup>2</sup> для площади первого снега;
- Нормативное значение давления ветра — 38 кг/м<sup>2</sup> в 3-м ветровом районе;
- строительная площадка расположена вне зоны затопления города;
- сейсмостойкость строительной площадки, КМК 2.01.01-19;
- Сейсмичность участка по карте строительно-монтажных работ города Ташкента — 8 баллов;
- категория грунтов по сейсмическим характеристикам - 2.

#### Несущие конструкции и конструктивные элементы здания:

- конструктивное решение — каркас;
- основания для несущих конструкций здания — монолитная фундаментная плита. Бетон класса Б 25 на традиционном цементе для несущих колонн. Бетонная подготовка под фундаментные плиты производится из бетона класса Б 20 толщиной 0,5 м;
- сечение двух несущих колонн лестничной клетки —

400х400 мм из бетона класса Б 25, сечение всех остальных колонн между этажами — 400х600 мм из бетона класса Б 25, сечения ригелей несущих межэтажные плиты перекрытия и лестничные клетки, 400х400 мм из бетона класса Б 20, стена технического этажа — подвала из бетона класса Б 20 толщиной 400 мм, межэтажные плиты перекрытия, перекрытия лестниц и лестничных клеток имеют размеры толщиной 180 мм из бетона класса Б 20;

- арматура класса А3 используется во всех несущих элементах здания;
- здание прямоугольной формы, размеры в осях — 24,7×16,6 м;
- этажность здания — 5 этажей;
- 1-5 - высота этажа (от пола до пола) - 3,6 м;
- высота цокольного (подвального) этажа (от пола до пола 1 этажа) - 3,0 м.

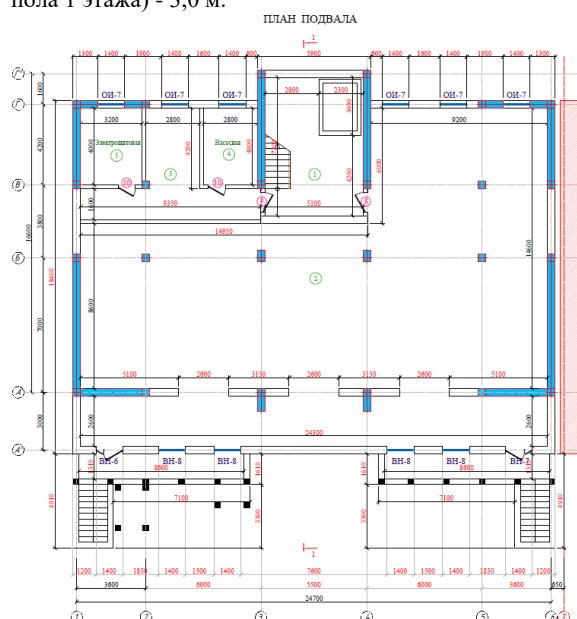


Рисунок 1. План технического этажа здания

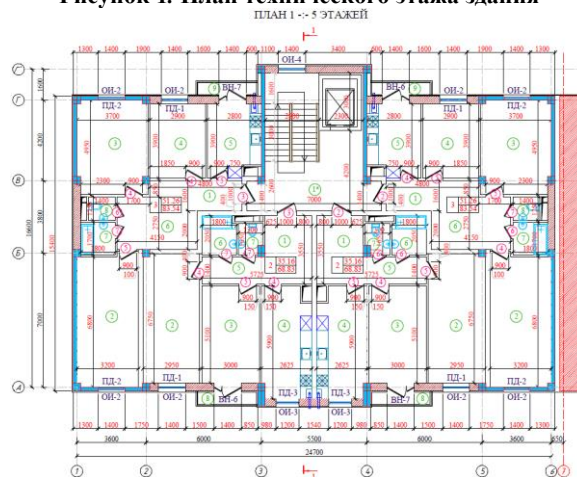


Рисунок 2. Типовой план этажа здания

**Модели объектов для проектирования.** При проведении численного анализа были сделаны расчётные работы со следующими наружными и внутренними стенами рассматриваемого здания:

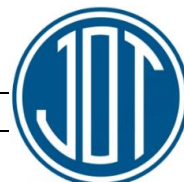


Таблица 1

## Наружные стены и их особенности

№	Типы и толщина наружных стен здания, мм	Характеристики наружных стен	Масса 1 м <sup>2</sup> наружной стены, кг, около
1	Газобетонная: - 300	Марка газобетона: - Д 800. $\rho = 800 \text{ кг/м}^3$ .	240 (250)
2	Каркасно-обшивная стена: - 240		80
3	Этажерка (без наружных стен)		

Таблица 2

## Внутренние стены и их особенности

№	Типы и толщина внутренних стен здания, мм	Особенности межкомнатных перегородок	Масса 1 м <sup>2</sup> внутренней перегородки, кг, около
1	Газобетонная: - 150 (+ 20, всего 170)	Марка газобетона: - Д 800. $\rho = 800 \text{ кг/м}^3$ .	130
2	Каркасно-обшивная перегородка: - 100 (155)		60
3	Этажерка (без внутренней стены)		

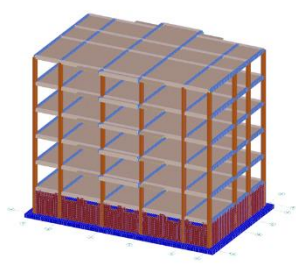


Рисунок 3. Вид расчётной модели (схемы) здания спереди

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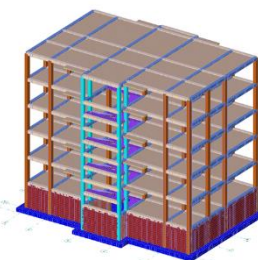


Рисунок 4. Вид расчётной модели (схемы) здания сзади

Как правило здания в сейсмических районах проектируются по схемам, при которых стены этих зданий воспринимают сейсмическую нагрузку как несущие конструкции, либо не являются несущими, а сейсмическую нагрузку воспринимает каркас здания. Однако не рекомендуется увеличивать высоту зданий, наружные стены которых воспринимают сейсмические нагрузки, более чем на 5-7 этажей. Поэтому, согласно пунктам Е и Ж, таблицы 3.1 КМК 2.01.03-19 расчёт наружных и внутренних стен в модели рассматриваемого многоэтажного здания выполняется как ненесущие и без жёсткого их закрепления в здании.

**Методы расчета.** Расчеты проводились с использованием нормативного документа КМК 2.01.03-19 «Строительство в сейсмических районах» и динамическим способом в программе ЛИРА СОФТ методом конечных элементов в перемещениях.

Деформированная схема элементов железобетонного каркаса здания приведена на рис. 5–10.

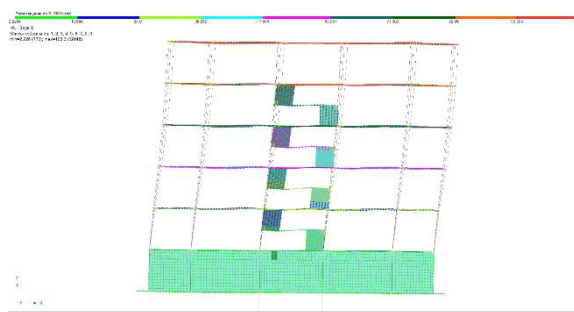


Рисунок 5. Мозаика перемещений по оси X пятиэтажного каркасного здания с наружными и внутренними стенами из газобетона; максимальное перемещение 105,33 мм.

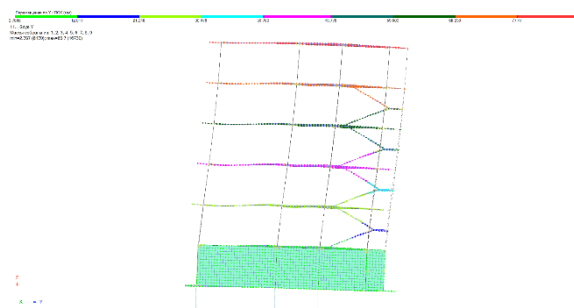


Рисунок 6. Мозаика перемещений по оси Y пятиэтажного каркасного здания с наружными и внутренними стенами из газобетона; максимальное перемещение 86,70 мм.



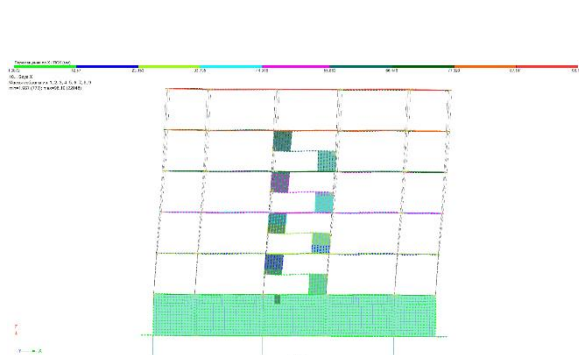


Рисунок 7. Мозаика перемещений по оси X пятиэтажного каркасного здания без наружных и внутренних стен; максимальное перемещение 98,19 мм.

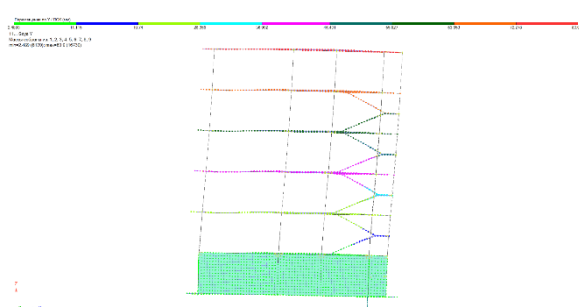


Рисунок 8. Мозаика перемещений по оси Y пятиэтажного каркасного здания без наружных и внутренних стен; максимальное перемещение 80,9 мм.

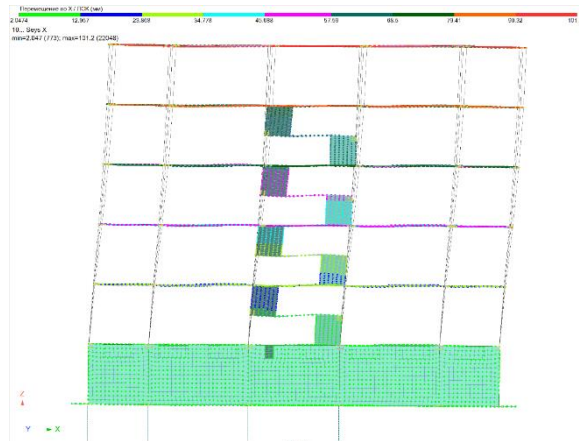


Рисунок 9. Мозаика перемещений по оси X пятиэтажного каркасного здания с наружными и внутренними каркасно-обшивными стенами; максимальное перемещение 101,23 мм.

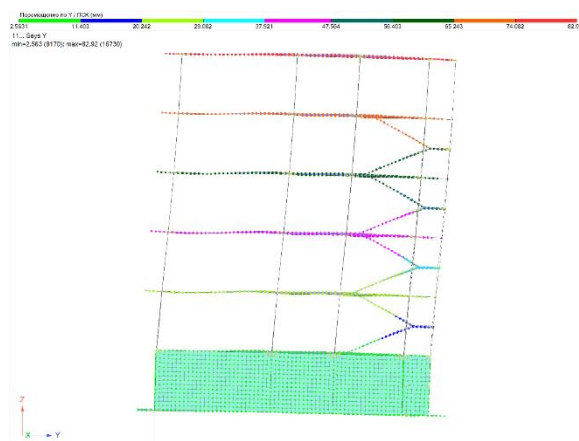


Рисунок 10. Мозаика перемещений по оси Y пятиэтажного каркасного здания с наружными и внутренними каркасно-обшивными стенами; максимальное перемещение 82,92 мм.

Приведенные выше результаты сведены в таблицу 3:  
Таблица 3

Результаты перемещения конструкций пятиэтажного железобетонного каркасного здания по осям X и Y

№	Конструктивная система и размеры здания с железобетонным каркасом	Максимальное перемещение в направлении оси X, мм	Максимальное перемещение в направлении оси Y, мм
1	5-этажное каркасное здание с наружными и внутренними стенами из газобетона, размеры 24,7×16,6 м.	105,33	86,70
2	5-этажное каркасное здание без наружных и внутренних стен, размеры 24,7×16,6 м.	98,19	80,9
3	5-этажное каркасное здание с наружными и внутренними каркасно-обшивными стенами, размеры 24,7x16,6 м.	<b>101,23</b>	<b>82,92</b>

По данным второго пункта таблицы 2.6 КМК 2.01.03-19, в случаях, когда несущие элементы зданий защищены от воздействия деформаций несущих конструкций, величина перемещений зданий по оси X и Y допускается в случаях, когда значения перемещений не превышают 1/70 общей высоты здания. Высота исследуемого 5-этажного железобетонного каркасного здания составляет 21,6 м при вертикальном положении несущих элементов. В этом случае максимальное

значение перемещения составляет  $h/70=21600/70=308,57$  мм.

При расчёте зданий с наружными и внутренними стенами и без них, во всех случаях значения перемещений не превышали максимально допустимого предела.

Следует отметить, что замена газобетонной кладки на легкую КОС позволило значительно снизить общую массу здания (таблица 4).





Таблица 4

Влияние наружных и внутренних стен на общую массу 5-этажного здания

№	Конструктивная система и размеры здания с железобетонным каркасом	Масса здания, тонна
1	5-этажное каркасное здание с наружными и внутренними стенами из газобетона, размеры 24,7×16,6 м.	4 014,46
2	5-этажное каркасное здание без наружных и внутренних стен, размеры 24,7×16,6 м.	3 513,49
3	5-этажное каркасное здание с наружными и внутренними каркасно-обшивными стенами, размеры 24,7x16,6 м.	3 747,09

Из приведенных выше результатов видно, что в 5-этажных железобетонных каркасных зданиях при использовании каркасно-обшивных стен в качестве ограждающих и разделительных стен (перегородок), значения перемещений и сдвигов значительно уменьшаются по сравнению со зданиями где применяются газобетонные стены, а общая масса здания становится легче. Это, в свою очередь, повышает сейсмостойкость здания.

Также проведен анализ расхода арматуры в несущих вертикальных конструкциях – колоннах и горизонтальных конструкциях – ригелях пятиэтажного железобетонного каркасного здания (рис.11-16).

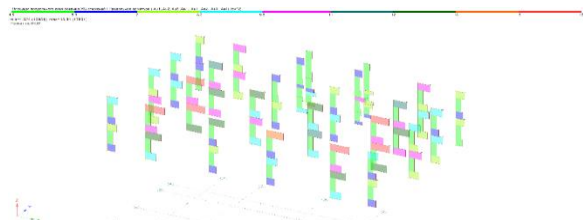


Рисунок 11. Расположение колонн и максимальная площадь армирование в колоннах на четвёртом и пятом этажах пятиэтажного каркасного железобетонного здания с внутренними и наружными стенами из газобетона.

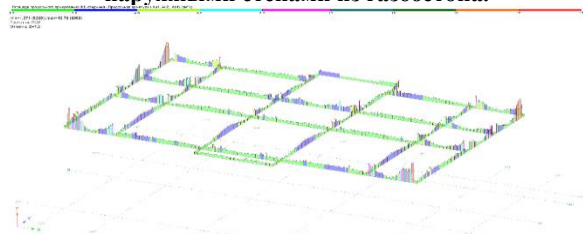


Рисунок 12. Расположение ригелей и максимальная площадь армирование на нижней грани ригелей с первого по пятые этажи пятиэтажного каркасного железобетонного здания с внутренними и наружными стенами из газобетона.

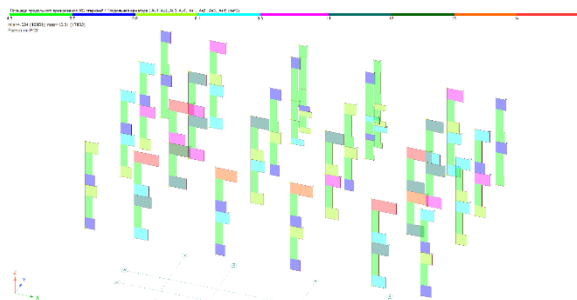


Рисунок 13. Расположение колонн и максимальная площадь армирование в колоннах на четвёртом и пятом этажах пятиэтажного каркасного железобетонного здания без внутренних и наружных стен.

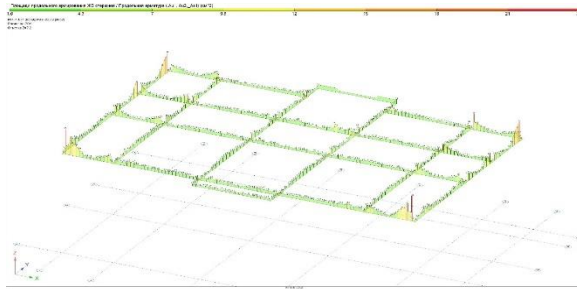


Рисунок 14. Расположение ригелей и максимальная площадь армирование на нижней грани ригелей с первого по пятые этажи пятиэтажного каркасного железобетонного здания без внутренних и наружных стен.

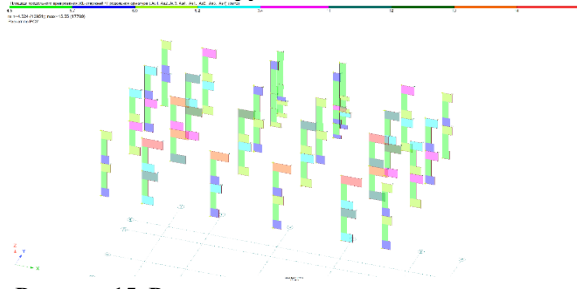


Рисунок 15. Расположение колонн и максимальная площадь армирование в колоннах на четвёртом и пятом этажах пятиэтажного каркасного железобетонного здания с внутренними и наружными каркасно-обшивными стенами.

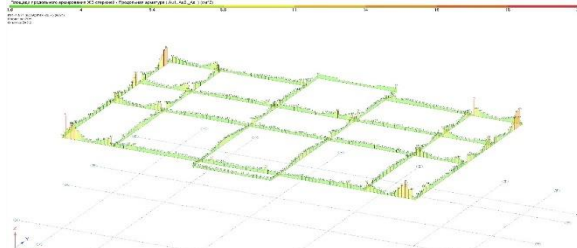


Рисунок 16. Расположение ригелей и максимальная площадь армирование на нижней грани ригелей с первого по пятые этажи пятиэтажного каркасного железобетонного здания с внутренними и наружными каркасно-обшивными стенами.



Данный анализ показал, что количество используемой арматуры для несущих колонн и ригелей 5-этажного железобетонного каркасного здания снижается при замене газобетонных стен на КОС

(таблица 5). Не трудно заметить, что расход арматуры при использовании КОС за счет его облегченной массы сопоставим с расходом арматуры для здания “этажерки”.

Таблица 5

Расход арматуры в несущих конструкциях колонн и ригелей

№	Конструктивная система и размеры здания с железобетонным каркасом	Расход арматуры в колоннах, тонна	Расход арматуры в ригелях, тонна	Общий расход арматуры для колонн и ригелей здания, тонна
1	5-этажное каркасное здание с наружными и внутренними стенами из газобетона, размеры 24,7×16,6 м.	73,8	107,91	181,7
2	5-этажное каркасное здание без наружных и внутренних стен, размеры 24,7×16,6 м.	64,93	100,53	165,5
3	5-этажное каркасное здание с наружными и внутренними каркасно-обшивными стенами, размеры 24,7×16,6 м.	<b>68,82</b>	<b>102,49</b>	<b>171,3</b>

### 3. Заключение

1 Создана пространственная модель многоэтажного железобетонного каркасного здания с применением КОС с помощью программного обеспечения ЛИРА СОФТ и проведены численные эксперименты.

2 Определены напряженно-деформационные состояния многоэтажного железобетонного каркасного здания с применением КОС. Проведён сравнительный анализ напряженно-деформационного состояния, под воздействием сейсмических и динамических нагрузок зданий с использованием КОС и газобетонных стен.

3 При расчёте зданий с наружными и внутренними стенами и без них, во всех из них значения перемещений не превышали максимально допустимого предела. Однако величина перемещения здания по оси X была примерно на **4%** выше у здания с **газобетонными стенами** по сравнению со зданием с **каркасно-обшивными стенами**. По сравнению с **каркасным зданием без наружных и внутренних стен** разница была всего на **3%** выше чем у здания с каркасно-обшивными стенами.

4 Величина перемещений здания по оси Y, была примерно на **4,5%** выше у здания с **газобетонными стенами** по сравнению со зданием с **каркасно-обшивными стенами**. При этом по сравнению с **каркасным зданием без наружных и внутренних стен** разница была всего на **3,5%** больше в здании с каркасно-обшивными стенами.

5 В здании со стенами из газобетона общий расход арматуры для колонн и ригелей увеличился примерно на **6%** по сравнению со зданием с **каркасно-обшивными стенами**. По сравнению с каркасным зданием без наружных и внутренних стен, общий расход арматуры в здании с каркасно-обшивными стенами был больше всего на **3,5%**.

6 При использовании стен из газобетона масса 5-этажного здания увеличилась примерно на **7,1%** по сравнению со зданием где применяется **каркасно-**

**обшивная стена**. По сравнению с массой каркасного здания без наружных и внутренних стен эта разница в массе была на **6,6%** больше у здания с каркасно-обшивными стенами.

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### Информация о авторах / Information about the authors

Abbos Khodjayev Министерство высшего образования, науки и инноваций <https://orcid.org/0009-0000-5159-2972>

Ibrokhim Karimjonov Ташкентский государственный транспортный университет, таянч докторантура изланувчиси <https://orcid.org/0009-0001-7326-5887>



## Issues of the use of securities in the financing of the development of the transport system in the Republic of Uzbekistan

R.F. Urakov<sup>1</sup> <sup>a</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** In this article, it is an undeniable fact that the transition to a socially oriented market economy based on the principles of the stock market model of the Republic of Uzbekistan is an integral part of the republic's economic development strategy. If we look at the experience of the developed countries of the world, it is stated that the stock market has been formed spontaneously for many years.

**Keywords:** national stock market, financial market, efficiency of the market mechanism.

## O'zbekiston Respublikasida transport tizimini rivojlantirishning moliyalashtirishda qimmatli qog'ozlardan foydalanish masalalari

UraKov R.F.<sup>1</sup> <sup>a</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Toshkent, O'zbekiston

**Annotatsiya** Ushbu maqolada O'zbekiston Respublikasining qimmatli qog'ozlar bozori modeli tamoyillariga asoslangan ijtimoiy yo'naltirilgan bozor iqtisodiyotiga o'tish respublika iqtisodiy rivojlanish strategiyasining yaxlit ekanligi hozirgi kundagi inkor etilmaydigan haqiqatdir. Dunyoning rivojlangan mamlakatlar tajribasiga nazar tashlasak, qimmatli qog'ozlar bozori uzoq yillar davomida stixiyali ravishda yuzaga kelganligi keltirilgan.

**Keywords:** milliy qimmatli qog'ozlar bozori, moliya bozori, bozor mexanizmining samaradorligi.

### 1. Kirish

O'tgan asrda iqtisodiyoti taraqqiy topgan mamlakatlarning tajribasi shuni so'zsiz tasdiqladiki, faqat bozor iqtisodiyotiga iqtisodiyot samaradorlik ko'rsatkichlarining eng yuqori darajasini ta'minlaydi. Bozor mexanizmining samaradorligi ko'p jihatdan iqtisodiyotning tovar – pul munosabatlari bilan qay darajada to'liq qamrab olinganligi bilan bevosita bog'liq. Bu tovar bozorlari bilan bir qatorda moliya bozorini jumladan, uning tarkibiy qismi hisoblanadigan qimmatli qog'ozlar bozorini shakllantirish zarurligini anglatadi. Chunki, bozor iqtisodiyoti qimmatli qog'ozlarning rivojlangan aylanmasiz amal qilishi mumkin emas.

O'zbekiston Respublikasida milliy qimmatli qog'ozlar bozori ilg'or xorijiy tajribalar asosida shakllantirilgan. Lekin hozirgi vaqtda milliy qimmatli qog'ozlar bozorida faqat mahalliy emitentlarning aksiyalar bozori va davlat qimmatli qog'ozlar bozori mo'tadil faoliyat yuritmoqda. Qimmatli qog'ozlarning boshqa bozorlari juda sust rivojlangan. Mazkur maqolada O'zbekistonda korporativ obligatsiyalar bozorining faoliyati tahlil etiladi. Muallif tomonidan milliy korporativ obligatsiyalar bozori qog'ozlar yordamida transport tizimini rivojlantirishda moliyaviy mablag'lar jalb etish bo'yicha ilmiy asoslangan amaliy tavsiyalar ishlab chiqilgan.

O'zbekiston Respublikasida milliy qimmatli qog'ozlar bozori bilan birgalikda uning faoliyatini tartibga solib turuvchi qonuniy me'yoriy – xujjatlar parallel ravishda takomillashtirib borilmoqda. 2008 yilning 22 iyulida mamlakatimizda bosib o'tilgan yillar davomida orttirilgan milliy va xorijiy tajribalarni chuqur taxliliy o'rganib egallangan malakalar yordamida, mavjud kamchiliklarni bartaraf qilgan holda, 1993 – 2001 yillarda qabul qilingan to'rtta yirik "Qimmatli qog'ozlar va fond birjasi to'g'risida"gi, "Qimmatli qog'ozlar bozorini faoliyat ko'rsatish mexanizmi to'g'risida"gi, "Qimmatli qog'ozlar bozorida depozitariyalar faoliyati to'g'risida"gi va "Qimmatli qog'ozlar bozorida investorlarning huquqlarini ximoya qilish to'g'risida"gi qonunlar takomillashtirilib, ularga o'zgartirishlar kiritilgan holda yagona "Qimmatli qog'ozlar bozori to'g'risida"gi qonun qabul qilindi. Mamlakatimizda milliy iqtisodiyotni modernizatsiya qilish shart-sharoitida yuzaga kelgan omillarni hisobga olgan holda 2015 yil 3 iyunda biz yuqorida ta'kidlab o'tgan "Qimmatli qog'ozlar bozori to'g'risida"gi qonunning yangi tahriri qabul qilindi.

Yangi qabul qilingan mazkur qonunning asosiy maqsadi milliy qimmatli qog'ozlar bozori sohasidagi munosabatlarni tartibga soluvchi amaldagi qonunlarning bixillashirishdan, ularni xalqaro standartlarga yaqinlashtirishdan, shuningdek xorijiy qimmatli qog'ozlar bozorlariga integratsiyalashish uchun zarur bo'lgan barcha shart – sharoitlarni yaratish yo'li bilan mamlakatimiz qimmatli qog'ozlar bozorining jadal sur'atlar bilan rivojlantirishni ta'minlashdan iboratdir. Lekin

<sup>a</sup>  <https://orcid.org/0009-0006-1563-7559>



O'zbekistonda milliy qimmatli qog'ozlar faoliyat yuritishi uchun yetarli darajada huquqiy-me'yoriy asos yaratilganligiga qaramay milliy qimmatli qog'ozlar bozori sust rivojlangan. Shuning uchun milliy iqtisodiyotni rivojlantirishda qimmatli qog'ozlar bozori faoliyatini yanada takomillashtirish hozirgi davrning dolarb masalalaridan biri hisoblanadi.

Xalqaro amaliyotda iqtisodiy adabiyotlarda yetakchi iqtisodchi olimlar xar bir davlatning milliy iqtisodiyotini qimmatli qog'ozlar bozori yordamida rivojlantirish muammolariga katta e'tibor qaratib kelishgan va hozirda ham e'tibor bermoqdalar. Qimmatli qog'ozlar bozori faoliyatini tadqiq etish, xususiyatlarini ochib berish va uni tartibga solishning nazariy va amaliy jihatlari yetakchi xorijlik iqtisodchi olimlarning, jumladan, Harpreet Kaur Kohli, Arvinder Singh Chawla,[1] Frederic Mishkin,[2] Charles Proctor,[3] Borovkova V.A., Borovkova V.A, V,[4] Galanov V.A,[5] Mirkin Ya.M.[6] va boshqalarning ilmiy izlanishlarida o'z ifodasini topgan.

O'zbekistonlik mahalliy iqtisodchi olimlar S.P.Abdullayev,[7] I.I.Alimov,[8] I.L.Butikov,[9] va boshqalarning ilmiy izlanishlarida qimmatli qog'ozlar bozorida olib boradigan operatsiyalar va ularni tartibga solishning nazariy va amaliy jihatlari tadqiq etilgan. Lekin respublikamizdagi qimmatli qog'ozlar bozorida faoliyatiga ta'sir ko'rsatayotgan zamonaviy ob'yektiv va sub'yektiv, jumladan ijobiy va salbiy omillar hozirda nisbatan kam o'rganilgan.

O'zbekistonlik iqtisodchi olimlardan S.M. Sultanova,[10,11] A.B. Djumanova[12,13] va N.U. Babaxanovlar[14] ilmiy izlanishlarida O'zbekistonda milliy transport tizimida statistika va buxgalteriya hisobi faoliyatini mohiyati va uning xususiyatlari yoritib berilgan

## 2. Tadqiqot metodologiyasi

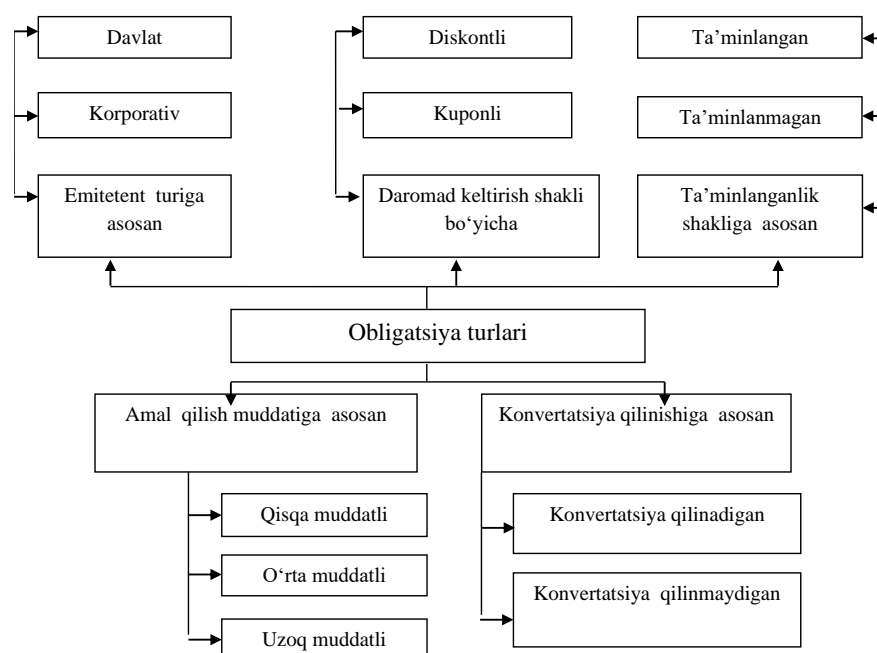
Tadqiqot olib borish va natijalarni asoslash maqsadida ilmiy abstraksiyalash, ma'lumotlarni guruhlash, taqqoslash

va iqtisodiy tahlil usullaridan foydalanildi. Maqolaning uslubiy asosi sifatida xorijiy va mahalliy iqtisodchi olimlarning adabiyotlari va maqolalari tahlil etilgan. Xozirda O'zbekiston Respublikasida milliy qimmatli qog'ozlar faoliyatini tahlil etishda O'zbekiston Respublikasi transport vazirligi va "Toshkyent" Respublika fond birjasining rasmiy saytidagi amaliy ma'lumotlaridan foydalanildi.

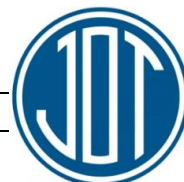
Mamlakatimizda keyingi yillarda moliya-bank tizimini mustahkamlash masalasiga alohida e'tibor qaratildi. O'zbekiston Respublikasi Prezidentining 2017 yil 7 fevraldagi "O'zbekiston Respublikasini yanada rivojlantirish bo'yicha Harakatlar strategiyasi to'g'risida"gi PF-4947-sonli farmonida bank tizimini isloh qilishni chuqurlashtirish va barqarorligini ta'minlash, sug'urta, lizing va boshqa moliyaviy xizmatlarning hajmini ularning yangi turlarini joriy qilish va sifatini oshirish hisobiga kengaytirish, shuningdek kapitalni jalb qilish hamda korxonalar, moliyaviy institutlar va aholining erkin resurslarini joylashtirishdagi muqobil manba sifatida fond bozorini rivojlantirish ko'zda tutilgan. O'zbekiston Respublikasida keyingi yillarda asta-sekin tarqalayotgan qimmatli qog'ozlarning yana bir turi obligatsiyalar hisoblanadi. Xalqaro amaliyotda obligatsiyalar amaldagi qonunchilikka va ularning nizomiga asosan mulkchilikning barcha shakldagi korxonalar tomonidan (korxonalar obligatsiyalari), shuningdek, davlat va mahalliy xokimiyatlar tomonidan chiqarilishi mumkin. Demak, obligatsiyalar quyidagi turlarga bo'linadi:

1. Markaziy xukumatning obligatsiyalari;
2. Mahalliy xokimiyatlarning (munisipal) obligatsiyalari;
3. Korxonalar obligatsiyalari.

Yuqoridagilardan tashqari obligatsiyalarning emitentlari, daromad keltirishi, ta'minlanganligi, muddati, ularni boshqa qimmatli qog'ozlarga almashtirib berish va boshqa omillarga asosan turli guruhlarga ajratish mumkin. Shuni ta'kidlash lozimki, xar bir mamlakatda qonunchilikka asosan obligatsiyalar qat'iy guruhlarga ajratiladi. Biz buni maqolamizning quyidagi rasminida keltiramiz.



1- rasm. Obligatsiyalarning tasnifi



O'zbekistonda yangi tahrirda qabul qilingan qimmatli qog'ozlar bozori to'g'risidagi qonunga asosan "obligatsiya - emissiyaviy qimmatli qog'oz bo'lib, u obligatsiyani saqlovchining obligatsiyaning nominal qiymatini yoki boshqa mulkiy ekvivalentini obligatsiyani chiqargan shaxsdan obligatsiyada nazarda tutilgan muddatda olishga, obligatsiyaning nominal qiymatidan qat'iy belgilangan foizni olishga bo'lgan huquqini yoxud boshqa mulkiy huquqlarini tasdiqlaydi"[15] ta'rif berilgan.

Agarda biz obligatsiyalarning ta'rifida quyidagilarni guvohi bo'lamiz:

1. Yangi ta'rifda obligatsiya egasi va obligatsiyani chiqargan shaxs (emitent) aniq belgilangan;
2. Yangi ta'rifda obligatsiyaning nominal qiymati bilan birga boshqa mulkiy ekvivalent nazarda tutilgan;
3. Yangi ta'rifda har bir obligatsiyaning nominal qiymatidan qayd etilgan foiz aniq belgilab qo'yilgan.

Yuqoridagilardan xulosa qilish mumkinki, yangi qonunchilikda yillar davomida milliy va xorijiy tajribalarni chuqur taxlil o'rganib egallangan malakalar yordamida obligatsiyalarga berilgan ta'rif uning mohiyatini to'liq ochib bergan deb hisoblashimiz mumkin. Shuni alohida ta'kidlash lozimki, obligatsiyalar qarzga oid qimmatli qog'ozlardir, ya'ni ularning egasi tomonidan pul mablag'lari qo'yilganligini tasdiqlaydi va unda ko'rsatilgan muddatda qayd etilgan foizni to'lagan holda qimmatli qog'ozning nominal qiymatini to'lash majburiyatini tasdiqlaydi. Aksiyadan farqli o'laroq, obligatsiya emitentning mol-mulkiga egalik qilish belgisi emas. Obligatsiya ovoz berish, shundan kelib chiqqan holda, jamiyatni boshqarish huquqini bermaydi.

Yangi qonunchilikda mamlakatimizda obligatsiyalarning quyidagi turlarini muomalaga chiqarish belgilab qo'yilgan:

- O'zbekiston Respublikasi Vazirlar Mahkamasi vakolat bergan organ tomonidan chiqariladigan obligatsiyalar, shuningdek, O'zbekiston Respublikasi Markaziy bankining obligatsiyalari;

- Korporativ obligatsiyalar;
- Infratuzilma obligatsiyalari.

O'zbekistonda yangi tahrirdagi qabul qilingan qonunchilikka asosan korporativ obligatsiyalar quyidagi shartlarga rioya etgan holda:

emitentning bunday obligatsiyalar chiqarish to'g'risida qaror qabul qilingan sanadagi, auditorlik tashkiloti xulosasi bilan tasdiqlangan o'z kapitali miqdori doirasida;

keyingi uch yilda rentabellik, to'lovga qobiliyatlilik, moliyaviy barqarorlik va likvidlilikning auditorlik tashkiloti xulosalari bilan tasdiqlangan ijobiy ko'rsatkichlariga ega bo'lgan, shuningdek qonun hujjatlarida belgilangan tartibda mustaqil reyting bahosini olgan emitentlar tomonidan;

investorlarga tegishli mablag'larning emitentlar tomonidan to'lanishi bo'yicha to'lov agentlari vazifasini bajaruvchi tijorat banklari ishtirokida chiqariladi.

Avval amal qilgan qonunchilikda aksiyadorlik jamiyatlari chiqarilgan barcha aksiyalar haqi to'liq tanlanganligidan keyingi ustav fondi miqdorining 20 foizidan ko'p bo'lmagan summada obligatsiyalar chiqarishlari belgilab qo'yilgan edi. Yangi qonunchilikda ushbu cheklov bekor qilingan va aksiyadorlik jamiyati auditorlik tashkilotining xulosasi bilan tasdiqlangan o'z ustav fondining korporativ obligatsiyalar chiqarish to'g'risida qaror qabul qilingan sanadagi miqdori doirasida chiqarish ko'zda tutilgan [15].

O'zbekiston Respublikasida mahalliy xo'jalik yurituvchi sub'ktlarga korporativ obligatsiyalarni muomalaga chiqarish bo'yicha qonunchilikda keng imkoniyatlar berilganiga qaramay hozirda ushbu bozor juda sust rivojlangan. "Toshkent" Respublika fond birjasining rasmiy ma'lumotlariga ko'ra, 2016 yilda respublikada atigi 2-ta emitent muomalaga korporativ obligatsiyalarni chiqargan. 2023 yilda 8-ta emitent muomalaga korporativ obligatsiyalarni chiqargan.[16] Ushbu emitentlar tarkibida faqatgina tijorat banklari va lizing kompaniyalar bor. O'zbekistonda faoliyat yuritayotgan transport tizimidagi korxonalar korporativ obligatsiyalar imkoniyatidan umuman foydalanmagan.

Yuqoridagilardan xulosa qilish mumkinki, O'zbekiston Respublikasida transport tizimida faoliyat olib borayotgan korxonalar milliy qimmatlali qog'ozlar imkoniyatlaridan umuman foydalana olmayptilar. Biz ushbu salbiy holatni ijobiy hal etish uchun ilmiy asoslangan amaliy tavsiyalarni taklif etamiz. Xorijiy va mahalliy tijorat banklaridan transport tizimini modernizatsiya qilish loyihalarini moliyalashtirish uchun kreditlar olish mumkin. Shuni alohida ta'kidlash lozimki, O'zbekistonda transport tizimida faoliyat yurituvchi korxonalar moliyaviy jihatdan barqaror hisoblanadi. Lekin kreditlarni xar oyda kreditning asosiy qarzi va unga hisoblangan foizlarni xar oyda to'lab borish majburiyati bor. Bu esa bizning fikrimizcha. Ushbu holat qarzga olingan mablag'lardan to'liq foydalanish imkoniyatini bermaydi.

Fikrimizcha, mavjud muammoni ijobiy hal etishning quyidagi ikki yo'nalishlari mavjud:

-birinchisi, O'zbekistonda amaldagi qonunchilikka asosan korporativ obligatsiyalar qarzga oid qimmatli qog'ozlardir, ya'ni ularning egasi tomonidan pul mablag'lari qo'yilganligini tasdiqlaydi va unda ko'rsatilgan muddatda qayd etilgan foizni to'lagan holda qimmatli qog'ozning nominal qiymatini to'lash majburiyatini tasdiqlaydi. Ushbu omil tijorat banklaridan olingan kreditlardan farqli ravishda, korporativ obligatsiyalarni muomalaga chiqarishdan kelgan mablag'lardan belgilangan muddat davomida to'liq foydalanish imkoniyatini beradi. Shuning uchun, transport tizimini rivojlantirishni moliyalashtirish uchun korporativ obligatsiyalar bozori imkoniyatlaridan foydalanishni amaliyotga kiritish lozim;

-ikkinchisi, O'zbekistonda hozirgi davrda 42-ta sug'urta kompaniyalari va 20ga yaqin mayda tijorat banklari faoliyat yuritib kelmoqda. Amaldagi qonunchilikka assan ular davlat qimmatli qog'ozlar bozorida ishtirok eta olmaydilar. Respublikamizda korporativ obligatsiyalar bozori sarmoyadorlari tarkibini kengaytirish lozim. Respublikamizda korporativ obligatsiyalar qog'ozlari sarmoyadorlari tarkibiga rivojlangan davlatlardagi (AQSH, Yaponiya, GFR va boshqalar) amaliyotiga asosan mamlakatimizda faoliyat yuritayotgan sug'urta kompaniyalari, mayda tijorat banklari va mikrokredit tashkilotlarini kiritish lozim

### 3. Xulosa

Yuqoridagi takliflarni amaliyotga kiritilishi mamlakatimizda transport tizimini rivojlantirishda mahalliy qimmatli qog'ozlar bozori orqali ichki imkoniyatlar hisobiga moliyalashtirishda mahalliy sarmoyadorlarning mavqeyini oshishiga ijobiy ta'sir ko'rsatishi mumkin deb hisoblaymiz.



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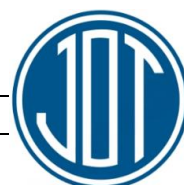
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## Mualliflar bo'yicha ma'lumot/ Information about the authors

Rustam Urakov

Toshkent davlat transport universiteti "Hisob va biznes" kafedrası katta o'qituvchisi  
<https://orcid.org/0009-0006-1563-7559>





## Studying the properties of cement concrete with complex additives based on modern superplasticizers and fillers

U.X. Abdullayev<sup>1</sup>, S.I. Kandakharov<sup>1</sup>, D.T. Sharipova<sup>1</sup>, N.B. Rakhimova<sup>1</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** This article describes the methods of using cement concrete with complex additives today. In modern construction, information is given on the effective ways of using chemical additives to enhance the high physical-mechanical and performance properties of new-generation concrete.

**Keywords:** Superplasticizer, complex additives, concrete, polycarboxylate esters, zolo-unos, steel melting waste.

## Kompleks qo‘shimchali syement betonlarining zamonaviy superplastifikatorlar hamda to‘ldiruvchilar asosidagi xossalarni o‘rganish

Abdullayev U.X.<sup>1</sup>, Kandakharov S.I.<sup>1</sup>, Sharipova D.T.<sup>1</sup>, Rakhimova N.B.<sup>1</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Toshkent, O‘zbekiston

**Annotatsiya:** Ushbu maqolada hozirgi kunda kompleks qo‘shimchali syement betonlaridan foydalanish usullari ko‘rsatib o‘tilgan. Zamonaviy qurilishda yangi avlod betonlarining yuqori fizik-mexanik va ishlash xossalarni kuchaytirishda kimyoviy qo‘shimchalardan qo‘shib foydalanishning samarali yo‘llari haqida ma‘lumot berilgan.

**Keywords:** Superplastifikator, kompleks qo‘shimchalar, beton, polikarboksilat efirlari, zolo-unos, po‘lat eritish chiqindilari.

### 1. Kirish

Zamonaviy qurilishda yangi avlod betonlarining yuqori fizik-mexanik va ishlash xossalarni kuchaytirishda kimyoviy qo‘shimchalardan qo‘shib foydalanmasdan tasavvur qilish mumkin emas. Qurilishda bunday kompozitsiyalar va ular asosidagi mahsulotlarni ishlab chiqarish uchun reologik xususiyatlarga ta‘sir qilish, strukturaning shakllanishi va havo kirish jarayonlarini nazorat qilish imkonini beradigan keng turdagi qo‘shimchalar qo‘llaniladi [1-3].

Xozirgi kunda kompleks qo‘shimchali syement betonlaridan foydalanish avvalgiga davrlarga nisbatan sezilarli ko‘paygan. Mahalliy va xorijiy olimlarning izlanishlari natijasida shu narsa mu‘lum bo‘ldiki, syement kompozitlarining xususiyatlariga sezilarli ta‘sir ko‘rsatadigan va uning xossalarni o‘zgartiradigan eng samarali omil plastiklashtiruvchi qo‘shimchalardan foydalanishdir [3-6].

Shuningdek, bunday muammolarni hal qilishda kompleks qo‘shimchali syement betonlarini xossalarni nazorat qilish va kerakli xossa ko‘rsatkichlariga ega bo‘lgan kompozitlarni yaratishda mineral to‘ldiruvchi moddalardan foydalanish xam samara beradi [4-6]. Syement-betonning tuzilishiga ta‘sir qilish xususiyatiga ko‘ra, mineral to‘ldiruvchi moddalar faol va inert turlarga bo‘linadi. Quruq issiq iqlim sharoitida ishlatiladigan kompleks qo‘shimchali syement betonlarini tayyorlashda muhim ahamiyat kasb etadi.

Oxirgi vaqtlarda kompleks qo‘shimchali syement betonlarini tayyorlashda polikarboksilat efirlari asosidagi moddalar keng qo‘llanilmoqda. Ushbu superplastifikatorlar boshqa turdagi kimyoviy qo‘shimchalardan syement

tizimiga sterik ta‘hiri bilan ajralib turadi va gidratlangan muhitda sodir bo‘ladigan fizik-kimyoviy o‘zaro ta‘sirlar va o‘zgarishlar jarayonini kuzatishga imkon beradi [3-6].

Kompleks qo‘shimchali syement betonlarini tayyorlashda mikroto‘ldiruvchilardan foydalanishning ta‘hiri quyidagicha tushuntiriladi [7-9]:

- faol qo‘shimchalar kalsiy oksidi bilan reaksiyaga kirishadi syement bog‘lovchi yopishtiruvchi-yopishqoq kuchli ulanishlarni yaxshilash orqali amalga oshadi, bu "bog‘lovchi +to‘ldiruvchi" interfeysidagi o‘zaro ta‘sirlar ishlab chiqilgan kompozitsiyani sezilarli darajada mustahkamlash uchun qulay sharoit yaratadi;
- inert mineral qo‘shimchalar, asosan, betonning zichligi oshirish g‘ovaklar sonining sezilarli darajada kamayishini ta‘minlaydi. Bundan tashqari, to‘ldiruvchilarning zarrachalari shartli ravishda yopiladi.

Olimlarning olib borilgan ilmiy izlanishlar shuni ko‘rsatdiki, yuqori sifatli betonlarini olish uchun kimyoviy yoki mineral qo‘shimchalarni alohida emas, balki kompleks shaklda ishlatish ancha samarali ekanligi aniqlandi [2-5]. Bundan tashqari, qo‘shimchalardan foydalanishga bunday kompleks yondashuv ham bog‘lovchining o‘rtacha iste‘moli bilan yuqori sifatli betonlarni ishlab chiqishga imkon beradi.

Shu nuqtai nazardan, turli xil tabiatdagi to‘ldiruvchi moddalari bilan murakkab qo‘shimchali syement betonining asosiy fizik-mexanik xususiyatlarini o‘rganish berilgan.



## 2. Tadqiqot metodologiyasi

Eksperimental tadqiqotlarda Oxangaron sement zavodining M400 D0 markali portlandsyementidan foydalanilgan. Mineral to'ldiruvchi sifatida YangiAngren IYeS dan uchuvchi kul (UK) va Toshkent quyuv-mexanika

zavodining (TQMZ) po'lat eritish chiqindilari (PECh) ishlatilgan. Sirtli faol modda sifatida, polikarboksilat superplastiklashtiruvchi (SP) POLIMIKS ishlatilgan.

Tadqiqot o'tkazish uchun uchta turdagi kompozitsiyalarning bir qator namunalari tayyorlandi: nazorat va kompleks qo'shimchali (1-jadval).

1-jadval

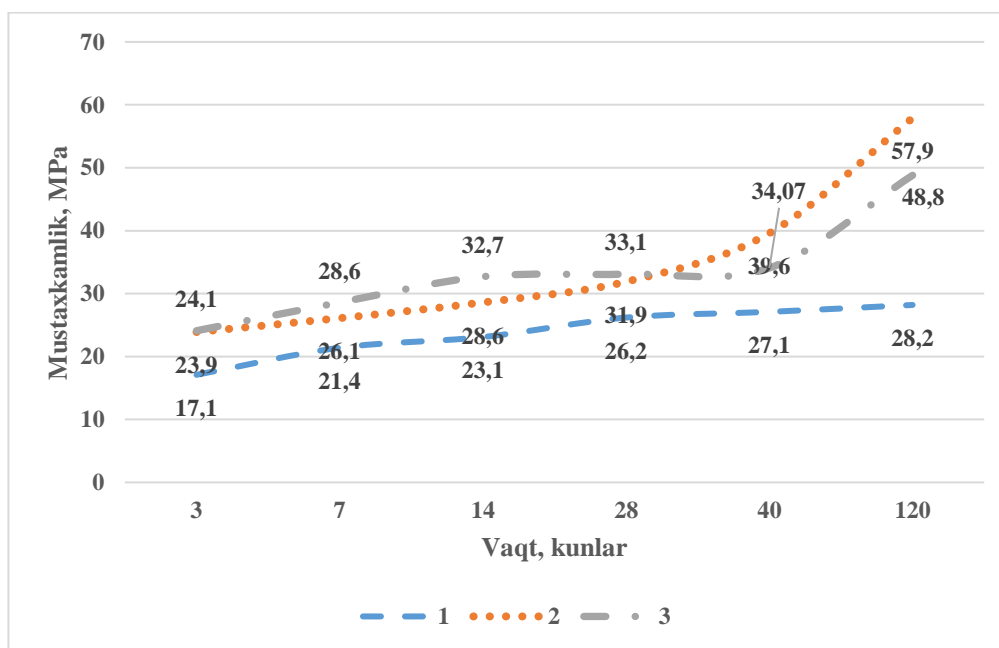
Beton qarishmasining o'rganilganlik tarkibi

Beton sinfi	Konus cho'kishi, sm	Syement, kg	Maydalangan tosh, kg fr. 5-20	Qum, kg $M_{cr}=2,7$	Suv, l	Zolo-unos, kg	Po'lat ishlab chiqarish chiqindilari, kg	Superplastifikat or POLIMIKS, kg
B1 <sub>5</sub>	1-2	236	1220	715	190	-	-	-
B1 <sub>5</sub>	1-2	201	1220	792	133	35	-	1.89
B1 <sub>5</sub>	1-2	201	1220	792	133	-	35	1.89

Namunalarning siqilishga mustaxkamligi, zichligi, suvga chidamliligi, suvni singdirish kabi fizik-mexanik xususiyatlarini o'rganish standart usullar asosida amalga oshirildi. Beton namunalari qattiqlashtirish normal sharoitda amalga oshirildi va 3, 7, 14, 28, 40, 120 sutkalik sinovdan o'tkazildi.

1-rasm shuni ko'rsatdiki, dastlabki 3 sutka ichida har xil turdagi to'ldiruvchi moddalari bo'lgan murakkab

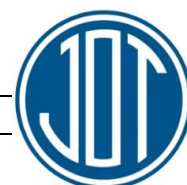
qo'shimchali kompozitsiyalarning mustahkamlik xususiyatlari deyarli bir xil va nazorat tarkibi 28 % ga oshadi. 14 sutkalikda PECh+SP tarkibining kuchi ZU+SP modifikatori bilan to'ldiruvchiga nisbatan 8-12 % va nazorat tarkibi 25-28 % ga oshadi. Ushbu ko'rsatkichga ko'ra, beton sinfi B25, etalon esa B15 sinfga taaluqli bo'ladi.

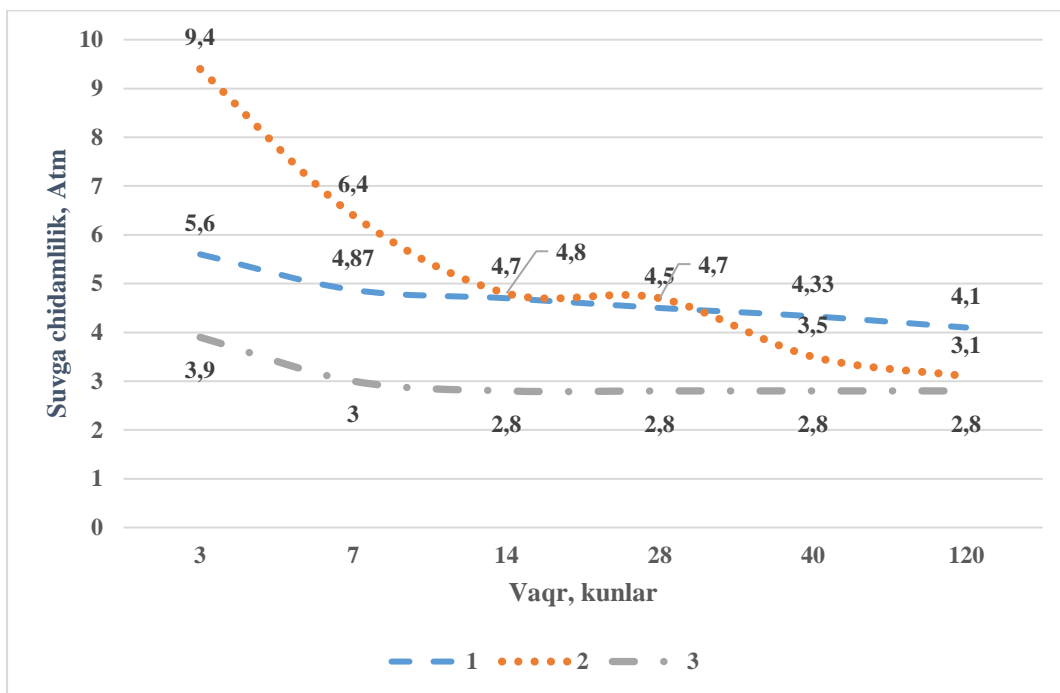


1-rasm. O'rganilayotgan tarkibning siqilishga mustahkamligi tekshirish: 1-nazorat; 2-ZU+SP; 3-SP+PECH

Bizning fikrimizcha, tashqi ta'sir va to'ldiruvchi moddalar, ularning kiritilishi, bir tomondan aralashtirish vaqtidagi suv miqdori kamayishi boshqa tomondan,

mikroto'ldiruvchilar va puzolan faolligini oshishi modifikatsiyalangan to'ldirgichlarning mustahkamligining sezilarli darajada oshishiga sabab bo'ladi.



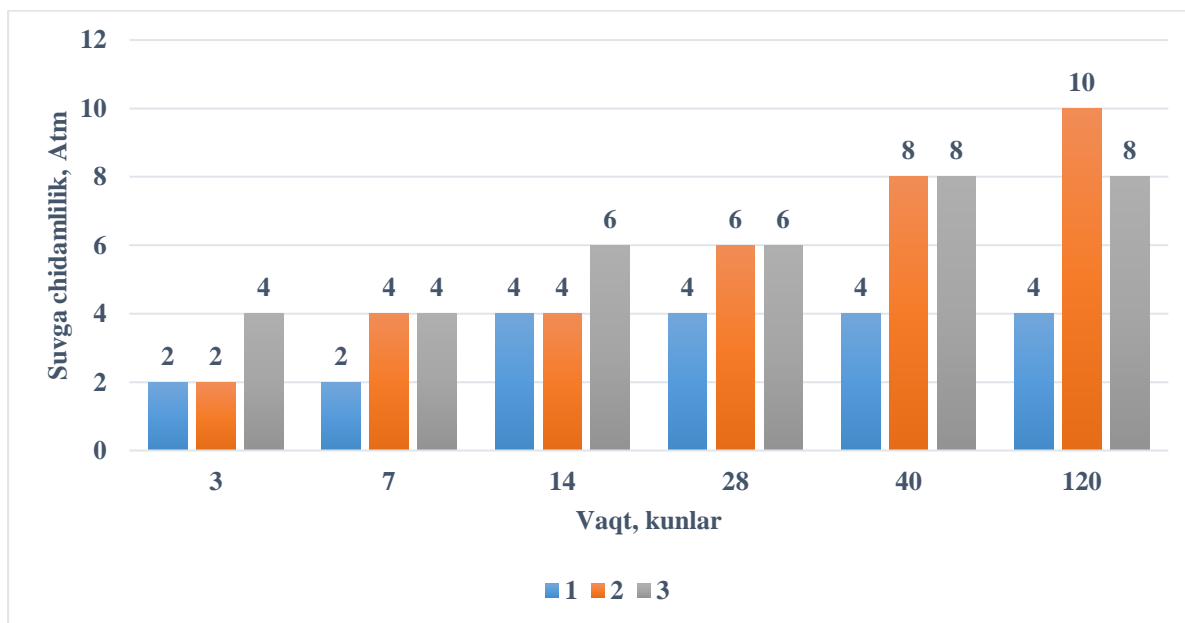


2-rasm. O'rganilayotgan tarkibning suv o'tkazuvchanligini tekshirish:  
1-nazorat; 2-ZU+SP; 3-SP+PECH

Tadqiqotlar shuni ko'rsatdiki, kompleks qo'shimchalar qotayotgan betonning suv shimuvchanligiga turlicha ta'sir ko'rsatadi (2-rasm). O'rganilayotgan tarkiblardan ZU+SP 14 sutkalik qotishda boshqa tarkiblarga qaraganda eng ko'p suv shimuvchanlikni namayon qildi.

Bu tarkibdagi ikkilamchi g'ovaklikni hosil qiluvchi erkin, to'liq yonib ketmagan ko'mir zarralarining mavjudligi

bilan bog'liq. Tadqiqotlarimiz shuni ko'rsatdiki, o'rganilayotgan g'ovaklar asosan yopiq g'ovaklar ekanligi aniqlandi va ular materialning o'tkazuvchanligiga ta'sir o'tkazmaydi (3-rasm). Eng kam suv shimuvchanlikni SP+PECH tarkibi ko'rsatdi. Yuqorida ta'kidlanganidek bu holat katta g'ovaklarning kichik zarralar bilan to'sib qo'yish orqali yuzaga keladi.



3-rasm. Tarkiblarning suvga chidamliligini o'rganish:  
1-nazorat; 2-ZU+SP; 3-SP+SPO

Suv o'tkazmaslik usulini o'rganish shuni ko'rsatdiki, murakkab modifikatorlardan foydalanish g'ovaklik tuzilishini yaxshilaydi, g'ovaklar orqali bloklanadi, katta

kapilyarlarning hajmini kamaytiradi va ularni geliyga aylantirishga olib keladi.



### 3. Xulosa

Bunday o'zgarishlar natijasida kompozitsiyaning zichligi oshishi ta'minlanadi va natijada mustaxkamlik ta'minlanadi. Tadqiqotlardan ma'lum bo'ldiki, eng yuqori mustaxkamlik chegarasiga 40 sutkalik muddatdan keyin erishildi. Shuni alohida ta'kidlab o'tish joizki, ko'rib chiqilayotgan qo'shimchalardan pussolan reaksiyaga eng yaxshi zolo-unos kirishdi. 120 sutkalik qotishdan so'ng ZU+SP tarkibi 57.9 MPa mustaxkamlikka erishdi. Bu natija o'z navbatida PECH+SP tarkibidan 15 % ga, etalon tarkibidan esa 51 % ga ko'p demakdir.

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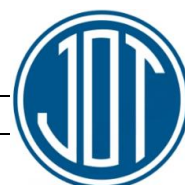
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### Mualliflar haqida ma'lumot / Information about the authors

Abdullaev Ulug'bek Hakimovich	Toshkent davlat transport universiteti "BSIQ" kafedrasida katta o'qituvchisi, texnika fanlari bo'yicha falsafa doktori (PhD); telefon: +998-71-299-03-02, e-pochta: <a href="mailto:uabdullaev@mail.ru">uabdullaev@mail.ru</a>
Kandaxarov Sanjar Ishratovich	Toshkent davlat transport universiteti "BSIQ" kafedrasida dotsenti, texnika fanlari bo'yicha falsafa doktori (PhD); telefon: +998-71-299-03-02, e-pochta: <a href="mailto:sanjar.kandaxarov@mail.ru">sanjar.kandaxarov@mail.ru</a>
Sharipova Dilafruz Tofukovna	Toshkent davlat transport universiteti "BSIQ" kafedrasida dotsenti v.b., texnika fanlari bo'yicha falsafa doktori (PhD); telefon: +998-71-299-03-02, elektron pochta: <a href="mailto:Dsharipova@mail.ru">Dsharipova@mail.ru</a>
Rahimova Nozima Baxtiyarovna	Toshkent davlat transport universiteti "BSIQ" kafedrasida katta o'qituvchisi, texnika fanlari bo'yicha falsafa doktori (PhD); telefon: +998-71-299-03-02, e-pochta: <a href="mailto:Nrahimova@mail.ru">Nrahimova@mail.ru</a>



## Geo-location of logistics centers and methods of their justification: a systematic analysis of the literature

G.A. Samatov<sup>1</sup>, I.X. Absattorov<sup>1</sup>, Q.Sh. Matrasulov<sup>1</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** Choosing suitable locations for logistics centers is as important as determining the need for them. In order to find optimal solutions for the location of logistics centers, it is necessary to define clear criteria and choose the right methodology. In this scientific article, a systematic analysis of the relevant literature (books, dissertations, scientific articles and theses) on the topic is carried out in order to determine the level of study of the topic of geo-location of logistics centers and methods of their justification, to assess the relevance of the topic and to determine the ways to achieve the set goal. increased. During the literature review, 25 research papers containing the problem of location selection from the studies on logistics centers were selected based on certain criteria. The literature review was reviewed in the following sequence: at the first stage, the theoretical researches in solving the problem were considered, and at the second stage, the criteria used in the evaluation process were considered. Based on the collected data, decision-making methods and frequency of use of decision-making criteria were also presented.

**Keywords:** logistics centers, location, literature analysis, criteria, methods.

## Logistika markazlari geojoylashuv joyini aniqlash va ularni asoslash usullari: adabiyotlar tizimli tahlili

Samatov G.A.<sup>1</sup>, Absattorov I.X.<sup>1</sup>, Matrasulov Q.Sh.<sup>1</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Toshkent, O'zbekiston

**Annotatsiya:** Logistika markazlari uchun mos joylarni tanlash ularga bo'lgan ehtiyojni aniqlash kabi muhimdir. Logistika markazlari joylashuv joylarini aniqlashda optimal yechimlarni topish uchun aniq mezonlarni aniqlash va to'g'ri metodologiyani tanlash kerak. Ushbu ilmiy maqolada logistika markazlari geojoylashuv joyini aniqlash va ularni asoslash usullari mavzusining o'rganilganlik darajasini aniqlash, mavzuning dolzarbligini baholash va belgilangan maqsadga erishish yo'llarini aniqlab olish uchun mavzuga tegishli adabiyotlarning (mavzuga oid kitoblar, dissertatsiyalar, ilmiy maqola va tezislar) tizimli tahlili amalga oshirildi. Adabiyotlarni o'rganish davomida logistika markazlari haqidagi tadqiqotlardan joy tanlash muammosini o'z ichiga olgan 25 ta tadqiqot ishi ma'lum bir mezonlar asosida tanlab olindi. Adabiyotlar sharhi quyidagi ketma ketlikda ko'rib chiqildi: birinchi bosqichda masalani hal qilishda nazariy jihatdan olib borilgan tadqiqotlar, ikkinchi bosqichda baholash jarayonida qo'llaniladigan mezonlar ko'rib chiqildi. To'plangan malumotlar asosida qaror qabul qilish usullari va qaror qabul qilish mezonlaridan foydalanish chastotasi ham taqdim etildi.

**Keywords:** logistika markazlari, joylashuv, adabiyotlar tahlili, mezonlar, usullar.

### 1. Kirish

Transport-logistika tizimini ishlab chiqishda muhim o'rinni logistika markazini yaratish dasturi egallaydi, uning g'oyasi moddiy, axborot, moliyaviy oqimlar va resurslarni umumiy logistika boshqaruv tizimi orqali birlashtirishda transport jarayoni ishtirokchilari uchun keng qamrovli transport xizmatlarini amalga oshirish taqozo etiladi. Jahon iqtisodiyotining globallashuvi davrida ta'minot zanjirlarining samaradorligi va kelajakda global bozorda vujudga kelishi mumkin bo'lgan o'zgarishlar va

muammolarga javob beradigan logistika markazlarini rivojlantirishga bugungi kunda dunyo bo'ylab katta e'tibor qaratilmoqda. Logistika markazlarining paydo bo'lishi biznes jarayonlarining globallashuvi, biznesning yangi yechimlari va o'zaro hamkorlik imkoniyatlarini izlash bilan rag'batlantirildi [1].

Shuni alohida ta'kidlab o'tishimiz lozimki adabiyotlarda "logistika markazi" tushunchasi uchun umumiy nomlar yoki ta'riflar berilmagan. Logistika markazining eng keng

<sup>a</sup>  <https://orcid.org/0000-0001-6479-6173>

<sup>b</sup>  <https://orcid.org/0000-0002-5968-0990>

<sup>c</sup>  <https://orcid.org/0009-0004-3300-9228>





qamrovli ta'rifini butun Yevropa bo'ylab 80 ga yaqin transport va logistika markazlarining birlashmasi bo'lgan EUROPLATFORMS tomonidan takomillashtirilgan [2]. EUROPLATFORMS logistika markazini quyidagicha ta'riflaydi: "Logistika markazi - bu belgilangan hududdagi obekt bo'lib, uning doirasida transport, logistika va tovarlarni taqsimlash bilan bog'liq barcha faoliyatlar - milliy va xalqaro tranzit uchun turli operatorlar tomonidan tijorat asosida amalga oshiriladi. Operatorlar bu yerda qurilgan bino va inshootlarning (omborlar, tarqatish markazlari, terminallar, ofislar, yuk mashinalari xizmatlari va boshqalar) egalari yoki ijarachilari bo'lishi mumkin"[3]. Logistika markazlariga bo'lgan ehtiyojning oshib borayotganligini inobatga olgan holda aytishimiz mumkinki logistika markazini tashkil etish bo'yicha qaror qabul qilingandan keyin, birinchi savol logistika markazi uchun eng munosib joyni aniqlash hisoblanadi. Joy tanlash uchun usullar va qaror mezonlari joy tanlash muammolarini bartaraf etishda hal qiluvchi ahamiyatga ega.

Logistika markazlarining joylashuvini tanlash uni tashkil etishga katta miqdorda sarmoya kiritilishi va o'bektlarning mavjudligi bilan ham strategik va uzoq muddatli qaror hisoblanadi. 1994 yilga kelib logistika markazlarining joylashuv joyini tanlash logistika markazini tashkil etishda ta'sir qiluvchi mezonlar orasida qaror qabul qilishning hal qiluvchi elementi sifatida ko'rib boshlandi [4]. Joyni tanlash nafaqat operatsion faoliyatning muvaffaqiyatiga ta'sir qiladi [5], balki ta'minot zanjiri boshqaruvi va transport tarmog'ini rejalashtirishga ta'sir ko'rsatishi natijasida butun tarqatish tizimlariga ta'sir qiladi [6,7]. Natijada, logistika markazining optimal joylashuvi transport xarajatlarini kamaytirishga, ishlab chiqarish va iste'mol o'rtasidagi sinxronlashtirishni rag'batlantirishga, transport tizimlarining muvozanatli rivojlanishini ta'minlashga va umumiy afzalliklarga erishishga olib kelishi mumkin [8]. Yuqorida sanab o'tilgan masalalarning ahamiyatini hisobga olgan holda, ushbu tadqiqot ishida logistika markazlarining joylashuvi bo'yicha mavjud adabiyotlar tahlil qilingan. Tahlil jarayonida muammoni bayon etish va asoslash usullari, muammoni hal qilish yondashuvlari, qaror qabul qilish usullari va mezonlari,

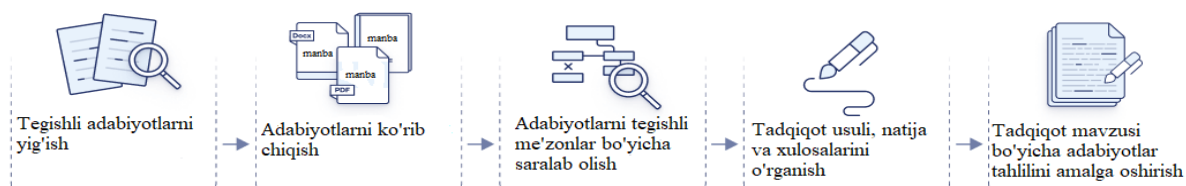
shuningdek erishilgan natijalar aniqlandi va bayon etildi. Logistika markazi (LM) ning joylashuvi bo'yicha boshqa sharhlardan farqli o'laroq, biz bu yerda ma'lum bir model yoki yechim yondashuvini ishlab chiqishga e'tibor qaratish o'rniga, LMLar joylashuvini aniqlashga qaratilgan tadqiqot ishlarini nazariy va amaliy yechimlari bo'yicha erishilgan natijalarni birlashtirdik. O'rganish natijalari LMLari geoyoylashuvini tanlash usullarini o'rganish va asoslashga qaratilgan. Tadqiqot ishi quyidagicha tashkil etilgan: anotatsiya, kirish, tadqiqot metodologiyasi, muhokama va natija (adabiyotlarni tanlab olish usuli, nashr yillari, davlatlari, foydalanilgan usullar, tahlil bayoni), xulosa va foydalanilgan adabiyotlar.

## 2. Tadqiqot metodikasi

Logistika markazlari joylashuvini asoslashga qaratilgan adabiyotlar tahlilini o'tkazish uchun biz tanlangan adabiyotlarni tizimli, miqdoriy va sifat jihatdan tavsiflashga qaratilgan usullardan foydalandik. Malum bir mavzu bo'yicha adabiyotlar tahlilini o'tkazish bu ushbu mavzu bo'yicha qaralayotgan davrgacha amalga oshirilgan ilmiy ishlar va natijalar haqida malumotlarni umumlashtirishda juda muhim vosita sanaladi. Ushbu tahlilni amalga oshirishda quyidagi mezonlarni etiborga olish lozim:

- adabiyotni ko'rib chiqish savollarini tuzish;
- adabiyotlarni malum mezonlar asosida chegaralash;
- tadqiqotni amalga oshirish uchun adabiyotlarni qidirish bazalarini belgilab olish;
- adabiyotlarni tanlab olish;
- adabiyotlarda mavzuning o'rganilganlik darajasini baholash;
- tegishli malumotlarni ajratib olish;
- natijalarni tahlil qilish
- natijalarni sharhlash va tadqiqot yechimini maqolada bayon etish [9].

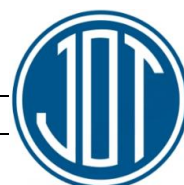
Yuqorida sanab o'tilgan mezonlarni etiborga olgan holda tadqiqot ishini amalga oshirishning dastlabki rejalashtirilgan usulini quyidagi 1-ramda ko'rsatib o'tilgan.

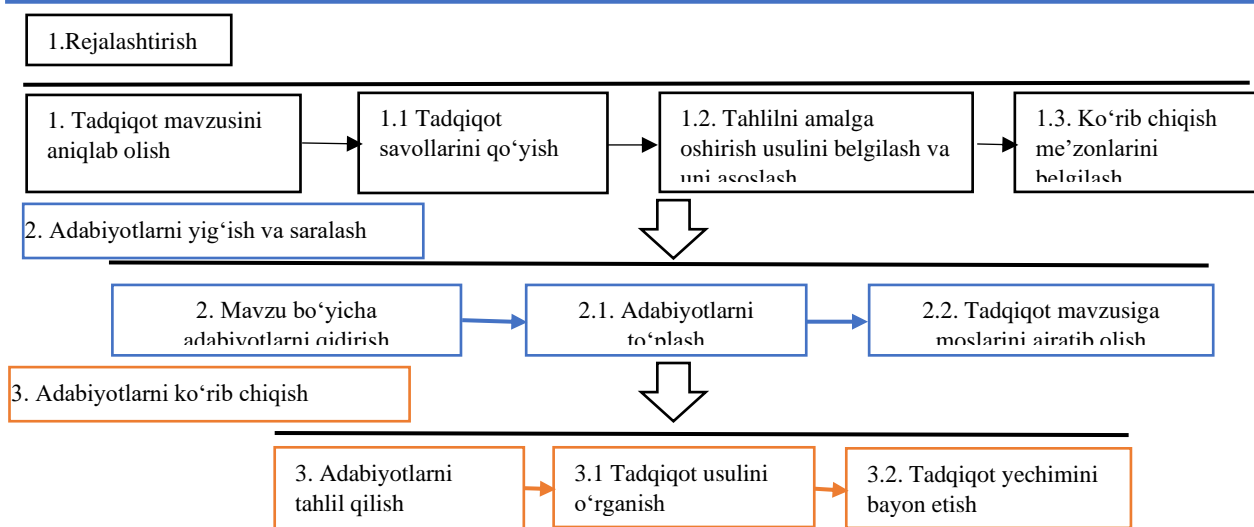


1-rasm. Adabiyotlar tahlilini amalga oshirish jarayonlarining ketma-ketligi (muallif ishlanmasi)

Tadqiqot ishi mavzusi bo'yicha adabiyotlar tahlilini o'tkazishda tizimlilik va ketma-ketlikni taminlash hamda 1-rasmda berilgan tartibda belgilab olingan ishlarni amalga

oshirish maqsadida 2-rasmda tasvirlangan bosqichlar va yo'nalishlar bo'yicha ishlarni amalga oshirish belgilab olindi





2-rasm. Adabiyotlar tahlilini amalga oshirish mezanlari asosida tadqiqot ishini bajarishning uch bosqichli sxemasi (muallif ishlanmasi)

### 3. Muhokama va natija

1. Tadqiqot ishini bajarish uchun “Logistika markazlari geoylashuvini asoslash” mavzusi tanlab olindi.

1.1 Tadqiqot mavzusi bo'yicha adabiyotlar tahlilini amalga oshirish uchun quyidagi tadqiqot savollari shakllantirildi:

1. Logistika markazlarining joylashuv o'rni nima?

2. Logistika markazlarining joylashuv o'rining umumiy logistika tizimiga ta'siri qanday?

3. Qaysi turdagi logistika markazlarining joylashuv o'rni eng ko'p va eng kam o'rganilgan?

4. Logistika markazining joylashuvini tanlash muammosi uchun qanday usullar qo'llaniladi?

5. Logistika markazining joylashuvini tanlash muammosi uchun qanday mezonlar hisobga olingan?

6. Logistika markazlarini joylashuv joyini asoslashdagi hozirgi davr qiyinchiliklari nima?

7. Logistika markazlarini joylashuvini asoslashda eng kam o'rganilgan va ta'sir doirasi oshib borayotgan tamonlar nima?

1.2. Tadqiqot ishini amalga oshirishda to'plangan adabiyotlardan tadqiqot mavzusiga moslarini ajratib olish uchun PRISMA (Preferred Reporting Items of Systematic

reviews and Meta-Analyses) Flow Diagram usuli tanlab olindi. Tadqiqot ishi mavzusini ko'lami va chegaralarini aniqlab olish uchun u bo'yicha amalga oshirilgan ishlarni ko'rib chiqish va tahlil qilish judayam muhim sanaladi. Biror bir belgilab olingan mavzu bo'yicha tadqiqot ishini amalga oshirishni boshlagan tadqiqotchilar albatta tadqiqot ishi mavzusi bo'yicha adabiyotlar tahlilini o'tkazadilar. Adabiyotlar tahlilini amalga oshirishda ilmiylik va ishonchlilikni taminlash maqsadida bir guruh tadqiqotchi olimlar tomonidan 2009-yilda tizimli sharhlar fanidagi bir qancha kontseptual va amaliy yutuqlarni hisobga olgan holda tahlil usullari yangilandi va PRISMA (Tizimli sharhlar va meta-tahlillarning afzal ko'riladigan hisoboti) deb o'zgartirildi. PRISMA mezonlarini birinchilardan bo'lib Moher D, Liberati A, Tetzlaff J va boshqalar tomonidan asoslab berildi [10]. Ushbu mezonlarga amal qilish va tadqiqot ishida ishonchlilikni taminlash maqsadida mualliflar quyida 1-jadvalda keltirilgan mezonlarni kiritdilar.

1.3. To'plangan adabiyotlarni ajratib olishda 1-jadvalda ko'rsatilgan mezonlardan foydalanildi.

1-jadval

#### Kritish va istisno qilish mezonlari

Mezon	Qaror
Oldindan belgilangan kalit so'zlar bir butun sifatida yoki hech bo'lmaganda sarlavhada, kalit so'zlarda yoki maqolaning mavhum qismida mavjud bo'lganda	kiritish
Adabiyot ilmiy ko'rib chiqiladigan jurnalda chop etilgan	kiritish
Adabiyot o'zbek, rus, ingliz va turk tillarida yozilgan bo'lsa	kiritish
Adabiyot kamida bitta tadqiqot savoliga javob bergan taqdirda	kiritish
Adabiyotda bayon etilgan muammo va natijalar boshqa adabiyotni takrorlasa	istisno qilish
Adabiyotda foydalanilgan ma'lumotlar manbalari va tadqiqot usuli ilmiy asoslanmagan bo'lsa	istisno qilish
Bir biridan ko'chirilgan yoki ikkita bir xil adabiyotlar	istisno qilish
Adabiyotda nashir qilingan jurnal yoki ilmiy baza haqida ma'lumot ko'rsatilmagan bo'lsa	istisno qilish
1990 yilgacha nashr etilgan adabiyotlar	istisno qilish

Manba: Mengist va boshqalar. [11] tomonidan adabiyotlar tahliliga bag'ishlangan ilmiy maqolasida ko'rsatilgan mezonlardan foydalanilgan xolda mualliflar tomonidan mavzuga moslashtirildi.

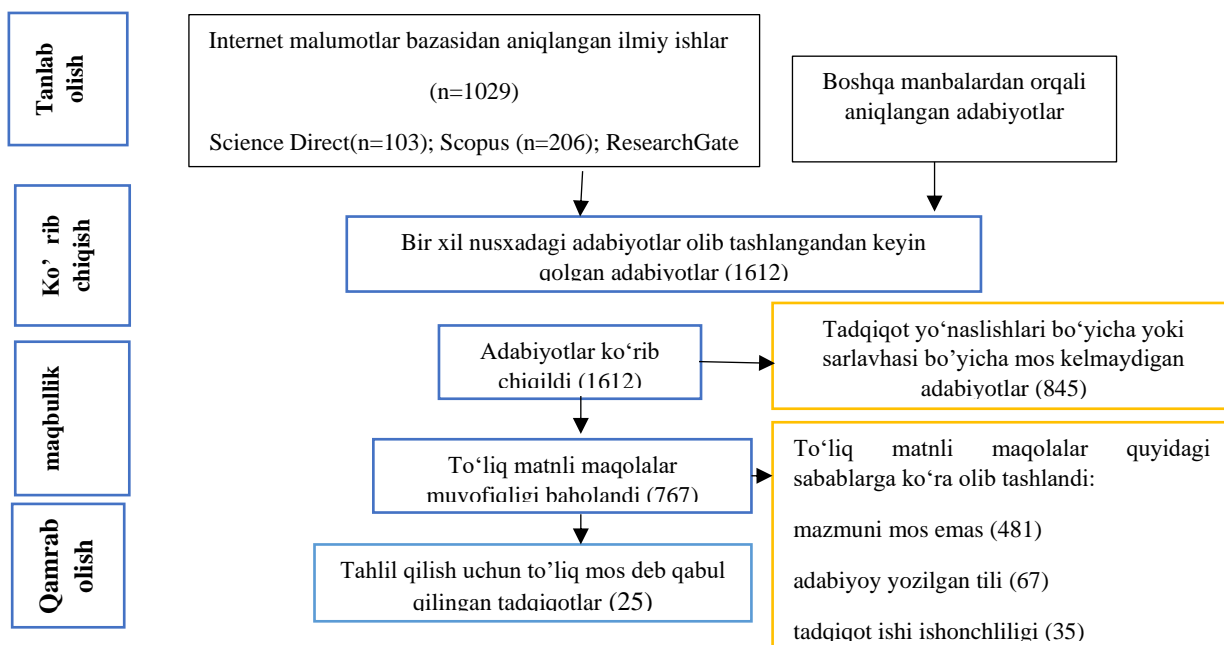


2. Ushbu tadqiqotni amalga oshirish uchun adabiyotlarni to'plashda Science Direct, Scopus, ResearchGate va IEEE Xplore Digital Library ma'lumotlar bazalari va boshqa ochiq manbalardan foydalanildi. Ushbu ma'lumotlar bazalaridan adabiyotlarni qidirishda yahlit tadqiqot mavzusi bo'yicha qidirilganda tegishli adabiyotlar chiqmaganligi hamda logistika markazlari terminalogiyasi bo'yicha adabiyotlarda aniq o'zgarimas ta'rif mavju bo'lmaganligi sababli va ushbu tadqiqot logistika markazlarini joylashuv joyini asoslash uchun ishlatilishi mumkin bo'lgan modellar va usullarni aniqlashga qaratilganligi sababli quyidagi kalit so'zlardan foydalanildi: logistika markazi, logistika markazini tashkil etishda ta'sir qiluvchi mezonlar, logistika qishlog'i, logistika

plafon'masi, transport-logistika markazi va logistika firmalari.

2.1. Yuqorida ko'rsatilgan ma'lumotlar bazalaridan foydalangan holda mualliflar birinchi bosqichda 1670 dan ortiq ilmiy adabiyotlarni to'pladilar (Science Direct-103, Scopus-206, ResearchGate-406, IEEE Xplore Digital Library-314 va boshqalar-653).

2.2. To'plangan adabiyotlar 1-jadvalda belgilab olingan mezonlar bo'yicha va PRISMA Flow Diagram usuli yordamida tekshirilgandan keyin 1645 ta adabiyot chiqarib tashlandi va 25 ta adabiyot tahlil qilish uchun tanlab olindi. (3-rasmga qarang).



3-rasm. PRISMA Flow Diagram (PRISMA usuli asosida muoliflar tomonidan tuzilgan)

3. Adabiyotlar tahlilini amalga oshirayotganda tahlil qilinayotgan adabiyotning sifatini baholovchi ko'rsatgichlar yordamida tekshirilishi kerak. Adabiyotlar tizimli tahlilini amalga oshirish to'rtta sifatni baholash savoliga asoslangan quyidagi mezonlar yordamida baholandi:

1. Ko'rib chiqilayotgan adabiyot kiritish va istisno qilish mezonlari asosida tekshirilganmi?
2. Adabiyotlarni qidirish mavzu bo'yicha barcha tegishli

tadqiqotlarni qamrab olganlik darajasi tekshirilganmi?

3. Tanlangan adabiyotda tadqiqot sifati/haqiqiyligini baholaydigan ko'rsatgichlar mavjudligi o'rganilganmi?

4. Adabiyotda tadqiqot savollariga yetarli darajada javoblar ko'rsatilganmi[12]?

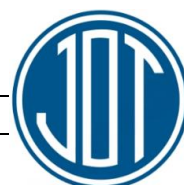
Yuqorida takidlangan baholash mezonlari bo'yicha tahlil qilish uchun tanlab olingan adabiyotlarni 2-jadvalda ko'rsatilgan tartibda turlarga ajratib chiqik

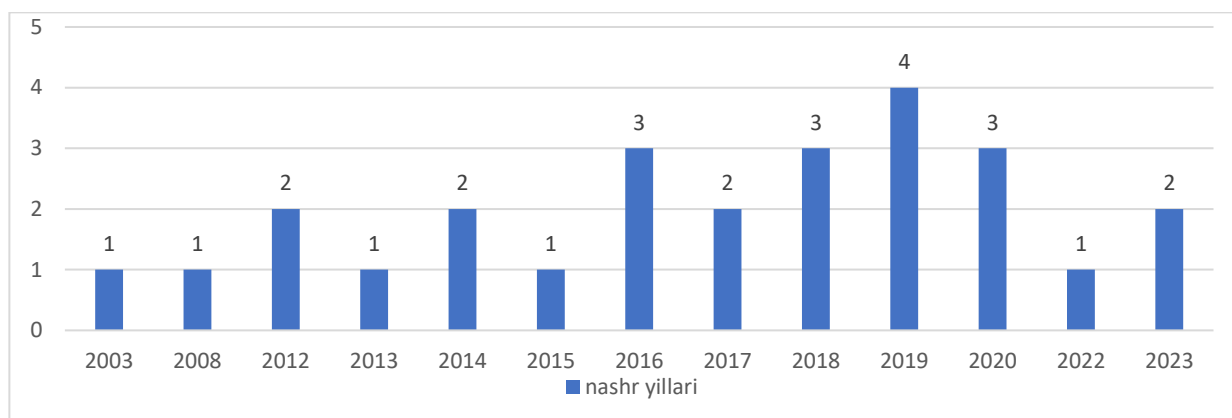
2-jadval

Tadqiqot ishida tahlil qilingan adabiyotlar		Soni	Ulushi
Adabiyot turi	Maqolalar	15	60%
		2	8%
Dissertatsiyalar	Magistrlik	6	24%
	PhD	1	4%
	Doktorlik	1	4%
Umumiy		25	100%

Ushbu adabiyotlar tahlilida 6 ta magistrlik, 1 ta PhD, 1 ta doktorlik dissertatsiyasi va 17 ta ilmiy maqolalardan (15 ta ilmiy jurnal va 2 ta konferensiya) iborat 25 ta tadqiqot ishi o'rganildi. Tadqiqot ishida tahlil qilingan adabiyotlarning

nashr yillari adabiyotlar tahlili amalga oshirilgan davrni belgilab olish va qaysi yillarda eng ko'p adabiyot va eng kam adabiyotlar nashr qilinganligini aniqlash maqsadida o'rganib chiqildi va 4-rasmda tasvirlandi.

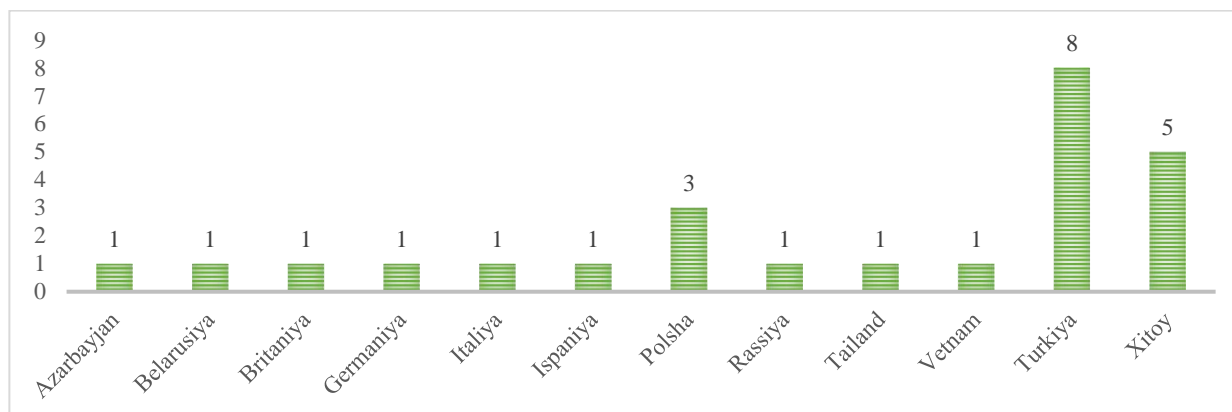




4-rasm. Tahlil qilingan adabiyotlarning nashr qilingan yillari

4-rasmdan malum bo'ladiki tahlil qilish uchun tanlab olingan adabiyotlarning eng ko'p qismi ya'ni 16% 2019-yilga to'g'ri keladi va tadqiqot ishi 2003-2023 yillarni qamrab olgan. Shuningdek mualliflar adabiyotlar tahlilining ishonchligini taminlash maqsadida tadqiqot ishida turli davlatlar tadqiqotchilari tomonidan amalga oshirilgan ishlarni ko'rib chiqishni niyat qilganlar. Turli davlatlar ilmiy tadqiqotchilari tomonidan yozilgan ilmiy ishlarni o'rganish

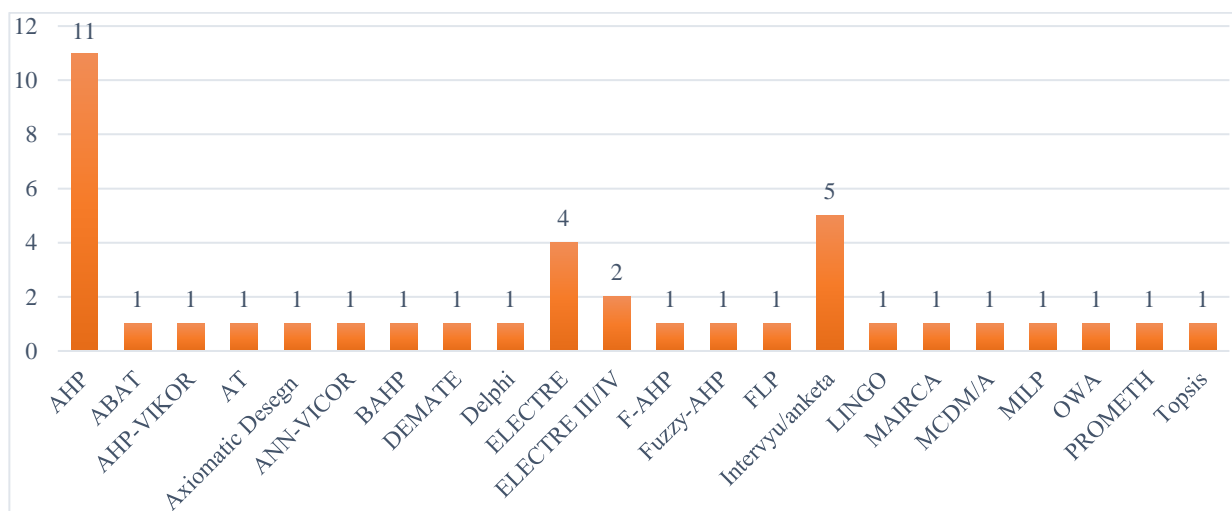
tadqiqot mavzusiga ko'p tomonlama yondoshuvni ta'minlaydi. Quyida 5-rasmda tahlil qilingan adabiyotlarning davlatlar ulushi tasvirlangan. 5-rasmdan ko'rinib turibdiki ushbu adabiyotlar tahlilini amalga oshirish jarayonida foydalanilgan adabiyotlar ichida dunyoning 12 ta davlati olimlari tomonidan LMLari joylashuviga oid ilmiy ishlar o'rganib chiqilgan, ularning eng ko'p ulushi 32 % Turkiya va 20% Xitoylik olimlar ishlariga to'g'ri keladi.



5-rasm. Tahlil qilingan adabiyotlarning davlatlar bo'yicha taqsimlanishi.

Tadqiqot ishida muammoni bayon etilishi va uni yechishda qo'llanilgan usullar erishilgan natijaning ishonchligini ta'minlovchi jihatlarni hisoblanadi. Mualliflar

tahlil qilingan adabiyotlarning tadqiqot muammosi LMLari uchun joy tanlash masalasi bo'lganligi sababli muammoni yechishda foydalanilgan usullarni o'rganib chiqdilar.



6-rasm. Adabiyotlarda LM lar uchun joy tanlash muammosini yechishda qo'llanilgan usullar

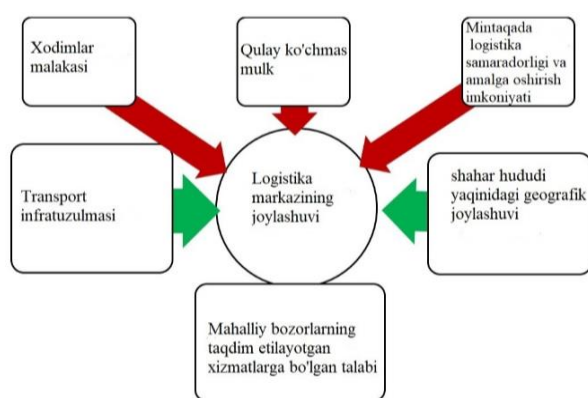


6-rasmda ko'rsatilgan usullarning aksariyati ko'p yoki bir mezonli qaror qabul qilish usullari oilasiga mansub bo'lib, ular ichida eng ko'p qo'llanilish ko'rsatgichi AHP (Analytic Hierarchy Process) analitik ierarxiya jarayoni 50% holatga to'g'ri kelgan. Mavzuni nazariy jihatdan tahlil qilishda intervyu/anketa usuli ommaviy tarzda eng ko'p qo'llanilar ekan. Yuqorida keltirilgan malumotlar asosida shuni aytishimiz mumkinki, tahlil qilish uchun tanlab olingan adabiyotlarning ishonchlik darajasi mavzuni yoritib berishda barcha sifat mezonlariga to'g'ri keladi.

**3.1** Tanlab olingan adabiyotlarni ko'rib chiqish jarayonida mualliflar LM lar uchun joy tanlash masalalarini yechishga bo'lgan ikki xil yondoshuvni aniqladilar. Bular:

1-yondashuv. Masalani nazariy jihatdan o'rganib joylashuv joyini tanlashda etibor qaratish lozim bo'lgan mezonlarni ko'rsatib o'tish usuli;

2-yondashuv. Aniq tegishli mezon va parametrlar asosida muayyan hudud uchun LM ni joylashtirish masalasini ko'p mezonli qaror qabul qilish usullaridan



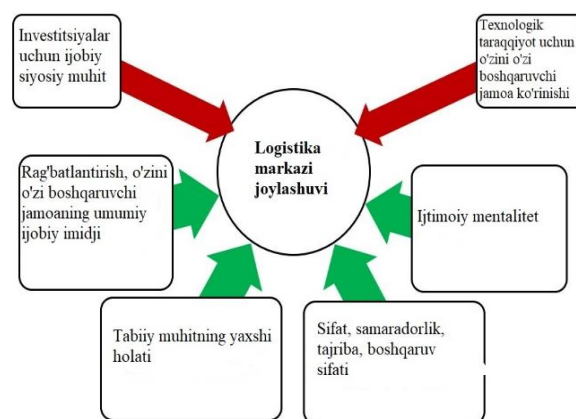
**7-rasm. Tekshirilayotgan logistika markazlariga ko'ra kompaniyaning joylashuvi to'g'risidagi qarorga ta'sir qiluvchi eng muhim qattiq omillar. Yashil – “juda muhim”; qizil “muhim”**

LMlari joylashuv joyini tanlashda anketa usulidan Ho Thi Thu Hoa va boshqalar [14] ham foydalangan bo'lib, ular so'rovnomanini Vetnam logistika xizmati provayderlaridan ularning Xoshimin shahrida logistika markazining tavsiya

foydalanib yoki matematik hisoblashlar yordamida aniqlash.

Ushbu ilmiy tadqiqot ishida tahlil qilingan adabiyotlarning 5 tasi 1-yondashuv o'yicha 20 tasi esa ikkinchi yondoshuv bo'yicha yozilgan. Dastlab tahlilni 1-yondashuv bo'yicha yozilgan adabiyotlardan boshlaymiz.

**3.2.** Waldemar W va boshqalar [13] LM joylashuvi to'g'risidagi qarorga qanday omillar ta'sir qilishini aniqlash, shuningdek, kompaniyalar va mahalliy ma'muriyat bo'linmalari o'rtasidagi hamkorlik sifatini baholash uchun anketa so'rovlari usulidan foydalanishgan. Anketa savollari 7 ta yirik logistika markazlari hodimlari o'rtasida o'tkazilgan bo'lib, ishtirokchilarga 26 ta omildan (14 ta qattiq va 12 ta yumshoq) markaz joylashuviga ta'sir qiluvchi omillarni tanlashlari vazifasi qo'yilgan. Ushbu anketa so'rovi shahar LM joyini tanlashga qaratilgan va ishtirokchilar tomonida 7 va 8-rasmlarda tasvirlangan omillar asosiylari deb topilgan. Shuningdek bu omillar ta'sir darajasiga ko'ra qattiq va yumshoq omillarga ajratilgan.



**8-rasm. Tekshirilayotgan logistika markazlariga ko'ra kompaniyaning joylashuvi to'g'risidagi qarorga ta'sir qiluvchi eng muhim yumshoq omillar. Yashil – “juda muhim”; qizil “muhim”**

etilgan joylashuvi bilan bog'liq muhim masalalar bo'yicha birlamchi ma'lumotlarni to'plash uchun ishlab chiqqanlar. Anketa so'rovini amalga oshirish shakli 3-jadvalda ko'rsatilgan.

**3-jadval**

**Anketa so'rovi va ma'lumotlarni tahlil qilish tafsilotlari**

N o.	Elementlar	Tarkib
1	So'rov usuli	Anketa so'rovi
2	Namuna olish usuli	Tasodifiy bo'lmagan tanlov
3	Baholash usuli	Miqdoriy, sifat jihatidan
4	Javob shakllarining turlari	-Ha/Yoq - Ko'p tanlov -ochiq-yopiq
5	So'rov vaqti	iyul, 2019
6	Respondentlar soni	Logistika xizmatlarini bilan shug'ullanuvchilar: 46
7	Ma'lumotlarni qayta ishlash va tahlil qilish vositalari	SPSS (Statistic Package for Social Science)
8	Ishonchlik tahlili	Cronbach Alpha factor ( $\alpha$ ): $0.6 \leq \alpha < 0.7$ : qoniqarli $0.7 \leq \alpha < 0.8$ : yaxshi $0.8 \leq \alpha \leq 1.0$ , $\alpha \geq 0.8$ : juda yaxshi

Mualliflar ma'lumotnomalar asosida Xo Chi Mindagi logistika markazlari uchun mos joyini tanlash uchun quyidagi

asosiy mezonlarni tahlil qilganlar:

- logistika markazi turli transport turlaridan





- foydalanish uchun yo'l tarmoqlariga ega bo'lishi kerak
- yer va ijara narxi: yangi logistika markazlarini tashkil etish yerning mavjudligi va kelajakda kengaytirish imkoniyatini talab qiladi.
- logistika markazlari shaharlardagi tirbandliklarni kamaytirishga yordam berishi kerak
- inson resurslari: xodimlar malakasi diqqat bilan ko'rib chiqilishi kerak

- axborot texnologiyalari uchun infratuzulmaning mavjudligi
  - logistika markazlaridan ta'minot manbalari va bozorlarigacha bo'lgan masofa:
  - Mamlakat yoki mahalliy hukumatning logistika sohasiga bo'lgan siyosati.
- Shuningdek mualliflarning fikriga ko'ra, logistika markazining tegishli joylashuvini tanlash uchun baholash va tanlash bosqichlari 4-jadvaldagi tartibda bo'lishi kerak.

## 4-jadval

## LM larni tashkil etishda tegishli joylarni tanlash uchun baholash, tanlash bosqichlari

N	Qadamlar	Taklif etilgan usullar
o.		
1	Joylarni tanlash mezonlarini berish	Hukumat tomonidan chiqarilgan qarorlar asosida
2	Logistika markazlarining mos joylari bo'yicha tadqiqotlar	GIS (Geografik Axborot Tizimi) dan ekspertlar fikrini o'rganish, optimal transport turlaridan foydalanish imkoniyati
3	Fiziologik joylashuvni filtrlash	Tanlov matritsasini tuzish, a'zolar o'rtasida muhokama qilish
4	Texnik-iqtisodiy asoslarni o'rganish	Dala ekskursiyasi
5	Yaxshi joylarni tanlash	A'zolar o'rtasida muhokama qilish
6	Logistika markazlarini qurish uchun tegishli yerni topish	Muzokaralar uchun yer egasi bilan bog'lanish
7	Logistika markazlarini qurish	

LM lar uchun joy tanlash uzoq muddatli qaror qabul qilish usuli hisoblanadi, ayniqsa gap xalqaro logistika markazi uchun joy tanlash haqida bo'lsa uning murakkabligi kiritiladigan sarmoya va ko'rsatiladigan xizmat sifatidan kelib chiqib anchagina murakkab muammo hisoblanadi. Sabina Kauf, Aleksandra Laskowska-Rutkowska [15] "Bir belbog', bir yo'l" tashabbusi doirasida Polshada xalqaro logistika markazi uchun joy tanlash masalasini ko'rib chiqqanlar. Maqola nazariy xarakterga ega bo'lib unda qo'llanilgan usul - adabiyot manbalarini tahlil qilish orqali manbalarda joy tanlashda ko'p takidlanadigan yer, mehnat va kapitalni hisobga olish omillariga makroiqtisodiy, ekologik va mintaqaviy/milliy rivojlanish strategiyasi ham hisobga olish kerakligini takidlaganlar. Tadqiqot ishi muammosi yechimi sifatida ikkita hudud mos deb tanlab olingan. Joy tanlashda transport turlari tutashadigan va erkin iqtisodiy hududning mavjudligi asosiy hal qiluvchi omil sifatida qaralgan.

LMlar uchun to'g'ri tanlangan joy transport xarajatlarini minimallashtirish va hududlarni ijtimoiy-iqtisodiy rivojlantirishga yordam beradi. Mintaqaning ehtiyojlarini hisobga olgan holda logistika markazini qurish yoki modernizatsiya qilish to'g'risida qaror qabul qilishda ko'rib chiqish uchun taklif qilingan variantlarni ekspert baholashini o'tkazish kerak. S. F. Kugan [16] tanlangan tasniflash mezonlariga muvofiq logistika markazi uchun joy tanlash variantini ajratib olish misolini ishlab chiqdi. Tanlovni amalga oshirish quyidagi ketma-ketlikda bo'lishi lozim:

1) ekspert guruhi a'zolarining fikr-mulohazalaridan foydalanib, loyihaning maqsadlariga maksimal darajada

erishiladigan aniq mezon bo'yicha daraja berish;

2) har bir mezonning vaznini aniqlash, buning uchun mezonlarning umumiy sonini berilgan mezon darajasiga bo'lish kerak;

3) har bir mezon uchun mumkin bo'lgan variantlarning har birini ball tizimidan foydalangan holda baholash va bunda har bir variant bo'yicha ballar yig'indisi o'nga teng bo'ladi;

4) har bir LM varianti bo'yicha har bir mezonning reytingini hisoblash (mezonning reytingi ma'lum bir mezon og'irligi va muayyan loyiha varianti uchun mezonni baholash omiliga teng);

5) har bir variant bo'yicha reytinglarni jamlash (5-jadval).

Tanlangan mezonlar nuqtai nazaridan, eng maqbul variant - reytinglar yig'indisi maksimal bo'lgan joy logistika markazi uchun tanlanadi. Bunday hisob-kitob mintaqaning ehtiyojlarini hisobga olgan holda logistika markazi variantini tanlash masalasini hal qilish imkonini beradi.

Logistika infratuzilmasi ob'ektining turini aniqlagandan so'ng, vazn koeffitsientlari bilan yoki bir guruh mezonlar bo'yicha amalga oshirilishi mumkin bo'lgan optimal joy tanlanadi. Ko'pincha samaradorlik markazning eng past umumiy qiymatida yoki transport xarajatlarida hisobga olinadi. Variantlarni ko'rib chiqishda mavjud ko'chmas mulk va ob'ekt joylashishi kerak bo'lgan yer maydoni, kommunal xizmatlarning mavjudligi, mintaqaning uzoq muddatli rivojlanish rejasini tahlil qilish, maxsus iqtisodiy zonani yaratish imkoniyati, logistika markazi va mavjud infratuzilma ham baholanishi lozim.

## 5-jadval

## Tanlangan tasniflash mezonlariga muvofiq logistika markazi variantini tanlash misoli

Mezon	Dara ja	Mezon turi, vazni	1 variant		Variant 2	
			dara ja	reyting	dara ja	reyting
1. Xizmatlar	1	4:1=4	2	2*4=8	4	4*4=16
2. Qoplash maydoni	2	4:2=2	3	3*2=6	2	2*2=4



3. Mulk turi	3	4:3=1,33	3	3*1,33=3,99	1	1*1,33=1,33
4. Hajmiy yaxlidlik	4	4:4=1	2	2*1=2	3	3*2=6
jami			10	19,99	10	27,33

LM joylashuvini tanlashda insonlarning logistika markazlariga bo'lgan munosabatlarini ham o'rganish lozim. Shengwei Zhang [17] logistika markazlarini tashkil etishda o'zgacha yondoshuvga asoslangan tadqiqot ishini amalga oshirgan. U insonlar hissiy omillarning LM joylashuv joyini tanlashga ta'sirini o'rgangan. Tadqiqot ishi bo'limlari asosan insoniyat nuqtai nazaridan hissiy omillarni o'rganish haqida hisobot beradi. Tadqiqot maqsadiga erishish uchun quyidagi ikkita tadqiqot savoli shakllantirilgan:

1. LMini tanlashga qanday hissiy omillar ta'sir qilishi mumkin?

2. Odamlarning his-tuyg'ulari logistika markazining

joylashuvini tanlash jarayoniga qanday ta'sir qiladi?

Muallif ushbu savollarga javob topish uchun logistika markazi xodimlari bilan suxbat o'tkazish, intervyu usulidan foydalangan. Intervyu uchun ikkita logistik kompaniyaning masul hodimlari tanlab olingan.

Intervyu savollari yarim holatda tuzilgan bo'lib bunday ko'rinishdagi savol javoblar suxbatdoshning his tuyg'ulariga qarab umumiy intervyu savolini shakllantirish imkonini beradi. Intervyu savollariga berilgan javoblarni o'rganish natijalarini quyidagi 6-jadvalda tasvirlangan xulosaga kelingan.

6-jadval

LMLarining joylashuvi o'rni bo'yicha amalga oshirilgan intervyu xulosasi

Logistika markazi nomi	Fengshen Logistics	Valtra
<b>O'xshashliklar</b>	atrof-muhit, infratuzilma va mijoz kabi umumiy omillar	
	kompaniya odamlarning fikrlariga katta ahamiyat beradi	
	Xodim hissiy omilning diqqat markazidir	
<b>farqlar</b>	asosan tashqi ta'sirlar, masalan, boshqaruv ta'siri	ichki ta'sirlar muhim ahamiyatga ega

LM lari uchun joy tanlash masalasini yechishda nazariy tadqiqotlar bilan bir qatorda matematik modellashtirish usullaridan ham foydalanish lozim. A.M. Talibov va boshqalar [18] LM ni joylashtirish masalasiga qaratilgan tadqiqot ishida Ozarbayjon Respublikasi hududida istiqbolli logistika markazlarining optikal manzilini aniqlash muammosi ko'rib chiqilgan bo'lib, mamlakatda joylashgan magistrat yo'llar bo'yab LM larini joylashtirish taklif etilgan. Bunda muammoni soddalashtirish uchun har bir yo'l uchun logistika markazlarining optikal ravishda joylashishini 1-formuladan foydalangan holda ko'rib chiqilgan.

$$\sum_{j=1}^m (w_j \sum_k |x_k^i - R_{j,k}^i|) \rightarrow \min \quad (1)$$

Bu yerda: i-magistral yo'llarning ustuvorligi, qaralayotgan magistrat yo'l uchaskasining uzunligi, K-magistral yo'lning kamida bitta oxirgi nuqtasi mamlakatdan chiqish bo'lsa, yo'llar to'plami, V- Agar yo'lning ikkala uchi mamlakat ichida bo'lsa, j-yo'llardagi infratuzulma ahamiyati,  $w_j$  – ekspert xulosasi asosida aniqlangan infratuzulma ahamiyatining og'irlik koeffitsienti  $w_j > 0$ ,  $R_{j,k}^i$  – i-magistral yo'lga joylashgan j-infratuzulma,  $x_k^i$  – ko'rib chiqilayotgan i-magistral yo'lga k-sonli logistika markazlarining taxminiy joylashuvining boshlang'ich nuqtasidan masofa

1-formilada keltirilgan qiymatlarni hisoblashda magistrat yo'llarda transport vositalarini bosharish vaqtini etiborga olgan holda yo'l uchaskalari bo'yab harakatlanish tezligi va haydovchilarning dam olish vaqtlarini hisobga oladigan masofalarda LMLarini joylashtirish nazarda tutilgan. Agar har xil magistrat yo'llarga tegishli bo'lgan hisob-kitoblar, logistika markazlari bir-birlariga yaqin bo'lib chiqsa, unda yangi logistika markazini joylashtirish

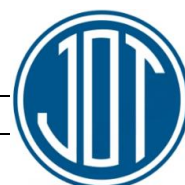
to'g'risidagi qaror qarorlarni qabul qilish bo'yicha ekspert tomonidan amalga oshiriladi.

Shuningdek LMLar uchun joy tanlashda tanlanayotgan hududa barqaror rivojlanish mavjudligini tekshiri juda muhim. Mai Nguyen [19] logistika markazlari uchun joy tanlashda barqarorlik omillarini hisobga olgan holda OWA operatorlari bilan o'xshashlikka asoslangan TOPSIS usulidan foydalanish bo'yicha tadqiqot ishini o'tkazgan. U ob'ektiv raqamli ma'lumotlardan foydalangan holda logistika biznesi nuqtai nazaridan barqarorlik omillari asosida potentsial logistika markazlarining joylashuvini baholash uchun ko'p mezonli qaror qabul qilish yondashuvidan foydalanadigan tizimni taklifini ishlab chiqdi. Barqarorlikni taminlovchi uchta komponent 9-rasmda tasvirlangan.



9-rasm. Barqarorlikning uchta komponenti

Barqarorlik komponentlari asosida logistika markazining joylashuvi manfaatdor tomonlarga ko'rsatadigan ta'siri shakllantirilgan va quyida 7-jadvalda tasvirlangan



7-jadval

## Logistika markazlarining joylashuvi va manfaatdor tomonlarning ta'siri (boshqa tegishli tarmoqlar bundan mustasno)

Logistika markazining joylashuvining ta'siri	Ta'sir qilingan manfaatdor tomon
Issiqxona gazlari emissiyasi, havo ifloslanishi, atmosfera ifloslanishining global ta'siri	Atrof-muhit, rezidentlar, mijozlar, xodimlar, firma ulushi egalari, mahalliy hukumat
Shovqin darajasining ortishi	Rezidentlar, xodimlar, atrof-muhit
Tirbandliklarning vujudga kelishi	Rezidentlar, xodimlar, logistika firmalari, atrof-muhit
Yerdan foydalanish talabi	Atrof-muhit
Daromad va xarajat	Firma aktsiyadorlari, logistika firmalari
Mintaqaviy iqtisodiy o'sish	Rezidentlar, xodimlar, mahalliy hukumat, logistika firmalar
Ish o'rinlarini yaratish	Xodimlar, rezidentlar

Shuningdek tadqiqot ishida qo'yilgan muammoni yechish uchun barqarorlik mezonlari ishlab chiqilgan (8-jadval) va bu mezonlar asosida OWA (Ordered Weighted Averaging) operatorlari bilan o'xshashlikka asoslangan

TOPSIS (Technique for Order of Preference by Similarity) usulidan foydalanib logistika markazi uchun tanlangan alternativ hududlar tekshirib chiqilgan.

8-jadval

## Mezonlar va ularning turlari

Mezon (birlik)	Tushuntirish	mezon turi
Asosiy mijozlar markazlariga yaqinlik (C1) (birlik yo'q)	0-1 shkalasi bilan asosiy mijozlar markazlariga yaqinlik balli. Qanchalik yuqori ball bo'lsa, mijozning joylashuvi shunchalik yaqinroq bo'ladi.	Foyda
Aeroportga yaqinlik (C2) (km)	Aeroportga yaqinlikni aks ettirish uchun yig'ilgan masofa qanchalik qisqa masofa bo'lsa, joylashuv shunchalik yaxshi.	xarajat
Portga yaqinlik (C3) (km)	Eng yaqin xalqaro dengiz portigacha masofa. Qisqaroq masofa, yaxshiroq joylashuv.	xarajat
Issiq xona effekti balli (C4) (birliksiz)	0-1 shkalasi bilan jamlangan ball, har bir kishi va hudud uchun km <sup>2</sup> yerga mos keluvchi CO <sub>2</sub> iste'molini aks ettiradi. Qanchalik yuqori ball bo'lsa, CO <sub>2</sub> iste'moli shunchalik ko'p.	xarajat
Yo'l harakati holati (C5) (avtomobillar/km/kun)	Asosiy yo'l umumiy uzunligi (km) uchun kunlik o'rtacha transport vositalari soni	xarajat
Ishchi kuchi soni (C6) (shaxslar)	Har bir aholi yashash joylaridagi ishchi kuchi soni.	foйда
Ish haqi (C7) (Evro)	Oylik yoki haftalik to'liq ish haqi.	xarajat
Ishsizlik darajasi (C8) (%)	Har bir aholi yashash joylaridagi ishsizlik darajasi.	foйда
Soliq stavkasi (C9) (%)	Sanoat binolari uchun umumiy ko'chmas mulk solig'i stavkasi.	xarajat
Malakali ishchi kuchi foizi (C10) (%)	Malakali ishchi kuchining ulushi.	foйда
Yer narxi (C11) (past, o'rta va yuqori)	Biznes uchastkalarining m <sup>2</sup> birligi narxidan kelib chiqqan holda.	

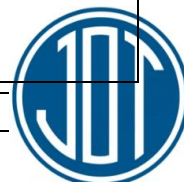
Adabiyotlar tahlili uchun tanlab olingan tadqiqot ishlarini ko'rib chiqish jarayonida biz aksariyat adabiyotlarda muammoning yechimini topishda ko'p/bir mezonli qaror qabul qilish (MCDM) usullaridan foydalanilganligining guvohi bo'ldik. Ushbu tadqiqot ishlarida joy tanlash qaroriga ta'sir qiluvchi mezonlarda

qamrov jihatidan o'zgarishlar mavjud bo'lib muammoni hal qilish usuli bir xil yo'nalishga ega bo'lganligi sababli 19 ta adabiyot tahlilini tadqiqot ishida belgilab olingan mezonlar va yechim uchun foydalanilgan usullarni har bir adabiyot uchun alohida shaklda umumiy holatda 9-jadvalda ko'rsatilgan tartibda tasvirladik



LMLar uchun joy tanlashda ko'p mezonli va bir mezonli qaror qabul qilish usullaridan foydalanilgan adabiyotlar va ularda qo'llanilgan usullar

Mualiflar	Logistika markazi uchun joy tanlashga ta'sir etadigan mezonlar	Tadqiqotda foydalanilgan usullar
Kurava A.Y.[20]	Iqtisodiy xolat, ijtimoiy xolat, siyosiy va huquqiy xolat, geografik xolat, ekologik xolat, transport infratuzilmasi	AHP
Sheikh Ariful Alam[21]	Magistral yo'ldan foydalanish imkoniyati, intermodal o'tkazuvchanlik sig'imi, port sig'imi, yerning mavjudligi	AHP
Murve Ozturk [22]	Ishchi kuchi, transport turlari (avtomobil, temir yo'l, dengiz va havo transporti) va masofalari, iste'mol – ishlab chiqarish markazlari va sanoat hududlarigacha bo'lgan masofasi, yer xususiyatlari va atrof-muhitga ta'siri.	AHP, BAHP
Ayshe Merve CAN [23]	Eng yaqin magistralgacha bo'lgan asofa, eng yaqin portgacha bo'lgan masofa, eng yaqin temir yo'lgacha bo'lgan masofa, eng yaqin aeroportgacha bo'lgan masofa, shahar markaziga yaqinlik, kengaytirish imkoniyati, geografik va topografik yaroqlilik, yer narxi, uyushgan sanoat zonasigacha masofa	AHP, ELECTRE, TOPSIS
Cihan UYANIK [24]	Xarajat, tabiiy boyliklar, temir yo'lga yaqinlik, magistral tizimiga yaqinlik, shahar markaziga yaqinlik, portga yaqinlik, yer maydoni, kengaytirish imkoniyati, sanoat zonasiga yaqinlik, makroiqtisodiy foyda / samaradorlik, atrof-muhit ta'siri, yuk avtomabillari, qurilishga yaroqlilik (topografiya, geografiya, yer osti tuzilishi), qurilish jarayonining narxi (infratuzilma-suv, elektr, xavfsizlik, yo'l), xizmat ko'rsatish bozoriga kirish imkoniyati, transport va logistika jozibadorligi	AHP, Fuzzy-AHP PROMETH, TOPSIS – ELECTRE – ANN- VIKOR
Muhammed BAMYACI [25]	Yer (yer maydoni, yerni kengaytirish imkoniyatlari, yerning infratuzilmasi, yerning jismoniy holati), xarajatlar (yer narxi, ob'ekt narxi, foydalanuvchilar uchun narx), yaqinlik (masofa) (ishlab chiqarish markazlariga yaqinligi, iste'mol markazlariga yaqinlik, aeroportga yaqinlik, temir yo'lga yaqinlik, magistral yo'lga yaqinlik, portga yaqinlik (dengiz), ichki suv yo'llariga yaqinlik) ijtimoiy-iqtisodiy ta'sirlar (shahar muhitiga ta'siri, shahar transportiga ta'siri, iqtisodiy hayotga ta'siri)	AHP, intervyu
Fulya ZARALI [26]	Hudud, kengayish maydoni, infratuzilma ob'ektlari, shaharga yaqinlik, sanoat va savdo markazlariga yaqinligi, portga yaqinlik, avtomobil yo'l aloqasi, temir yo'l aloqasi, yer xarajatlari	ABAT, AHP, AT, ELECTRE, FLP, LINGO, MILP, TOPSIS
H.Tezcan UYSAL, Kemal YAVUZ [27]	Portga yaqinlik, aeroportga yaqinlik, yashash joylarigacha bo'lgan masofa, mehnatga kirish imkoniyati, ekologik xavfsizlik, magistral yo'llar va bog'lovchi yo'llarga kirish imkoniyati, trafik zichligi, havoning ifloslanishi, qurilish maydoni, mintaqaviy rag'batlantirish	ELECTRE
B.L. MacCarthy, W. Atthirawong [28]	Xarajat, ishchi kuchi sifati, infratuzilma, yetkazib beruvchilarga yaqinlik, bozorlarga/mijozlarga yaqinlik, bosh kompaniyaning ob'ektlariga yaqinlik, raqobatga yaqinlik, hayot sifati, huquqiy va me'yoriy baza, iqtisodiy omillar, hukumat va siyosiy omillar, muayyan joylashuvning xususiyatlari, ijtimoiy va madaniy omillar	Delphi
Burchin PACHACI va boshqalar [29]	Tashqi savdo, uyushgan sanoat zonalar, qishloq xo'jaligi uyushgan sanoat zonasi, avtomobil, temir yo'l va suv yo'llariga chiqish	AHP
Krzysztof Witkows va boshqalar [30]	Mahalliy hokimiyat, ko'p tarmoqli aloqa infratuzilmasining mavjudligi, aholi soni, iqtisodiy zonalarining mavjudligi, yer narxi, ish haqi, mol-mulk solig'i miqdori, bozorning mavjudligi, malakali kadrlar mavjudligi, rivojlanish rejalar, rejalashtirish hujjatlari yozuvlari, iqtisodiy zonalar hajmi, raqobatchilik markazkar soni, investitsiyalarning jozibadorligi	AHP
Baiyu Chen, Biying Wang [31]	Shahar joylashuvi koeffitsienti, shahar markazlashganligi, bozor farovonligi darajasi, yuk tashish hajmining nisbati, aholi jon boshiga YaIM, aholi soni.	AHP
Kursat Yildiz va boshqalar [32]	Narx (yuk tashish narxi), Transport turlari, yetkazib berish muddati, markazga yaqinlik, muqobil koridorning eng yaqin poezd stantsiyasidan masofasi.	AHP-VIKOR
Ismail Önden va boshqalar [33]	Avto magistralga yaqinlik, temir yo'lga yaqinlik, aeroportlarga yaqinlik, dengiz portiga yaqinlik, xalqaro savdo hajmi, aholi soni, dengiz portlarini boshqarish imkoniyatlari	F-AHP



Fulya Zarali va boshqalar [34]	Yer, kengaytirish maydoni (%), infratuzilma imkoniyatlari, viloyatga yaqinlik, sanoat va savdo zonalariga yaqinlik, portga yaqinlik, magistral yo'lga ulanish, temir yo'lga ulanish, yer narxi	Axiomatic Design
Jacek ŻAK, Szymon WEGLIŃSKI [35]	Viloyatning umumiy maydoni, aholi soni, aholi jon boshiga YaIM, iqtisodiy rivojlanishning o'rta darajasi, investitsiya va logistika jozibadorligi, erkin iqtisodiy hududlar soni, infratuzilma, ijtimoiy va ekologik holat, ishsizlik darajasi, harakat xafsizligi	MCDM/A ELECTRE III/IV
Maria CRISTEA va boshqalar [36]	Iqtisodiy samaradorlik, transport infratuzilmasi, raqobatbardoshlik darajasi, maqsadli bozor, iqtisodiy rivojlanish salohiyati, xorijiy investitsiyalar, eksport darajasi, davlat byudjeti subsidiyalari, ijtimoiy o'lchov, ish haqi, xavfsizlik, yashil maydonlar	ELECTRE III
Dmitri Muravev va boshqalar [37]	Aholi soni, Aholi jon boshiga YaIM, sanoat ishlab chiqarish hajmi, savdo hajmi, eksport mahsulotlari hajmi, import mahsulotlari hajmi, transport xizmatlari hajmi, transport infratuzilmasi, investitsiya jozibadorligi, transport logistikasi raqobat darajasi, transport karidorlariga chiqish, yer narxi, xafsizlik va qo'riqlash, temir yo'l transportida tashilgan yuklar darajasi, avtomobil transportida yuk tashish darajasi	DEMATE, MAIRCA
Xiaohui Liu va boshqalar [38]	Biznes muhiti (xizmat ko'rsatish darajasi, mehnat sharoitlari, logistika xarajatlari), infratuzilma (yo'l harakati shartlari, ijtimoiy ob'ektlar holati, tabiiy muhit gidrologik va geologik sharoitlar, tuproq sharoitlari)	center of gravity

7-jadvalda ko'rsatilgan adabiyotlarda LM joylashuvini tanlashda ta'sir qiluvchi mezonlarni asosiy va sub mezonlarga ajratish mumkin. Ushbu mezonlarning

adabiyotlarda foydalanilganlik ko'lamini tahlil qilish uchun 10-jadvaldagi ko'rinishda tasvirladik.

10-jadval

## Har bir adabiyot uchun qaror qabul qilishda ta'sir qiluvchi deb belgilab olingan mezonlar soni

Muallif/mualliflar	Asosiy mezonlar soni	Sub mezonlar soni	Baholangan umumiy mezonlar
Kurava A.Y. [20]	6		6
Sheikh Ariful Alam [21]	4		4
Murve Ozturk [22]	5	11	11
Ayshe Merve CAN [23]	14		9
Cihan UYANIK [24]	13	20	20
Muhammed Bamyaci [25]	4	17	17
Fulya Zarali [26]	9		9
H.Tezcan Uysal, Kemal Yavuz [27]	11		11
B.L. MacCarthy, W. Atthirawong [28]	13		13
Burchin Pachaci va boshqalar [29]	6		6
Krzysztof Witkows va boshqalar [30]	14		14
Baiyu Chen1, Biying Wang [31]	6		6
Kursat Yildiz va boshqalar [32]	5		5
İsmail Önden va boshqalar [33]	7		7
Fulya Zarali va boshqalar [34]	9		9
Jacek ŻAK, Szymon Węgliński [35]	10		10
Maria Cristea va boshqalar [36]	12		12
Dmitri Muravev va boshqalar [37]	10		10
Xiaohui Liu va boshqalar [38]	8		8

Qaror qabul qilish mezonlarini qamrab olish va undan foydalanish darajasi boyicha eng katta ko'rsatgichlar mos ravishda Cihan Uyanik[24] va Muhammed Bamyaci [25] lar

tamonidan tahlil qilingan. Biz ushbu baholash mezonlarini 5 ta katta guruhga ajratib oldik va ularning har birini adabiyotlarda foydalanilganlik darajasini ajratib chiqdik.

11-jadval

## Adabiyotlarda foydalanilgan baholash mezonlari va ularning foydalanilganlik chastotasi

Joylashuv		Hovoning ifloslanishi	3
Temir yo'lga yaqinlik	11	Yashil hudud	1
Avtomagistralga yo'lga yaqinlik	12	<b>Yuk tashish hajmi/iqtisodiy aks ettirish</b>	





Aeroportga yaqinlik	10	Makro iqtisodiy ko'rsatgich	4
Suv po'rtiga yaqinlik	7	Avtomobil transportida yuk tashish hajmi	3
Yer maydoni	5	Temir to'1 transportida yuk tashish hajmi	3
Kengaytirish imkoniyati	4	Transport va logistika jozibadorligi	4
Iqtisodiy hududlarga yaqinlik	8	Transport infratuzulmasi	5
Qurilish uchun yaroqlilik	3	Xalqaro savdo hajmi	2
Geografik, tuproq xolati	2	Sovdo markazlari soni	1
Shahar markaziga yaqinlik	8	Rivojlanish darajasi	2
Joylashuv hududi	2	Iqtisodiy tasir	4
Joy infratuzulmasi	4	Tashqi investitsiya	1
Ichki suv yo'llariga yaqinlik	1	Investitsiya darajasi	3
Ishlab chiqarish korxonalariga yaqinlik	5	Biznes muhiti	3
Bozorga yaqinlik	3	Raqobat darajasi	2
Istemolchilarga yaqinlik	2	<b>ijtimoiy omillar</b>	
<b>Xarajat</b>		Xafsizlik va qo'riqlash	3
Yer narxi	4	Aholi soni	3
Tashish xarajatlari	3	Ijtimoiy foyda	2
<b>Atrof-muhit</b>		Yerga egalik shakli	1
Tabiiy boyliklar	2	Ishchilar malakasi	2
Ekologik tasir	6	Qonun ustuvotligi va hokimiyat organlarining ro'li	4
Ekologik xafsizlik	3	Ijtimoiy barqarorlik	1

#### 4. Xulosa

Logistika markazlari mamlakat ichida va mintaqaviy miqyosda yuk tashish jarayonida xarajatlarni kamaytirish va turli transport turlarini birlashtiruvchi yechim sifatida paydo bo'ladi. Yuqori muqobil xarajatlar tufayli joy tanlash to'g'risida qaror qabul qilish muhimdir. Hozirgi davrda LM lari joylashuvini tanlash butun dunyoda iqtisodiy va jismoniy muammo sifatida baholanmoqda va ilmiy tadqiqotchilar tomonidan tadqiqot ishlari amalga oshirilib kelinmoqda. Ushbu muammoga bag'ishlangan maqolalar, konferensiya ma'ruzalari va magistrlik/PhD/doktorlik dissertatsiyalarida o'rganilmoqda. Tadqiqot ishida yaxshiroq yechimlarga erishish uchun aniq mezonlarni aniqlash va to'g'ri metodologiyani tanlash kerak.

Ushbu tadqiqotda logistika markazlarining joylashuvini tanlash muammosi bo'yicha adabiyotlar quyidagilarga asoslangan holda ko'rib chiqiladi: nazariy jihatdan qaror qabul qilish texnikasi, qaror mezonlari va amalga oshirish usullari. Ushbu tadqiqotning asosiy maqsadi tadqiqotchilar va soha vakillari uchun logistika markazlari joylashuv joyining ahamiyati bo'yicha tushuncha berish, shuningdek muammoning dolzarblilik darajasini ochib berishdan iborat. Shu maqsadda adabiyotlardan 6 ta magistrlik dissertatsiyasi, 1 ta PhD, 1 ta doktorlik va 17 ta ilmiy maqola ko'rib chiqildi. Ushbu tadqiqot ishida tahlillar natijalaridan quyidagilarni xulosa qilish mumkin: LM joylashuvi muammosi bo'yicha nashrlar tez sur'atlar bilan o'sib bormoqda va bu muammoning dolzarblilik darajasi yildan yilga oshib borayotganligini bildiradi. 2003-2023 yillar oralig'ida olib borilgan qidiruv natijalariga ko'ra, jami tadqiqotlarning deyarli yarmi bilan Turkiya ushbu tadqiqot sohasi bo'yicha yetakchi davlat ekan. Turkiyadan keyin Xitoy peshqadamlik qilmoqda. Bundan tashqari, ko'p meonli qaror qabul qilish (MCDM) texnikasi orasida AHP MCDM texnikasining boshqa qo'llanilish sohalari kabi eng mashhuri degan xulosaga kelish mumkin. AHPdan keyin mos ravishda TOPSIS va ELECTRE usullari keng qo'llanilib kelmoqda. Garchi ko'pgina tadqiqotlar ushbu tadqiqot sohasida MCDM usullaridan foydalangan bo'lishiga qaramasdan, bu muammoning noaniqligi hali ham batafsilroq ko'rib

chiqilishi kerak va takomillashtirish usullarini topish zarur. Shuningdek, ushbu tadqiqotning bir qismi bo'lgan qaror mezonlari tahlil qilinganda, eng ko'p etibor qaratilgan mezonlar xarajatlar va tabiiy resurslarning asosiy mezonlari guruhlariga ekanligi haqida xulosa chiqarish mumkin. Bugungi davr sharoitlaridan kelib chiqib ekologik omillarni ham ko'proq tahlil etish zarur. Ushbu ilmiy maqola muallifning PhD dissertatsiyasi doirasida tadqiqot ishi mavzusi bo'yicha turli qarashlar va ilmiy yondoshuvlarni aniqlab olish maqsadida yozildi. Logistika markazlarining joylashuv manzilini tanlash masalasi uzul-kesil tadqiqot nihoyasida amalga oshiriladi.

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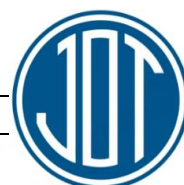
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## Mualliflar to'g'risida ma'lumot/ Information about the authors

Samatov G'affor / Gaffor Samatov	Toshkent davlat transport universiteti, "Transport logistikasi" kafedrasini mudiri, i.f.d. prof, E-mail: <a href="mailto:transportlogistikasi@mail.ru">transportlogistikasi@mail.ru</a> ; Tel: +99897 404 90 56 <a href="https://orcid.org/0000-0001-6479-6173">https://orcid.org/0000-0001-6479-6173</a>
Absattorov Isomiddin / Isomiddin Absattorov	Toshkent davlat transport universiteti tayanch doktranti, E-mail: <a href="mailto:isomiddinabsattorov@gmail.com">isomiddinabsattorov@gmail.com</a> Tel: +99894 574 59 97 <a href="https://orcid.org/0000-0002-5968-0990">https://orcid.org/0000-0002-5968-0990</a>
Matrasulov Qahramon / Kahraman Matrasulov	Toshkent davlat Transport universiteti "Transport logistikasi" kafedrasini assistenti, E-mail: <a href="mailto:kaxramonmatrasulov207@gmail.com">kaxramonmatrasulov207@gmail.com</a> Tel: +99890 807 82 07 <a href="https://orcid.org/0009-0004-3300-9228">https://orcid.org/0009-0004-3300-9228</a>



## Increasing the traffic safety of vehicles on the example of a real intersection

R.G. Samatov<sup>1</sup>, A.S. Rakhmanov<sup>1</sup>, N.H. Tursunov<sup>1</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** In this article, each intersection is studied according to the level of danger at the intersection using the fatality coefficient to improve the safe movement of vehicles at intersections. The safety of intersections and road junctions varies depending on the number of dangerous points there, the angle of intersection of traffic flows, the amount of traffic on the intersecting road, the amount of traffic joining and leaving. The traffic safety indicator describing the number of traffic accidents at the intersection was considered.

**Keywords:** conflict point, fatality rate, intersection, hazard rate, hazard rate, traffic.

## Real chorraha misolida transport vositalarini harakat xavfsizligini oshirish

Samatov R.G.<sup>1</sup>, Raxmonov A.S.<sup>1</sup>, Tursunov N.H.<sup>1</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Toshkent, O'zbekiston

**Annotatsiya:** Ushbu maqolada chorrahalarida transport vositalarini xavfsiz harakatini oshirisha halokatlilik ko'effitsiyentidan foydalangan holda chorrahada xavflilik darajasi bo'yicha har bir kesishma o'rganilgan. Chorrahalar va yo'l birikmalarining xavfsizligi u yerdagi xavfli nuqtalar soniga, transport oqimlari kesishish burchagiga, kesishayotgan yo'ldagi harakat miqdoriga, qo'shilayotgan va ajralayotgan transport miqdoriga bog'liq ravishda o'zgaradi. Chorrahada yo'l-transport hodisalari sonini tavsiflovchi harakat xavfsizligi ko'rsatkichi ko'rib chiqilgan.

**Keywords:** ziddiyatli nuqta, halokatlilik ko'effitsiyenti, chorraha, xavflilik ko'effitsiyenti, xavflilik darajasi, transport.

### 1. Kirish

So'nggi yillarida Poytaxtimizda aholi soni ham, transport vositalari ham ko'payib bormoqda. Oxirgi 10 yilda shaharda avtomobillar soni 250 mingtadan 510 mingtaga, ya'ni 2 baravar oshgan. Statistika agentligi xabar qilishicha Toshkent shahri aholisiga tegishli yengil avtomobillar soni yarim milliondan oshdi. Qayd etilishicha, 1-yanvar holatiga ko'ra, Toshkent shahrida jismoniy shaxslarga tegishli yengil avtomobillar soni 562,1 ming tani tashkil etmoqda. Bu ko'rsatkich o'tgan yilning 1-yanvar holati bilan solishtirilganda 94,9 mingtaga oshgan. Shunga mos ravishda transport infratuzilmasi ham rivojlantirilmoqda. Yangi yo'llar, ko'priklar, yerusti metrosi qurilmoqda. Xususan, joriy yilda Toshkent metropolitenining "Yunusobod" yo'nalishida 2 ta stansiya hamda yerusti xalqa yo'lining birinchi bosqichi ishga tushirildi. Jamoat transportida 56 ta yo'nalish maqbullashtirildi. Bular natijasida 170 ming aholining transport xizmati yaxshilandi, ularning transportga ketadigan vaqti o'rtacha 15-20 minutga qisqardi. Ammo poytaxtimiz ko'chalarida yuklama ko'p, yo'l harakatini tartibga solishda kamchiliklar yetarli. Transport vositalari tirbandligi yildan-yilga ortib bormoqda.

O'zbekiston Respublikasi Prezidentining 2024-yil 19-yanvarda "Yo'l harakati to'g'risida"gi O'RQ-900 son qonuni qabul qilindi.[1] Shu o'rida avtomobil yo'llarida yo'l

harakati xavfsizligini ta'minlash masalasi davlatning fuqarolar hayoti va sog'lig'ini saqlash sohasidagi asosiy vazifalaridan biri ekanligini ko'rsatmoqda

Toshkent shahrida 500 dan ortiq katta chorrahalar mavjud bo'lib, ularning 200 tasida transport vositalarining o'tkazish qobiliyati va yo'l harakati talablariga javob bermaydi. Avtomobil to'xtash joylari yetishmasligi sababli yo'lning birinchi tasmasida mashinalar yig'ilib, qatnovga xalaqit bermoqda. Bularning barchasi tufayli chorrahalarida transport vositalarini ushlanishi, kechikishi va tirbandliklar ko'paymoqda. Bu aloqa tezligining pasayishiga, asossiz ortiqcha yoqilg'i sarfiga va avtomobil komponentlari va agregatlarining eskirishiga olib keladi. Bularning barchasi transport vositalaridan foydalanish samaradorligini va transport vositalarining harakat tezligini pasayishiga ta'sir qiladi. Chorrahalarida bo'sh turish tufayli transport vositalarini tezligining pasayishi shovqin darajasining oshishiga, shahar havosi ifloslanishining oshishiga va yoqilg'i-moylash materiallarining haddan tashqari sarflanishiga olib keladi. Chorrahalarida transport vositalarining tez va xavfsiz harakatlanishini ta'minlash uchun manyovr qilish, qayta tizilish va tashkiliy tadbirlar majmuasini qo'llash zarur.

<sup>a</sup>  <https://orcid.org/0009-0007-4701-2518>

<sup>b</sup>  <https://orcid.org/0000-0003-1640-8839>

<sup>c</sup>  <https://orcid.org/0009-0000-6675-855X>



## 2. Tadqiqot metodikasi

Yo'l harakati xavfsizligi yo'l harakati ishtirokchilarining yo'l-transport hodisalari va ularning oqibatlaridan himoyalanganlik darajasini aks ettiruvchi yo'l harakati holati.

Yo'l-transport hodisasi transport vositasining yo'lda harakatlanishi jarayonida va uning ishtirokida sodir bo'lgan, fuqarolar vafot eishi yoki ularning sog'lig'iga zarar yetkazilgan, transport vositalari, inshootlar, yuklar shikastlangan yoxud boshqa moddiy zarar yetkazilgan hodisa.

Yo'l harakati xavfsizligini ta'minlash bu yo'l-transport hodisalarining sabablarini oldini olishga va oqibatlarining og'irligini kamaytirishga qaratilgan faoliyat.

Halokatlik koeffitsiyenti deb yo'l bo'lagining reja va kesimidagi har xil elementlaridagi YTHning sonini yo'lning etalon qismidagi hodisalar soniga nisbatiga aytiladi. Chorrahalar va yo'l birikmalarining xavfsizligi u yerdagi xavfli nuqtalar soniga, transport oqimlari kesishish burchagiga, kesishayotgan yo'ldagi harakat miqdoriga, qo'shilayotgan va ajralayotgan transport miqdoriga bog'liq ravishda o'zgaradi.

Chorrahalar va yo'l birikmalarining xavfsizligi u yerdagi xavfli nuqtalar soniga, transport oqimlari kesishish burchagiga, kesishayotgan yo'ldagi harakat miqdoriga, qo'shilayotgan va ajralayotgan transport miqdoriga bog'liq ravishda o'zgaradi.

Chorrahadagi yil davomida sodir bo'lishi mumkin bo'lgan hodisalar soni quyidagicha aniqlanadi:

$$G = \sum_1^n q_1;$$

bu yerda:  $n$  - xavfli nuqtalar soni;  $q_i$  - tekshirilayotgan nuqtaning xavflilik darajasi.

$$q_i = K_i \cdot M_i \cdot N_i \frac{25}{K_r} \cdot 10^{-7};$$













bu yerda:  $K_i$  - ziddiyatli nuqtaning nisbiy halokatlik tekshirilayotgan ziddiyatli nuqtadagi kesishayotgan transport oqimining harakat miqdori avt/sutka.  $K_r$  - harakat miqdorining oylar bo'yicha yillik notekislik koeffitsiyentini. Yangi loyihalananayotgan yo'llar uchun  $K_r$ -ning qiymati 1/12 ga teng deb qabul qilinishi mumkin.

Chorrahadagi yoki tutashmadagi halokatlik ko'rsatkichi quyidagi formula bilan aniqlanadi:

$$K_a = \frac{G \cdot K_r \cdot 10^7}{(M+N) \cdot 25};$$

bu yerda:  $M$  va  $N$  - asosiy va ikkinchi darajali yo'llardagi harakat miqdori, avt/sut; 25 koeffitsiyenti formulaga bir oyda 25 ish kunini hisobga olish uchun kiritilgan.

### 1-jadval

Ziddiyatli nuqtalar				
Ajralish	 O'ngga	 Chapga	 O'ngga va chapga	 To'g'riga, o'ngga va chapga
Qo'shilish	 O'ngdan	 Chapdan	 O'ngdan va chapdan	 To'g'ridan, o'ngdan va chapdan
Kesishish	 O'ngda	 Chapda	 Bir tomondan	 Qarama-qarshi

Har qanday chorrahada yo'l-transport hodisalari sonini tavsiflovchi harakat xavfsizligi ko'rsatkichini hisoblash uchun quyidagi formuladan foydalaniladi:

$$k_a = \frac{\sum_{i=1}^n k_i M N}{M + N}$$

bu yerda  $M$  - ziddiyatli nuqtalar soni,  $N$  - ziddiyatli transport oqimlarining harakat intensivligi,  $k_i$  - har bir ziddiyat nuqtasining nisbiy xavflilik koeffitsienti

### 2-jadval

Chorrahadagi ziddiyatli nuqtalarining  $k_i$  holatlari uchun nisbiy xavflilik koeffitsientlarining qiymati

№	Harakatlanish shartlari	Avtomobil yo'nalishi	Keshuv	$k_i$
1	Oqimning qo'shilishi	O'ngga burilish	$R < 15$ m	0,0 25
			$R \geq 15$ m	0,0 04
		Chapga burilish	$R < 10$ m	0,0 32
			$10 < R < 25$ m	0,0 25
2	Oqimning ajralishi	O'ngga burilish	$R < 15$ m	0,0 2
			$R \geq 15$ m	0,0 06
		Chapga burilish	$R < 10$ m	0,0 3
			$10 < R < 25$ m	0,0 04
3	Oqimning kesishishi	Burchak kesishishi	$\alpha \leq 30^\circ$	0,0 08
			$30^\circ < \alpha \leq 45^\circ$	0,0 36
			$45^\circ < \alpha \leq 90^\circ$	0,0 12
			$150^\circ \leq \alpha < 180^\circ$	0,0 35
			$180^\circ$	0,0 35

$k_a$  qiymatiga qarab, xavflilik darajasi bo'yicha har bir kesishma quyidagilar bo'lishi mumkin.

$k_a < 3$  - xavfli emas

$3 < k_a < 8$  - past xavfli

$8 < k_a < 12$  - xavfli

$k_a > 12$  - juda xavfli

Tadqiqot obyekti sifatida tanlab olingan chorraha Parkent ko'chasi va Mirzo Ulug'bek shox ko'chalari kesishmasi olingan. Chorrahaning umumiy malumotlar quyida keltirilgan. Parkent ko'chasining umumiy tasmlar soni 4 ta, piyodalar o'tish joyi bilan jihozlangan, ko'chening umumiy eni 28 metr, Mirzo Ulug'bek shox ko'chasining umumiy tasmlar soni 4 ta, piyodalar o'tish joyi bilan jihozlangan, ko'chening umumiy eni 32 metr, tashkil etadi.

Ushbu yo'nalishda transport vositalari harakati miqdori soatiga o'rtacha 4 mingta, kundalik transport oqimi o'rtacha 45 ming dan ortiq. Ma'lumotlar yig'ishda yo'lning geometrik ma'lumotlari (uzunligi, kengligi va yo'laklar soni (polosalar)), piyodalar o'tish joyi, avtobus bekatlari, chorrahada signal vaqtlari va ishlash rejimi hamda boshqa ma'lumotlar o'rganildi. Belgilangan uchastkada transport oqimi va tezligini o'rnatilgan GPS moslamalari yordamida



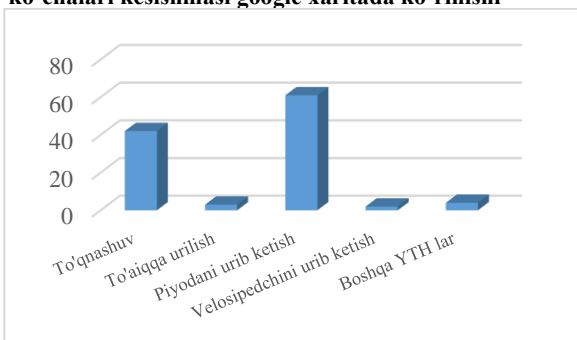


harakati tezligi ma'lumotlari to'planildi. Transport vositalarining maksimal tezligi 67 km/soat, minimal tezligi 20 km/soat va o'rtacha harakatlanish tezligi esa 35 km/soat tashkil etdi.

Transport vositalari turli tezliklarda harakatlanishi va yo'llardagi yo'laklarning (polosa) o'zgarishi ko'cha yo'llarning o'tkazish qobiliyatiga ta'sir qiladi. Bundan tashqari shahardagi svetoforlar esa ўтказиш қобилиятини янада чеклайди.



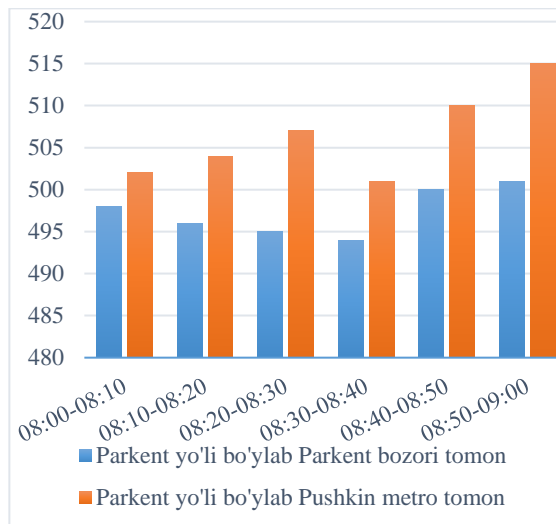
1-rasm. Parkent ko'chasi va Mirzo Ulug'bek shox ko'chalari kesishmasi google xaritada ko'rinishi



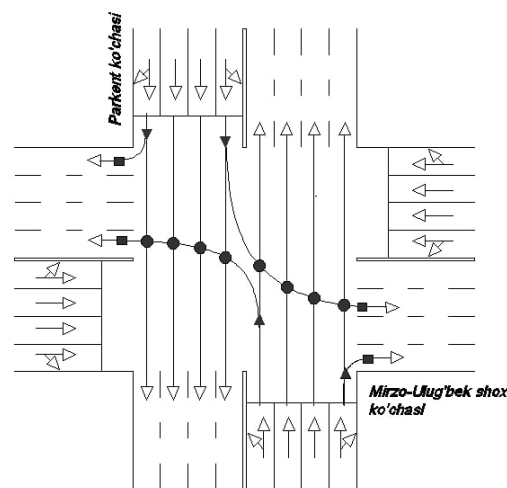
2-rasm. 2023 yil Mirzo Ulug'bek tumanida sodir etilgan YTH larning turlari bo'yicha tahlili

Tahlil natijalariga ko'ra eng ko'p sodir edilgan piyodani urib ketish, keying o'rinda to'qnashuv ekanligi ko'rinib turadi. Bundan kelib chiqadiki chorrahalarda piyodalar va avtomobillar xavfsizligini oshirish juda muhim.

Parkent ko'chasi va Mirzo Ulug'bek shox ko'chalari kesishmasida kuzatish usulida harakat miqdori yo'lning ko'rsatilgan bo'lagida bir yoki bir necha soat davomida hisobchilar yordamida maxsus tayyorlangan blankaga transport vositalarining o'tishini belgilash orqali aniqlanadi. Ko'pchilik davlatlarda, shuningdek, O'zbekistonda ham avtomobil yo'llaridagi harakat miqdorini kuzatuvchilar orqali aniqlanadi. Biz bu tadqiqotda 1 soatlik oqimni inobatga olgan holda halokatlilik koeffitsiyenti aniqlaymiz.



3-rasm. Parkent ko'chasi bo'yicha qarama-qarshi harakat transport oqimi diagrammasi



4-rasm. Parkent ko'chasi va Mirzo Ulug'bek shox ko'chalari kesishmalarining sxematik ko'rinishi

1. Oqimning qo'shilishi:

$$k_a = \frac{0,004 * 51 * 1239}{51 + 1239} = 0,2$$

$$k_a = \frac{0,004 * 80 * 982}{80 + 982} = 0,3$$

$$k_a = \frac{0,004 * 41 * 575}{41 + 575} = 0,15$$

$$k_a = \frac{0,004 * 41 * 635}{41 + 635} = 0,16$$

2. Oqimning ajralishi:

$$k_a = \frac{0,006 * 51 * 853}{51 + 853} = 0,3$$

$$k_a = \frac{0,006 * 80 * 1366}{80 + 1366} = 0,4$$

$$k_a = \frac{0,006 * 41 * 720}{41 + 720} = 0,2$$

$$k_a = \frac{0,006 * 41 * 490}{41 + 490} = 0,2$$

3. Oqimning kesishishi:

$$k_a = \frac{0,012 * 51 * 2119}{51 + 2119} = 0,6$$

$$k_a = \frac{0,012 * 80 * 1673}{80 + 1673} = 0,9$$

$$k_a = \frac{0,012 * 41 * 1082}{41 + 1082} = 0,5$$

$$k_a = \frac{0,012 * 41 * 731}{41 + 731} = 0,9$$

### 3. Xulosa

Hisob-kitoblardan biz shunday xulosaga keldikki, Parkent ko'chasi va Mirzo Ulug'bek shox ko'chalari kesishmada transport oqimlarining barcha mumkin bo'lgan yo'nalishlarini va transport oqimini hisobga olgan holda chorrahaning xavflilik darajasi 4,81 ni tashkil qildi. Bundan kelib chiqadiki, bu hudud past xavfli hisoblanadi.

Chorraha xavfsizligini ta'minlash ko'p qirrali yondashuvni talab qiladi, bunda ta'lim, infratuzilmani yaxshilash, amalda qo'llash, hamkorlik va doimiy tadqiqotlarni amalga oshirish orqali biz barcha yo'l harakati qatnashchillari uchun xavfsizroq muhit yaratishimiz, chorrahalar xavfsizligini birinchi o'ringa qo'yish va zonalarimizni avariylarsiz qilish uchun birgalikda ishlashni unutmang. Bugungi kunda amalga oshirilayotgan har bir harakat bizni chorrahadagi to'qnashuvlar kamroq va ko'proq hayotni tejaydigan kelajakka bir qadam yaqinlashtiradi.

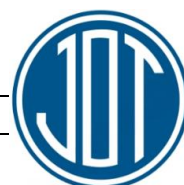
Chorraha xavfsizligini oshirishda texnologiyaning rolini osirib bo'lmaydi. Aqlli yo'l signallari tizimlaridan tortib, piyodalarni aniqlash tizimlari va texnologiyalarigacha bo'lgan har bir yangilik bizni ushbu yutuqlardan foydalanish va integratsiyalashgan yondashuvni qo'llash orqali yanada xavfsiz yo'l aloqalarini yaratishga yaqinlashtiradi, biz o'zaro to'qnashuvlarni minimallashtirishga va haydovchilar va piyodalarning hayotini himoya qilishga harakat qilishdan iborat.

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## Mualliflar bo'yicha ma'lumot/ Information about the authors

Samatov Rustam / Rustam Samatov	Toshkent davlat transport universiteti "Transport intellektual tizimlari muhandisligi" kafedrası PhD dotsent, E-mail: <a href="mailto:samatovrustam5005@gmail.com">samatovrustam5005@gmail.com</a> Tel.:+998997965005 <a href="https://orcid.org/0009-0007-4701-2518">https://orcid.org/0009-0007-4701-2518</a>
Raxmonov Azimjon / Azimjon Rakhmonov	Toshkent davlat transport universiteti "Transport intellektual tizimlari muhandisligi" kafedrası katta o'qituvchi, E-mail: <a href="mailto:azimjonraxmonov81@gmail.com">azimjonraxmonov81@gmail.com</a> Tel.:+998974308920 <a href="https://orcid.org/0000-0003-1640-8839">https://orcid.org/0000-0003-1640-8839</a>
Tursunov Nodir / Nodir Tursunov	Toshkent davlat transport universiteti doktaranti, E-mail: <a href="mailto:tursunovnodir7069@gmail.com">tursunovnodir7069@gmail.com</a> Tel.:+998912407697 <a href="https://orcid.org/0009-0000-6675-855X">https://orcid.org/0009-0000-6675-855X</a>



# Determining the impact of serving requests with a default sequence on server performance

E. Abdullaev<sup>1</sup><sup>a</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** Server devices are one of the most significant instruments for handling remote service requests. As a result, measuring the efficacy of its service is one of the most important aspects of properly organizing the work process. This study article looks at the impact of the usual method of serving requests on server performance and examines the findings during request congestion. In addition, this technique examines request service models to determine server efficiency in service. The findings revealed that at peak hours, the traditional method of providing requests lost more than 40% of all user requests.

**Keywords:** server samaradorligi, standart usulda xizmat ko'rsatish modeli, so'rovlarga xizmat ko'rsatish ko'rsatkichi, so'rovlarga xizmat ko'rsatish vaqti.

## Standart ketma-ketlik bilan so'rovlarga xizmat ko'rsatishning server samaradorligiga ta'siri aniqlash

Abdullaev E.<sup>1</sup><sup>a</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Tashkent, O'zbekiston

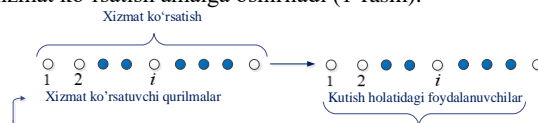
**Annotatsiya:** So'rovlarga masofadan xizmat ko'rsatishda server qurilmalari eng muhim vositalardan hisoblanadi. Shu sababli uning xizmat ko'rsatish samaradorligini aniqlash ish jarayonini to'g'ri tashkil etishning asosiy omillaridan biridir. Ushbu tadqiqot ishida standart usul orqali so'rovlarga xizmat ko'rsatishning server samaradorligiga ta'siri o'rganilgan bo'lib, uning so'rovlar tirbandligi vaqtidagi natijalari tahlil qilingan. Shuningdek, ushbu usulda xizmat ko'rsatishda server samaradorligini aniqlashning so'rovlarga xizmat ko'rsatish modellari tahlil qilingan. Olingan natijalar esa so'rovlarning tirbandligi vaqtlarida standart usulda xizmat ko'rsatish so'rovlarning har qanday foydalanuvchi so'rovlarning 40 % dan ortig'i yo'qotilishini ko'rsatdi.

**Kalit so'zlar:** server samaradorligi, standart usulda xizmat ko'rsatish modeli, so'rovlarga xizmat ko'rsatish ko'rsatkichi, so'rovlarga xizmat ko'rsatish vaqti.

### 1. Kirish

Serverlar orqali masofadan so'rovlarga xizmat ko'rsatish hozirgi kundagi eng keng tarqalgan xizmat ko'rsatish turlaridan biridir. Ushbu xizmat ko'rsatish turi insonlar orasida tobora ommalashib bormoqda. Bu esa o'z navbatida xizmat ko'rsatishni tashkil etish bilan bog'liq bir qancha muammolarni keltirib chiqarmoqda. Jumladan, ko'plab foydalanuvchilar tomonidan bir vaqtda xizmat ko'rsatish serveriga bo'lgan so'rovlar sonining ortishi so'rovlarga xizmat ko'rsatishda turli uzulishlar yoki kechikishlarga sabab bo'lmoqda [2], [5]. Chunki, har qanday texnik qurilma qatori serverlar ham xizmat ko'rsatish chegarasiga ega bo'lib, bir vaqtdagi so'rovlar sonining keskin ortishi ushbu chegaraning buzilishiga va xizmat ko'rsatishdagi turli muammolarga sabab bo'ladi. Odatda http so'rovlarga xizmat ko'rsatishda serverda o'rnatilgan veb server dasturlari xizmat ko'rsatishni amalga oshiradi. Bunda veb serverlar so'rovlarni qabul qiladi va dasturiy ta'minotga uzatadi, dasturiy ta'minotdan kelgan natijani esa foydalanuvchiga qaytaradi. Veb server shu ketma-ketlikda so'rovlarga xizmat ko'rsatishni amalga oshiradi. Odatda har

qanday veb serverlar orqali so'rovlarga xizmat ko'rsatish ketma-ket xizmat ko'rsatish prinsipiga asoslanadi [3], [4]. Ya'ni so'rovlarning yuqori tirbandligi vaqtlarida yoki tirbandligi kuzatilmagan vaqtlarga ham so'rovlarga bir vaqtda emas, ularning tizimga kelish ketma-ketligi asosida xizmat ko'rsatish amalga oshiriladi (1-rasm).



1-rasm. So'rovlar xizmat ko'rsatish ketma-ketligi

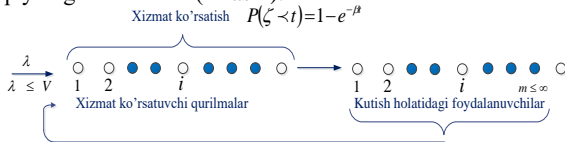
So'rovlarga aynan tizimga kelish ketma-ketligida xizmat ko'rsatish, so'rovlarning yuqori tirbandlik vaqtlarida server xizmat ko'rsatish samaradorligini pasayishiga sabab bo'ladigan omillardan hisoblanadi. Chunki, 1-rasmda keltirilgan tartibga ko'ra, har qanday foydalanuvchi so'rovi faqatgina xizmat ko'rsatish qurilmasi va kutish joylarida bo'sh joy bo'lgandagina xizmat ko'rsatishga qabul qilinadi. Qolgan holatlarda esa xizmat ko'rsatish rad etiladi.

<sup>a</sup> <https://orcid.org/0000-0002-8954-9731>



## 2. Metodologiya

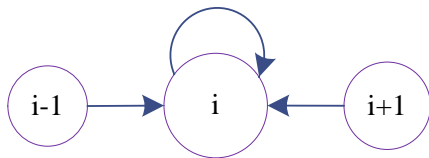
Shu sababli, tizim samaradorligini oldindan baholash, uning samaradorligini mo'tadilligini ta'minlashda muhim omillardan hisoblanadi. Ushbu usullar bilan so'rovlariga xizmat ko'rsatishning sifat samaradorligini aniqlash uchun ommaviy xizmat ko'rsatish modellaridan foydalanish maqsadga muvofiqdir. Buning uchun bir qancha modellari mavjud bo'lib, yuqorida ko'rib o'tilgan tizim uchun quyidagi matematik modeldan  $M_1/M_2/V/m < \infty$  foydalanish mumkin. Bu yerda,  $m$  kutish joylari soni,  $V$  - xizmat ko'rsatish qurilmalari soni,  $M_1$  - oddiy tasodifiy so'rovlar oqimi,  $M_2$  - xizmat ko'rsatish davomiyligi. Ushbu model asosida yuqoridagi 1-rasmda keltirilgan ketma-ketlik quyidagicha bo'ladi (2-rasm).



2-rasm. Foydalanuvchi so'rovlariga xizmat ko'rsatish modeli

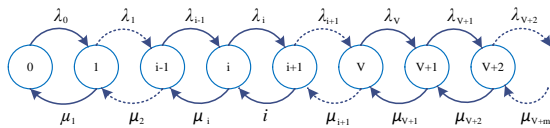
Bu yerda  $\lambda$  - tizimga tushayotgan so'rovlar (so'rovlar) jadalligi,  $V$  - xizmat ko'rsatuvchi qurilmalar soni,  $\beta$  - xizmat ko'rsatish jadalligi, ya'ni  $\beta = 1/t$ ,  $t$  - o'rtacha xizmat ko'rsatish davomiyligi.

Bu holatda foydalanuvchilar hosil qilgan so'rovlar oqimini oddiy oqim deb qarash mumkin. Bu esa Markov jarayonining xususiy holi hisoblanadi, hamda tug'ilish va halok bo'lish jarayonlariga bo'linadi [3]. Tug'ilish va halok bo'lish jarayonlari bu tizim ish jarayonida biror i holatdan  $i+1$  yoki  $i-1$  holatlarga o'tish jarayonlari hisoblanadi. Ushbu holatda to'liq imkoniyatli xizmat ko'rsatish qurilmasining holati quyidagi ko'rinishga ega bo'ladi (3-rasm)



3-rasm. To'liq imkoniyatli qurilmaning holati

Agarda serverning ish holati turg'un holatda deb qaralsa, u holda to'liq imkoniyatli qurilmaning statsionar holati quyidagi 4-rasmda keltirilgan ko'rinishni aks ettiradi. Ushbu ko'rinishda Markov xususiy holi bo'yicha tug'ilish jarayoni  $\lambda_i$  ni, halok bo'lish jarayoni esa  $\mu_i$  ni hosil qiladi.



4-rasm. To'liq imkoniyatli qurilmaning statsionar holati

Bunda [7], [8] ga asosan to'liq imkoniyatli statsionar tizim uchun quyidagi tenglamani o'rinni deb keltirish mumkin.

$$\lambda_{i-1}P_{i-1} - (\lambda_i + \mu_i)P_i + \mu_{i+1}P_{i+1} = 0 \quad 0 \leq i \leq V$$

$$\lambda_{i-1}P_{i-1} - (\lambda_i + \mu_V)P_i = 0 \quad V \leq i \leq \infty \quad (1)$$

Bu yerda,  $P_0$  - xizmat ko'rsatish tizimidagi barcha qurilmalarning bo'sh bo'lish ehtimolligi;

$P_i$  - aniq  $i$  ta xizmat ko'rsatish qurilmalarining band bo'lish ehtimolligi;

$PV+m$  - barcha  $v$  xizmat ko'rsatish qurilmalarining band bo'lishi va  $m$  ta kutayotgan so'rovlarning bo'lish ehtimolligi.

Markovning tug'ilish va halok bo'lish jarayonlari statsionar holatda bo'lish ehtimolligi quyidagi  $P_i$  tenglama orqali aniqlanadi [8].

$$P_i = P_0(\lambda_0\lambda_1\lambda_2\dots\lambda_{i-1})/(\mu_1\mu_2\mu_3\dots\mu_i) \quad (2)$$

Bunda, barcha holatlar ehtimolligi  $\sum_{i=0}^{\infty} P_i = 1$  ga teng bo'ladi.

Shuningdek, tizimga tushayotgan so'rovlariga xizmat ko'rsatish Erlangning turli formulalari yordamida qurilgan yoki qurilayotgan tizimning kutish yoki oshkora yo'qotish usullarida xizmat ko'rsatishiga qarab turli ko'rinishlarda bo'ladi. Xususan, Erlangning ikkinchi formulasiga ko'ra, kutish joylari uchun cheklovlar bor ekanligini inobatga olmaydi.  $M1/M2/V/m$  modeli kutish va oshkora yo'qotish usullarini birlashtirgan holda amalga oshirilgan. Bu modelda so'rovlarning kutish va yo'qotilish ehtimolliklari mos ravishda quyidagi ifodalar bilan aniqlanadi.

$$P(\gamma > 0) = \frac{v * [1 - (\frac{A}{v})^m]}{\frac{(v-A)}{Ev, v(A)} + A * [1 - (\frac{A}{v})^m]} \quad (3)$$

Bu yerda  $Ev, v(A)$  Erlangning  $B$  formulasi. Ko'rilyotgan modelda so'rovlarning yo'qotilish ehtimolligi

$$P = \frac{(v-A) * (\frac{A}{v})^m}{(\frac{(v-A)}{Ev(A)} + A * [1 - (\frac{A}{v})^m])} \quad (4)$$

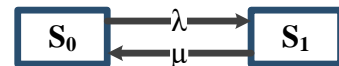
(4) ifodadan ko'rinadiki, agar  $m=0$ , ya'ni kutish joylari bo'lmasa, formula oshkora yo'qotish tizimiga aylanadi (Erlangning  $B$  formulasi) va yo'qotishlar ehtimolligi Erlangning  $B$  formulasi bilan aniqlanadi [10].

Agar  $m=\infty$  bo'lsa, formula shartli yo'qotish tizimiga aylanadi (Erlangning  $C$  formulasi). Bu holatda yo'qotishlar nolga teng deb qaraladi va tizim hamma so'rovlarga xizmat ko'rsatishga harakat qiladi. Ammo yuqorida ta'kidlanganidek so'rovlar sonining ko'payishi ularning yo'qotilish ehtimolligi oshirib boradi.

Yuqoridagi keltirib o'tilgan tenglama va ifodalar yordamida biror-bir tizimning ish samaradorligi quyidagicha aniqlanadi. Bunda, tizimning sifat ko'rsatkichini ikki holat - kutish va oshkora yo'qotish tamoyillari uchun alohida hisoblanadi.

Bir kanalli tizimlarda so'rovlarga oshkora yo'qotish usulida xizmat ko'rsatishda [9] ga asosan so'rovlar oqimining jadalligi  $\lambda$ , qurilmaning so'rovlardan ozod bo'lish oqimi jadalligi  $\mu$  ga teng bo'ladi.

Ushbu usul yordamida tizimning so'rovlarga xizmat ko'rsatish jarayoni ikki ko'rsatkichga asoslanadi. Ya'ni, tizimning bo'sh bo'lishi  $S_0$  va band bo'lishi  $S_1$  ehtimolliklari. Ushbu holatlar tizim orqali so'rovga xizmat ko'rsatish yoki ko'rsatmasligini anglatadi. Bunda tizim  $S_0$  holatda ekanligi so'rovga xizmat ko'rsatish mumkinligini,  $S_1$  esa xizmat tizim band ekanligini anglatadi (5-rasm).



5-rasm. So'rovlarga rad etish usulida xizmat ko'rsatishning strukturaviy sxemasi

Shu bilan birga, ushbu ko'rinishdagi tizimning bo'sh yoki band bo'lish ehtimoli (5) ifoda ko'rinishida bo'ladi.

$$\begin{cases} \lambda * p_0 = \mu * p_1 \\ \mu * p_1 = \lambda * p_0 \end{cases} \quad (5)$$

bu yerda,  $p_0$  so'rovlarga xizmat ko'rsatish ehtimolligini anglatadi. Bunga mos ravishda  $p_1$  so'rovning yo'qotilish ehtimolligiga teng bo'ladi. Ehtimollar nazariyasining normalashtirish shartiga ko'ra  $p_0+p_1=1$  qonuniga amal qiladi va (5) ifoda quyidagi (6) ko'rinishni hosil qiladi.





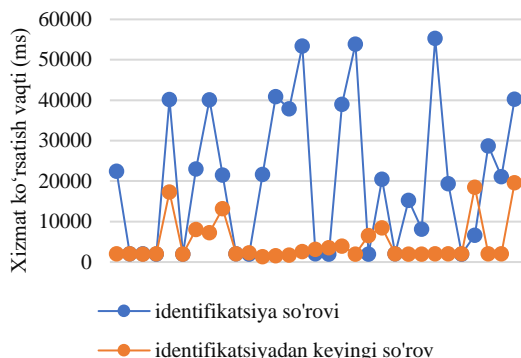
$$p_0 = \frac{\mu}{\lambda + \mu}, \quad p_1 = \frac{\lambda}{\lambda + \mu} \quad (6)$$

Yuqorida aytilgan so'rovlar soni va bitta so'rovga xizmat ko'rsatishning o'rtacha vaqtlarini (6) mos o'rinlariga qo'yish orqali tizimning xizmat ko'rsatish samaradorligini va yo'qotilish ehtimolligini aniqlashga imkon beradi.

### 3. Natija va muhokamalar

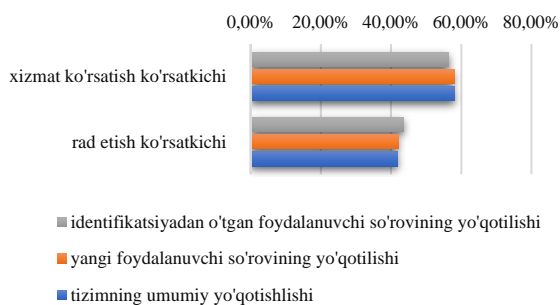
Endi, yuqorida keltirilgan ifodalarga mos tizimning sifat ko'rsatkichlarini aniqlash bo'yicha tadqiqotlarni amalga oshiramiz.

Unga ko'ra, identifikatsiyali tizimlarda so'rovlarga bir necha bosqichli xizmat ko'rsatish amalga oshiriladi. Ya'ni dastlab foydalanuvchi identifikatsiyadan o'tadi, so'ngra navbatdagi bosqichlarda o'zi uchun zarur bo'lgan natijalarni olishga harakat qiladi. Bunda foydalanuvchi tomonidan har bir jo'natilgan so'rovlar 1-rasmda keltirilgan ketma-ketlikdan o'tadi. Lekin, foydalanuvchining dastlabki so'rovi va identifikatsiya jarayonidan keyingi so'rovlarga xizmat ko'rsatish tartibi esa turlicha bo'ladi. Xuddi shuningdek, ushbu so'rovlarga xizmat ko'rsatish uchun sarflangan vaqt ham farqli bo'ladi (6-rasm). Chunki, identifikatsiya jarayoni foydalanuvchining haqiqiylikini tekshirish bilan bo'g'liq jarayonlarni o'z ichiga oladi va bu xizmat ko'rsatish vaqtining ortishiga olib keladi. Qayta so'rov hosil qilayotgan foydalanuvchi so'rovida esa foydalanuvchi identifikatsiyadan o'tganligi to'g'risida maxsus belgi mavjud bo'lib, bu identifikatsiyaning ma'lum aktivlik vaqti doirasida qayta amalga oshirilmasligiga sabab bo'ladi.



6-rasm. So'rovlarning tirbandlik vaqtlarida ularga xizmat ko'rsatish vaqti

So'rovlarning tirbandligida tizimga kelayotgan so'rovlarga 1-rasmdagi tartibda xizmat ko'rsatishda, tasodifiy miqdordagi yangi foydalanuvchilar va tasodifiy miqdordagi qayta so'rov hosil qilayotgan foydalanuvchilar so'rovlarga xizmat ko'rsatiladi. Bunda, tirbandlik vaqtlarida yangi foydalanuvchilar sonining ko'payishi navbatdagi so'rovlarni xizmat ko'rsatishga qabul qilishning kechikishiga sabab bo'ladi. O'tkazilgan tadqiqot natijalarida ushbu sabablar tufayli barcha turdagi foydalanuvchilardan kelayotgan so'rovlarning yo'qotilishi va xizmat ko'rsatish ko'rsatkichlari quyidagicha bo'ldi (7-rasm).



7-rasm. Tirbandlik vaqtlarida so'rovlarga xizmat ko'rsatish ko'rsatkichi

Bundan kelib chiqadiki, so'rovlarning tirbandlik vaqtlarida so'rovlarga bir xil usulda xizmat ko'rsatish samarasiz hisoblanib so'rovlarning katta qismiga xizmat ko'rsatilmagligiga olib keladi. Ayniqsa, server xizmat ko'rsatish qurilmasining uzoq vaqt bitta so'rov bilan band bo'lishi, boshqa so'rovlarni qabul qilishga ham imkon bermaydi va tizim samarasiz egallanadi. Yuqorida keltirilgan 2-3-raslardagi natijalarga ko'ra tizim o'rta hisobda deyarli 42% so'rovga xizmat ko'rsatmadi. Bunda o'rta 15 sekunddan ortiqroq vaqt rad etilgan so'rov uchun sarflandi va shuncha vaqt davomida xizmat ko'rsatishga boshqa so'rovlarni qabul qilmadi. Lekin identifikatsiya so'rovi va identifikatsiyadan keyingi so'rovlarga xizmat ko'rsatish uchun sarflangan vaqtga e'tibor bersak, identifikatsiya so'rovlari uchun o'rtacha ikki barobar ko'p vaqt sarf etilganligini ko'ramiz (1-jadval).

1-jadval

Sinovning umumiy ko'rsatkichlari

	Xizmat ko'rsatilgan	Rad etilgan	O'rtacha sarflangan vaqt (ms)
Yangi foydalanuvchi so'rovi	58.00%	42.00%	20847
Identifikatsiyadan o'tgan foydalanuvchi so'rovi	56.40%	43.60%	10182
Umumiy natija	57.20%	42.80%	15514.5

Ushbu ketma-ketlik bilan so'rovlarga xizmat ko'rsatishda tizim samarasizligining yuqori bo'lishida yana bir omil xizmat qiladi [2]. Ya'ni, tizim har bir qabul qilingan so'rovga xizmat ko'rsatish uchun veb serverda alohida xizmat ko'rsatish kanalini (thread) tashkil etadi. Ushbu yaratilgan kanallar soni esa standart veb server sozlamalariga ko'ra Nginx veb serveri uchun 1024, Apache veb serveri uchun 400 tani tashkil etadi. Bu esa tizimda bir vaqtda veb serverlarga mos ravishda 1024 va 400 ta foydalanuvchi bo'lishi mumkinligi anglatadi. Ammo (Abdullaev, E., Zakirov, V., & Shukurov, F. 2023) ishlari shuni ko'rsatadiki, har bir server bir vaqtda ma'lum miqdordagi foydalanuvchilarga xizmat ko'rsatish imkoniga ega. Bu esa serverning texnik ko'rsatkichlariga asosan aniqlanadi. Yuqoridagi olingan natijalar serveri Montage Jintide® C5220R 2.20 GHz, RAM 32.0 GB, HDD 500 GB texnik ko'rsatkichlarga ega bo'lib, uning bir sekunddagi xizmat ko'rsatish imkoniyati maksimum 177 tani tashkil etadi. Bundan kelib chiqadiki, foydalanuvchilar sonining





server imkoniyat miqdoridan oshishi, serverning so'rovlarga xizmat ko'rsatish imkoniyatini yo'qotishiga olib keladi.

#### 4. Xulosa

Xulosa qilib aytganda, so'rovlarning tirbandlik vaqtlarida standart ketma-ketlik asosida so'rovlarga xizmat ko'rsatish, server samaradorligini pasayishiga olib keladi. Shu bilan birga, server xizmat ko'rsatish jarayonida samarasiz egallanadi va boshqa so'rovlarni xizmat ko'rsatishga qabul qilishdagi muammolarni keltirib chiqaradi. Olingan natijalar ko'rsatadiki, tirbandlik vaqtlarida standart usulda xizmat ko'rsatish so'rovlarning 40% dan ortiq qismini yo'qotilishiga olib keldi.

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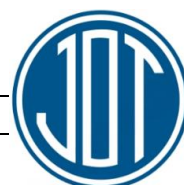
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#### Mualliflar to'g'risida ma'lumot/ Information about the authors

Abdullayev Eldor Toshkent davlat transport universiteti  
Sa'dulla o'g'li / "Radioelektron qurilmalar va tizimlar"  
Eldor Abdullaev kafedra doktoranti. E-mail:  
[eldorabdullayev0223@gmail.com](mailto:eldorabdullayev0223@gmail.com)  
Tel.:+99890 043 11 04  
<https://orcid.org/0000-0002-8954-9731>



## Processes of strategic planning of enterprise activity in the market of passenger transport services

G.E. Pulatova<sup>1</sup><sup>a</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** This article highlights that the development of public transport currently increases the level of mobility of the population in the city and directly affects macroeconomic indicators. In addition, during the research, planning processes consisting of 9 main stages of strategic planning of the activities of public transport enterprises were proposed. Also, a block diagram of strategic planning of the company's activities is proposed and divided into 4 blocks: "Analysis block", "Choosing an alternative strategy option", "Strategy improvement" and "Strategy effectiveness assessment".

**Keywords:** public transport, strategic planning, services market, financial stability.

## Yo'lovchi tashish xizmatlari bozorida korxonalar faoliyatini strategik rejalashtirishni jarayonlari

Pulatova G.E.<sup>1</sup><sup>a</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Tashkent, O'zbekiston

**Annotatsiya:** Ushbu maqolada hozirgi kunda jamoat transportini rivojlantirish shahardagi aholi harakatchanlik darajasini oshirishi va bevosita makroiqtisodiy ko'rsatkichlarga ta'sir etishi yoritilgan. Qolaversa tadqiqot davomida jamoat transporti korxonalar faoliyatini strategik rejalashtirishni asosiy 9 bosqichdan iborat bo'lgan rejalashtirish jarayonlari taklif etilgan. Shuningdek korxonalar faoliyatini strategik rejalashtirishning blok-sxemasini taklif etilgan bo'lib 4ta "Tahlil bloki", "Muqobil strategiya variantini tanlash", "Strategiyani oshirish" va "Strategiyani samaradorligi baholash" bloklariga ajratib berilgan.

**Kalit so'zlar:** jamoat transporti, strategik rejalashtirish, xizmatlar bozori, moliyaviy barqarorlik.

### 1. Kirish

Bugungi kunda shahar jamoat transporti tizimining samarali ishlashini ta'minlashning qiyinligi shundan iboratki, bir tomondan, uning yetkazib beruvchilar va boshqaruv mexanizmi bilan o'zaro aloqasi bozor munosabatlari asosida amalga oshirilishi tufayli yuqori operatsion xarajatlar bilan tavsiflanadi va boshqa tomondan, investitsiyalar va transport xarajatlari nisbatan past darajadagi tariflar aholini ijtimoiy himoya qilish masalalari bilan bevosita bog'liq.

Ayni paytda O'zbekistonda jamoat transportini rivojlantirishga qaratilgan qator islohotlar amalga oshirilmoqda. Xususan, chiptalarni sotishning avtomatlashtirilgan tizimi, qulay va ma'lumot beruvchi to'xtash joylari, integratsiyalashgan tarif rejalarini joriy etish kabi islohotlar aholining jamoat transportidan foydalanishda duch keladigan ko'plab muammolarining oldini olishga xizmat qilmoqda. Bundan tashqari, transport bozori sub'ektlari o'rtasidagi raqobatning kuchayishi ulardan uzoq muddatga mo'ljallangan strategik rajalarni ishlan chiqishni talab qiladi.


Shahar ichida yo'lovchi tashish jarayonida raqobatning kuchayishi, korxonalar moliyaviy imkoniyatlarini cheklanganligi kabi omillar salbiy ta'siri ostida xizmat ko'rsatayotgan korxonani tashqi muhit ta'sirini sezilarli

darajada ortishiga olib keladi. Tashqi muhit ta'siri, ichki muhitdagi murakkab jarayon korxonalar rahbariyatidan ko'plab muammolarni hal etishni talab etadi. Ushbu muammolarni majmuaviy hal qilishda albatta korxonani strategik boshqaruv bosh bo'g'ini sifatida strategik rejalashtirish asos bo'lib hisoblanadi, chunki u qaror qabul qilish hamda xizmatlarni amalga oshirish uchun resurslarning taqsimlanishini asoslab beradigan kompleks tizim bo'lib hisoblanadi.

Yo'lovchi tashish faoliyati bilan shug'ullanuvchi korxonalar faoliyati murakkab munosabatlardan iborat yaxlit tizim hisoblanishi inobatga olsak, muammolarni hal qilish qaratilgan korxonalar faoliyatini strategik rejalashtirish ma'lum bir yondashuvlarga asoslangan ketma ketlikda amalga oshirishni talab etadi.

### 2. Metodologiya

Strategik rejalashtirish nazariyasida ko'plab turli yondashuvlar va tushunchalarni, shuningdek, strategik rejalashtirishni amalga oshirish bosqichlari mavjud. Strategik rejalashtirish nazariy jihatdan xilma-xillik va farqlarga qaramay, strategik rejalashtirish bosqichlari bir-biriga ma'no jihatidan juda yaqin bo'lganligi sababli, strategik rejalashtirish jarayonini bosqichlarni

<sup>a</sup> <https://orcid.org/0009-0006-6358-624X>



umumiy lashtirish orqali korxonaga xususiyatlaridan kelib chiqib, strategik rejalashtirish jarayoni strategik rejalashtirish algoritmi sxemasi tuzish imkoniyatini yaratadi.

Galina Timokhina va Natalia Ivashkova ilmiy ishlarida shaxsiy avtomobillardan foydalanish bo'yicha Moskva shahridagi jamoat transportining raqobatbardoshligiga asosiy ta'sir etuvchi omillarini, shu jumladan mamalakatdagi iqtisodiy jarayonlar ta'sirini hisobga olgan holda yondashuvlarini shakllantirishgan [1]. Shaxsiy avtomobil egalari yettita klasteri aniqlashgan va jamoat transporti xizmatlari uchun maqsadli segment sifatida ikkita yirik klasteri tanlab olishgan.

Irina Yatskiv va Evelina Budilovichlar tadqiqotlarida Riga jamoat transporti tizimining turli darajasini aniqlashdagi rolini ko'rib chiqadi, bu esa o'z navbatida miqyos, aglomeratsiya effektlari iqtisodini yaratishga yordam beradi. Mualliflar uzoq masofali sayohatlarni ko'rib chiqadilar va Riga shahri va Latviya mintaqalari va Boltiqbo'yi davlatlarining asosiy yo'nalishlari o'rtasidagi qulaylik va aloqalarni baholaydilar. U butun shahar transport tizimini, mintaqaviy va xalqaro tarmoqni, shuningdek, harakatlanish zanjiridagi shaharlararo terminalni o'z ichiga oladi [2].

Irina Makarova va Anton Pashkevichlar "Ratsional boshqaruv orqali jamoat transporti tizimining barqarorligini ta'minlash" nomli maqolasida menejment tizimini joriy etish orqali shahar jamoat transporti tizimining barqarorligini yaxshilash imkoniyatlarini o'rganish ko'rsatilgan. Taklif etilgan usul sinovi Naberejnye Chelni misolida o'tkazildi [3]. Tizimning kontseptual modeli hamda uning dasturiy modullarining o'zaro ta'sir sxemasi ko'rsatildi. Tizim samaradorligini baholash uchun kompozit indikator taklif qilindi. Ma'lumotlarning axborot-mantiqiy modeli hamda shahar jamoat transporti yo'nalishi bo'yicha ilmiy asoslangan qarorlar qabul qilish jarayoni tasvirlangan. Marshrutlashning bunday yondashuvi shahar yo'llarida transport oqimlari to'g'risida haqiqiy ma'lumotni talab qiladi va shu bilan birga aholining harakatchanligi indeksini saqlab, atrof-muhitga salbiy ta'sirni minimallashtirishni hisobga olgan.

Strategik rejalashtirish sohasidagi olimlarning ilmiy materiallarini o'rganish va tahlil qilish natijasiga asoslanib, strategik rejalashtirishni asosiy bosqichlari quyidagi bosqichlardan iborat bo'lishi maqsadga muvofiq deb hisoblaymiz (1-jadval).

#### 1-jadval

##### Strategik rejalashtirishni asosiy bosqichlari

<b>1-bosqich</b>	Tashqi muhit tahlili	<ol style="list-style-type: none"> <li>Iqtisodiy, siyosiy, ijtimoiy-madaniy va texnologik tendensiyalarni tahlil qilish;</li> <li>Raqobatchilarni o'rganish va raqobat muhitini baholash;</li> <li>Bozor konyukturasini taxlil qilish.</li> </ol>
<b>2-bosqich</b>	Ichki muhit tahlili	<ol style="list-style-type: none"> <li>Ichki resurslarni, vakolatlarni va kuchli va zaif tomonlarini baholash;</li> <li>Korporativ madaniyat va tashkiliy tuzilmani tahlil qilish;</li> <li>Mavjud aktivlar va imkoniyatlarni tahlil qilish.</li> </ol>

<b>3-bosqich</b>	Missiya, maqsadlar va qadriyatlarini shakllantirish	<ol style="list-style-type: none"> <li>Tashkilotning asosiy missiyasini aniqlash;</li> <li>Aniq va o'lganadigan maqsadlarni belgilash;</li> <li>Asosiy qadriyatlar va tamoyillarni aniqlash</li> </ol>
<b>4-bosqich</b>	Strategiya shakllantirish	<ol style="list-style-type: none"> <li>Strategik muqobil variantlari ishlab chiqish va optimal strategiyani tanlash;</li> <li>Strategiyani amalga oshirish bo'yicha harakatlar rejasini ishlab chiqish.</li> <li>Strategiyani amalga oshirish rejasini ishlab chiqish.</li> </ol>
<b>5-bosqich</b>	Aniq maqsad va rejalarni ishlab chiqish	<ol style="list-style-type: none"> <li>Maqsadga erishish uchun amalga oshiriladigan reja bosqichlarini ketma-ketligini belgilash;</li> <li>Tezkor va taktik rejalarni shakllantirish;</li> <li>Rejalarning bajarilishini baholash uchun asosiy samaradorlik ko'rsatkichlarini (KPI) belgilash.</li> </ol>
<b>6-bosqich</b>	Strategiya amalga oshirish	<ol style="list-style-type: none"> <li>Loyihalarni amalga tadbiiq etish;</li> <li>Mas'uliyatlarni belgilash va resurslarni taqsimlash;</li> <li>Xodimlarning loyihani amalga oshirishga jalb etish</li> <li>Monitoring va nazorat:</li> </ol>
<b>7-bosqich</b>	Monitoring va nazorat	<ol style="list-style-type: none"> <li>Strategiyani amalga oshirishning doimiy monitoring qilish;</li> <li>Natijalarni belgilangan KPI bilan taqqoslash;</li> <li>Agar kerak bo'lsa, rejalarni tuzatishlar kiritish.</li> </ol>
<b>8-bosqich</b>	Baholash	<ol style="list-style-type: none"> <li>Natijalarni qo'yilgan maqsadlarga muvofiqligini baholash;</li> <li>Strategiyani samaradorligini baholash.</li> </ol>
<b>9-bosqich</b>	Strategiya o'zgartirishlar kiritish	<ol style="list-style-type: none"> <li>Tashqi va ichki muhitni qayta tahlil qilish;</li> <li>Aniqlangan muammolar va yangi imkoniyatlar asosida zaruriyat mavjud bo'lsa strategiyaga o'zgartirishlar kiritish..</li> </ol>

Keltirilgan bosqichlar va ularda amalga oshiriladigan ishlarni ketma-ketligi uzviy ta'minlangan holda, strategik rejalashtirishni soddalashtirish maqsadida barcha bosqichlarni umumiy bloklarga joylashtirish orqali, strategik rejalashtirish jarayoni aks ettiruvchi blok-sxemani shakllantirish maqsadga muvofiqdir. Chunki, rejalashtirish jarayonlarning tasvirlashni osonlashtirish bilan birga, strategiya elementlarining bir-biri bilan o'zaro ta'sirini



tushunishni, rejalashtirish va boshqarish jarayoni ishtirokchilari o'rtasidagi aloqani, munosabatlarni, ustuvor yo'nalishlarni ajratib ko'rsatish uchun zarur bo'lgan harakatlar ketma-ketligini, ichki va tashqi omillarni, resurslarni, xavflarni va imkoniyatlarni tahlil qilishni, bu strategiyani amalga oshirilishini kuzatish va kerak bo'lganda tuzatishlar kiritishni osonlashtiradi.

Strategik rejalashtirishni barcha bosqichlarini 4ta, "Tahlil bloki", "Muqobil strategiya variantini tanlash", "Strategiyani oshirish" va "Strategiyani samaradorligi baholash" bloklarni birlashtirish lozim (1-rasm). Umuman olganda korxonada strategik rejalashtirish jarayonida eng umumiy shaklda uchta bosqichni ajratish mumkin:

- 1) korxonani rivojlantirishning ichki va tashqi muhitlarini tahlil qilish;
- 2) strategik rivojlanish maqsadlari va ularni amalga oshirish mexanizmini asoslash;
- 3) strategik rivojlantirish kontseptsiyasi, dasturlar, rejalar va loyihalar ko'rinishida ko'zlangan maqsadlarga erishish uchun boshqaruv qarorlarini tayyorlash va qabul qilish.

### 3. Natijalar

Korxonani rivojlantirish strategiyasi iqtisodiy rivojlantirishning uzoq muddatli vazifalarini amalga oshirishga qaratilgan chora-tadbirlar tizimi sifatida qaralsa, korxonada rivojlantirish yo'nalishlarni belgilab olish zarur. Chunki, korxonani iqtisodiy o'sish barqarorligi, birinchi navbatda yo'lovchilarga ko'rsatilayotgan xizmatlar darajasiga bog'liqdir. Shu bilan birga, xizmat darajasini oshirish atrof-muhitga salbiy ta'sir ko'rsatmasligi ham zarur.



1-rasm. Korxonada faoliyatini strategik rejalashtirishning blok-sxemasini (muallif ishlanmasi)

Jamoat transportini strategik rivojlantirishda o'z oldiga qo'ygan maqsad va missiyasidan kelib chiqqan holda korxonada kadrlar, ishlab chiqarish salohiyatini oshirishga, korxonada infratuzilmasini takomillashtirishga hamda ekologik muammolarni hal qilishga qaratilgan strategik vazifalarni belgilab olishi kerak. Ushbu strategik vazifalar yo'lovchilarga yuqori xizmat ko'rsatish, xavfsizlik va qulaylikni ta'minlash, shuningdek, transportni ekologik jihatdan barqaror va resurslardan samaraliroq foydalanish imkonini beradi.

### 4. Xulosa

Natijalarini miqdoriy va sifat jihatidan baholash va monitoring qilish korxonada turgan muammolarni hal qilishga qaratilgan maqsadlarni shakllantirish, ularni



boshqarish va o'rnatilgan rivojlanish parametrlariga erishishni o'z ichiga olishi kerak.

Strategik rejalashtirish asosiy bosqichlari va Korxonalar faoliyatini strategik rejalashtirishning blok-sxemasida jamoat transportida yo'lovchi tashishni tashkil etuvchi korxonalar faoliyatini rivojlantirishning bozor konyukturasiga moslashuvchan strategik rejasi tuzilmasi tarkibiy qismlari shakllantirildi. Bu esa, o'z navbatida o'zgaruvchan va kuchli raqobatli bozor sharoitida, o'z vaqtida oqilona boshqaruv qarorlarni qabul qilish orqali korxonaning moliyaviy barqarorligini oshirishga yordam beradi.

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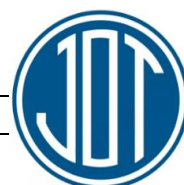
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## Mualliflar to'g'risida ma'lumot/ Information about the authors

Pulatova Gulchexra Erkinovna Tashkent davlat transport universiteti "Korporativ boshqaruv" kafedrasida mustaqil izlanuvchisi.  
e-mail: [pulatovag873@gmail.com](mailto:pulatovag873@gmail.com)  
tel: +99893-536-16-32  
ORCID: <https://orcid.org/0009-0006-6358-624X>





## Improvement of public transport activities based on strategic planning model

Z.N. Raxmatov<sup>1</sup>, G.E. Pulatova<sup>1</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** This article examines the existing shortcomings and problems in the field of passenger transportation of Tashkent city. Currently, factors directly and indirectly affecting public transport services are analyzed. Based on the research, the components of the strategic plan structure, flexible to the market conjuncture, of the development of the enterprise, which organizes passenger transport in public transport, were formed. A model of strategic planning of public transport is proposed, taking into account the current management and laws, the concept of economic development of the region. Also, a strategic plan structure has been developed that adapts to today's rapidly changing market environment.

**Keywords:** strategic planning model, transport enterprises, public transport, strategic planning, market conjuncture.

## Jamoat transporti faoliyatini strategik rejalashtirish modeli asosida takomillashtirish

Raxmatov Z.N.<sup>1</sup>, Pulatova G.E.<sup>1</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Toshkent, O'zbekiston

**Annotatsiya:** Ushbu maqolada Toshkent shahrining yo'lovchi tashish sohasidagi mavjud kamchilik va muammolar o'rganilgan. Hozirgi kunda jamoat transporti xizmatlariga bevosita va bilvosita ta'sir etuvchi omillar tahlil etilgan. Tadqiqotlar asosida jamoat transportida yo'lovchi tashishni tashkil etuvchi korxonalar faoliyatini rivojlantirishning bozor konyukturasiga moslashuvchan strategik reja tuzilmasi tarkibiy qismlari shakllantirilgan. Bugungi kundagi boshqaruv va qonuniyatlar, hududni iqtisodiy rivojlantirish konsepsiyasini inobatga olgan holda jamoat transportini strategik rejalashtirish modeli taklif etilgan. Shuningdek, bugungi kundagi tezkorlik bilan o'zgarayotgan bozor konyukturasiga moslashuvchan strategik rejani tuzilmasi ishlab chiqilgan.

**Keywords:** strategik rejalashtirish modeli, transport korxonalari, jamoat transporti, strategik rejalashtirish, bozor konyukturasini.

### 1. Kirish

Hozirgi tezlik bilan o'zgarib borayotgan iqtisodiy noaniqlik sharoitida, korxonalar o'zlarining raqobatbardoshligini saqlab qolishlari muhim ahamiyat kasb etmoqda. Bozor iqtisodiyotiga o'tish korxonalar oldida boshqaruvning tubdan farq qiluvchi shakllari, usullari va texnologiyalarini ishlab chiqishni taqazo qildi. Bugungi kunda strategik rejalashtirishning roli sezilarli darajada oshdi, uning maqsadi strategik qarorlarni ishlab chiqish va uzoq muddatli istiqbolda korxonani rivojlantirishga qaratilgan aniq rejani shakllantirishdir.

Bugungi kunda mamalakatimizda faqat bir nechtagina kompaniyalar samarali strategik rejalashtirish tizimiga egadir. Shunga qaramay, aksariyat menejerlar biznesni samarali boshqarish uchun strategik rejalashtirish muhimligini tushunib yetishgan. Bugungi kunda strategik rejalashtirish boshqaruv funksiyalarining eng muhim tarkibiy qismlaridan biri hisoblanadi. Strategik rejalashtirish uzoq muddatli rejalashtirishni o'rini egallagan holda

korxonalar faoliyatida asosiy tizimga aylanmoqda. Strategik rejalashtirish va uzoq muddatli rejalashtirish o'rtasidagi eng muhim farq kelajakdagi korxonani rivojlantirishning muqobil variantlarini ishlab chiqishdadir.

### 2. Metodologiya

Ma'lumki, strategik rejalashtirish muayyan taktikalarni aniqlash va ularni amalga oshirish uchun uzoq muddatli rejadir. Shu bilan birga, rahbar maqsadlarga erishish uchun zarur resurslarni to'g'ri taqsimlashi va korxonaning qarorlar qabul qilish jarayonini tartibsizlikdan olib chiquvchi rejalashtirish jarayoniga ega bo'lishi kerak.

Strategik boshqaruv va qonuniyatlar, hududni iqtisodiy rivojlantirish konsepsiyasi asosida jamoat transportini strategik rejalashtirish modelini quyidagichashakllantirish mumkin (1-rasm).

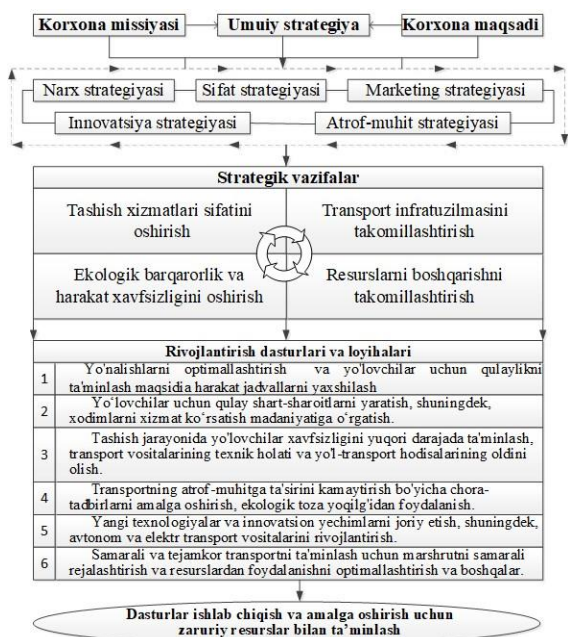
<sup>a</sup>  <https://orcid.org/0000-0002-8819-1678>

<sup>b</sup>  <https://orcid.org/0009-0006-6358-624X>



Umuman olganda, jamoat transportini strategik reja hududning uzoq muddatga mo'ljallangan barqaror rivojlanish strategiyami doirasida amalga oshiriladi. Chunki, jamoat transportini rivojlanishi ko'rsatilayotgan transport xizmati sifatini oshirish orqali, aholini turmush darajasini oshirishga qaratilgan.

Har qanday korxonona yoki tashkilot, shu jumladan jamoat transportini yo'lovchi tashish bilan shug'ullanuvchi tashkilotlarning strategik rejalashtirish jarayoni asosiy maqsadni aniqlash va shu maqsadlarga erishish uchun rejalashtirish usullari, uslublari asosida tegishli strategiyalarni tanlashdan ibrat bo'ladi. Shu bilan birga strategik reja korxonani rivojlantirish konsepsiyasiga asos bo'lishi kerak. Lekin, strategik reja o'zgartirishlar kirib bo'lmaydigan darajada bo'lmashligi kerak. Strategik reja bozor konyukturasiga moslashuvchan bo'lishi kerak, zarur hollarda strategik rejaga bozordagi o'zgarishlardan kelib chiqib tuzatishlar kiritish imkoniyati mavjud bo'lishi lozim.



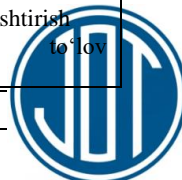
1-rasm. Jamoat transportini strategik rejalashtirish modeli (muallif ishlanmasi).

Yo'lovchi tashish, ushbu faoliyatini olib boruvchi tashkilotning o'ziga xos xususiyatini inobatga olib, bozor konyukturasiga moslashuvchan strategik rejani tuzilmasini quyidagi jadvalda keltiramiz.

1-jadval Bozor konyukturasiga moslashuvchan strategik rejani tuzilmasi

No	Strategik reja yo'nalishi	Strategik ko'rsatkichlari
1	2	3
1	Korxonaning missiyasi va uzoq muddatli rejalari	Korxonona rivojlanish maqsad va vazifalari Korxonona qadriyatlar Xodimlar samaradorligi Xodimlarni rag'batlantirish Boshqaruv uslublari optimallashtirish Iste'molchilarni qoniqishi Hamkorlar bilan ishlash Mijozlarga xizmat ko'rsatish Daromadlarni rejalashtirish va tahlil qilish

		Korxonona imidji takomillashtirish
2	Xizmat ko'rsatish xajmi	Xizmat ko'rsatishni tashkiliy-texnik darajasi Bozordagi imkoniyatlar Xizmatlarning rentabelligi Narx siyosati Xizmatlar sifati Marketing tadbirlari
3	Raqobatbardoshlik	Raqobatdagi ustunliklari Raqobatning intensivligi Iste'molchilarga xizmat ko'rsatish darajasi Xizmat turlarining raqobatbardoshligi
4	Bozor konyukturasiga moslashish	Bozor ulushi Tovarlarni ilgari surish strategiyasi Joriy va kelajakdagi talab Turli segmentlarni qamrab olish imkoniyati Potensial raqobatchilarni aniqlash
5	Resurslarni rejalashtirish	Ishlab chiqarish resurslari bilan ta'minlash Xom ashyo va materiallarni iste'mol qilish me'yorlari va normalari Aylanma mablag'lar O'z kapitali va qarz kapitali Pesurslarni rejalashtirish talablari Resurslarni tejash chora-tadbirlari
6	Biznes "portfelini" shakllantirish	Portfel rentabelligini hisoblash Korxonaning diversifikatsiya Qimmatli qog'ozlar emissiyasi
7	Innovatsion faoliyat	Yangi texnologiyalarni joriy etish Xizmat ko'rsatish jarayonini avtomatlashtirish Atrof-muhitni muhofaza qilish Ishlab chiqarish va boshqaruv jarayonlarida zamonaviy tamoyillaridan foydalanish: Nou-xau asosida ishlab chiqarishni tashkil etish
8	Investitsiyalar va ularni shakllantirish	Investitsion jarayonning davomiyligi Investitsiya obyektining progressivlik darajasi Mahsulot bozori sig'imi Narxlar o'zgarishi Marketing xarajatlarini moliyalashtirish Moliyalashtirish manbalari (o'z, qarz)
9	Moliyaviy ko'rsatkichlari	Xizmat ko'rsatish va boshqa operatsiyalardan olingan daromadlar Xarajatlarni rejalashtirish Korxonaning qobiliyati



10	Nazorat va natijalarni baholash, ular bo'yicha qarorlar qabul qilish
Natijalarini miqdoriy va sifat jihatidan baholash va monitoring	Rejadan og'ishlarning maqbul chegaralarini belgilash Boshqaruv qarorlarini qabul qilish uchun zarur bo'lgan tahliliy ma'lumotlar

### 3. Natijalar

Strategik reja yo'nalishi mazmun va mohiyatiga batafsil to'xtalib o'tsak:

1. Korxonaning missiyasi va uzoq muddatli rejalari – bu uning maqsadlari, qadriyatlari va strategik yo'nalishini belgilaydigan asosiy elementlari hisoblanadi hamda korxonaning missiyasi va istiqboli rejalari “Biz nima uchun mavjudmiz?”, “Kelajakda o'zimiz qanday ko'ramiz va qanday maqsadlarga erishamiz?” va “Qanday ijtimoiy qiymat yaratamiz” degan savollarga javob berishi zarur. Shu sababli, tashkilotning missiyasi va uzoq muddatli rejalari barcha manfaatdor tomonlar uchun aniq, tushunarli va ilhomlantiruvchi va maqsadlarga erishishga qaratilgan strategiya ishlab chiqish uchun asos bo'lishi kerak.

2. Xizmat ko'rsatish xajmi — bu tashkilotning ma'lum davrda ko'rsatiladigan xizmatlar miqdorini aks ettiruvchi, innovatsiya va investitsion faoliyat natijasini ifodalovchi miqdoriy ko'rsatkichdir. Ushbu ko'rsatkich tashkilotning strategik rejasining bir qismi bo'lib va uning bozordagi muvaffaqiyatining kaliti hisoblanadi.

3. Raqobatbardoshlik — bozorda ustunlikka erishish uchun samarali va axloqiy biznes strategiyalarini qo'llashni anglatadi. Bu biznes amaliyotining joriy talablari va standartlariga javob beradigan ilg'or tajriba va yondashuvlardan foydalanishni o'z ichiga oladi.

Raqobatbardoshlini ta'minlovchi usullardan foydalanish tashkilotga nafaqat bozorda omon qolishga, balki mijozlarni jalb qilish va saqlab qolish, innovatsiyalarni rivojlantirish, manfaatdor tomonlar bilan uzoq muddatli munosabatlarni o'rnatish orqali muvaffaqiyatga erishishga yordam beradi.

4. Bozor konyukturasiga moslashish — strategik rejalashtirishda asosiy rol o'ynaydi. Bozor konyukturasi orqali kompaniyalar mijozlarini, ularning ehtiyojlari va afzalliklarini yaxshiroq tushunishga va maqsadli marketing va strategik yondashuvlarni ishlab chiqishga yordam beradi.

5. Resurslarni rejalashtirish — strategiyani muvaffaqiyatli amalga oshirish va tashkiliy maqsadlarga erishish uchun zarur bo'lgan resurslarni aniqlash va tashkil etish jarayonidir. Bu jarayon ehtiyojlarni tahlil qilish, resurslarni taqsimlash, ulardan foydalanishni optimallashtirish va ularning bajarilishini nazorat qilishni o'z ichiga oladi. Resurslarni rejalashtirish samaradorlikni oshirish va mavjud resurslardan foydalanishni optimallashtirish istagiga asoslanadi.

Resurslarni samarali rejalashtirish tashkilotga o'z aktivlarini samarali boshqarish, xavf va xarajatlarni minimallashtirish, samaradorlikni oshirish va strategik maqsadlariga erishish imkonini beradi.

6. Biznes “portfelini” shakllantirish — bu kompaniyaning biznes bo'linmalari yoki mahsulotlarini optimallashtirish va kompaniyaning umumiy muvaffaqiyatiga hissa qo'shish uchun tahlil qilish va boshqarish jarayoni hisoblanib, kompaniyaga qaysi biznes

bo'linmalari yoki mahsulotlari eng ko'p foyda keltirishini, eng yuqori o'sish potensialiga ega ekanligini va qaysilari qo'shimcha sarmoya yoki strategiyani qayta ko'rib chiqishni talab qilishini aniqlashga yordam beradi.

Biznes portfelini shakllantirish kompaniyaga o'z resurslarini biznesning eng istiqbolli va daromadli sohalariga yo'naltirish, portfelini optimallashtirish va bozorda raqobatbardoshligini oshirish imkonini beradi.

7. Innovatsion faoliyat — (ba'zan innovatsiya deb ham ataladi) — kompaniya, uning mijozlari va umuman bozorga qiymat keltiradigan yangi g'oyalar, mahsulotlar, xizmatlar yoki jarayonlarni yaratish va amalga oshirish jarayoni ekanligi, innovatsiyalar biznesning turli jihatlariga, jumladan, mahsulotlar, texnologiya, ishlab chiqarish usullari, marketing va boshqalarga tegishli bo'lishi mumkin.

Innovatsiyalar bugungi dinamik biznes muhitida tashkilotning rivojlanishi va muvaffaqiyatining asosiy elementidir. Bu kompaniyalarga o'zgaruvchan bozor sharoitlariga moslashish, raqobatchilardan ajralib turish va mijozlari uchun qiymat yaratish imkonini beradi.

8. Investitsiyalar va ularni shakllantirish - Investitsiyalar kompaniyaning strategik rejalashtirishida asosiy rol o'ynaydi. Kompaniya o'z maqsadlariga erishishda, strategiyalarini amalga oshirishda va bozordagi mavqeiini mustahkamlashda yordam beradi. Investitsiyalar tashkilotning umumiy strategiyasi va maqsadlariga mos kelishi kerak. Bu esa resurslardan samarali foydalanishga va qisqa muddatda kerakli natijalarga erishishga yordam beradi.

9. Moliyaviy ko'rsatkichlari — Korxonaning moliyaviy natijalarini prognoz qilish strategik rejalashtirishning muhim elementidir. Bu kompaniyaga mavjud vaziyatni baholash, potensial xavf va imkoniyatlarni aniqlash va kerakli natijalarga erishish uchun strategiyalarni ishlab chiqish imkonini beradi. Asosiy moliyaviy ko'rsatkichlar daromad, foyda, pul oqimi, aktivlar aylanmasi, moliyaviy holat kabi ko'rsatkichlarni turli usullar va vositalar yordamida prognoz qilish mumkin, masalan, moliyaviy modellashtirish, tendensiyalarni tahlil qilish, ekspert baholashlari va boshqalar. Shuningdek, prognoz qilinayotgan ko'rsatkichlarga ta'sir ko'rsatishi mumkin bo'lgan iqtisodiy sharoitlar, qonunchilik, raqobat muhiti va boshqalar kabi tashqi omillarni hisobga olish muhimdir.

10. Natijalarini miqdoriy va sifat jihatidan baholash va monitoring – quyidagi muammolarni hal qilishga qaratilishi kerak:

- strategik rejalarning amalga oshirilishi;
- strategik rejalar uchun asos sifatida qabul qilingan ichki va tashqi muhitning joriy monitoringi;
- strategik muhim qarorlarni nazorat qilish;
- tashkilotning strategik rivojlanishining holatini tekshirish;
- tashkilot faoliyati tamoyillari bo'yicha strategik qarorlarni nazorat qilish.

### 4. Xulosa

Natijalarini miqdoriy va sifat jihatidan baholash va monitoring qilish korxonada turgan muammolarni hal qilishga qaratilgan maqsadlarni shakllantirish, ularni boshqarish va o'rnatilgan rivojlanish parametrlariga erishishni o'z ichiga olishi kerak.

Shuni ham ta'kidlash kerakki, strategik rejalashtirishning samarali faoliyat yuritishining asosiy sharti unga yuqori



darajali menejerlar tomonidan doimiy e'tibor va yangi strategiyani ishlab chiqishda xodimlarning keng tarkibini jalb qilishdir. Aniq va samarali strategiyaga ega bo'lmagan har qanday korxonani hech qanday tarzda samarali biznes yurutuvchi deb atash mumkin emas. Strategik rejalashtirish nafaqat bozorda mavjud bo'lish yoki omon qolishga, balki bozorda raqobatbardosh mavqeini mustahkamlashga ham yordam beradi. Korxonada o'z oldiga qo'yadigan vazifalar rahbariyatdan nafaqat bilim kengligini, balki faoliyatning iqtisodiy, ijtimoiy, ma'naviy va ekologik oqibatlar uchun mas'uliyat hissini ham talab qiladi, bu esa ish samaradorligini oshiradi va keng imkoniyatlar ochadi.

Shunday qilib, o'tkazilgan tadqiqotlar asosida jamoat transportida yo'lovchi tashishni tashkil etuvchi korxonada faoliyatini rivojlantirishning bozor konyunkturasiga moslashuvchan strategik rejasi tuzilmasi tarkibiy qismlari shakllantirildi. Bu esa, o'z navbatida o'zgaruvchan va kuchli raqobatli bozor sharoitida, to'g'ri va o'z vaqtida oqilona boshqaruv qarorlarni qabul qilish orqali korxonaning moliyaviy barqarorligini oshirishga yordam beradi.

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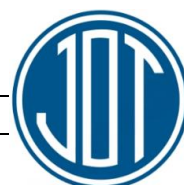
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## Mualliflar bo'yicha ma'lumot/ Information about the authors

Raxmatov Ziyodullo Nosirovich	Toshkent davlat transport universiteti "Korporativ boshqaruv" kafedrasini mudiri. e-mail: <a href="mailto:znaxmatov@tstu.uz">znaxmatov@tstu.uz</a> ; tel: +99899-883-55-09 ORCID: <a href="https://orcid.org/0000-0002-8819-1678">https://orcid.org/0000-0002-8819-1678</a>
Pulatova Gulchexra Erkinovna	Toshkent davlat transport universiteti "Korporativ boshqaruv" kafedrasini mustaqil izlanuvchisi. e-mail: <a href="mailto:pulatovag873@gmail.com">pulatovag873@gmail.com</a> tel: +99893-536-16-32 ORCID: <a href="https://orcid.org/0009-0006-6358-624X">https://orcid.org/0009-0006-6358-624X</a>





## Simulation of the process of migration of sand particles through vertical protective barriers

S.T. Djabbarov<sup>1</sup>, Kh.D. Abdullaev<sup>1</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** This article reflects the results of research on the impact of sandslides on roads, and the results of determining the factors affecting the movement of sand. Also, the results of the modeling of the vertical barriers installed along the road in order to protect the highway from sand drift in the virtual aerodynamic laboratory are presented.

**Keywords:** sand drift, vertical barriers, solidworks, aerodynamic laboratory.

## Qum zarrachalarini vertikal himoya to'siqlari ustidan ko'chib o'tish jarayonini modellashtirish

Djabbarov S.T.<sup>1</sup>, Abdullayev X.D.<sup>1</sup>

<sup>1</sup>Toshkent davlat transport universiteti, Toshkent, O'zbekiston

**Annotatsiya:** Ushbu maqolada qum ko'chkilarini yo'llarga ta'siri haqida olib borilgan tadqiqotlar tahlili, qumlarni ko'chishiga ta'sir etuvchi omillarni aniqlash natijalari aks etgan. Shuningdek, avtomobil yo'lini qum ko'chishidan himoya qilish maqsadida yo'l bo'yiga o'rnatilgan vertikal shakldagi to'siqlarni virtual aerodinamik laboratoriyada modellashtirish natijalari keltirilgan.

**Keywords:** qum ko'chkilari, vertikal to'siqlar, solidworks, aerodinamik laboratoriya.

### 1. Kirish

Transport xizmatlariga bo'lgan ehtiyojning kundan kunga o'sib borishi zamonaviy talablarga mos keladigan yangi avtomobil yo'llarini barpo qilishni talab qilmoqda. Bu esa, turli topografik va iqlim zonalaridan o'tuvchi transkontinental va transmintaqaviy avtomagistralarni, mavjud avtomobil yo'llari tarmoqlarini rivojlantirish va takomillashtirish kabi dolzarb muammolarni keltirib chiqarmoqda.

Shunday muammolardan biri bu qumli hududlardagi mavjud hamda yangi loyihalayotgan yo'llarni ko'chki qumlardan saqlash, unda harakatlanayotgan barcha turdagi transport vositalarining xavfsiz va uzluksiz harakatini ta'minlash katta ahamiyat kasb etmoqda. Yo'l infratuzilmasini takomillashtirish va avtomobil yo'llari tarmog'ini jadal rivojlantirish, mamlakatimizning qumli cho'l hududlaridan o'tgan 4000 km ga yaqin xalqaro, davlat hamda mahalliy ahamiyatdagi avtomagistralarni ko'chuvchan qumlar ta'siridan himoya qilish, har bir yo'l uchun mahalliy sharoitlarni inobatga olgan holda samarali himoya vositalarni tanlash, innovatsion texnologiyalarga asoslangan texnologik yechimlar ishlab chiqish muhim hisoblanadi [1].

Qumli hududlardagi yo'llarni qum ko'chkilaridan himoya qilish bo'yicha turli usul va vositalarni qo'llash bo'yicha L.Bruno, J.Zakeri, L.Rafaye, F.Pellerey, N.Koste, M.Ismoili, Ning Huang, Shuai Zhang, Zhibao

Dong, Qingjiye Han, Ke-cun Zhang, Ruiping Zu, Podgornov A.S., Viyesov S.K., Babayev A.G., Petrov M.P., Baynatov J.B., Uteshbayeva A.A., Zokirov R.S., M.Miraxmedov, T.I.Fozilov va boshqalar tomonidan ilmiy-tadqiqot ishlari olib borilgan [2-10].

Aerodinamik laboratoriyada harakatlanuvchi qumlarga qarshi turli shakldagi to'siqlar ko'plab olimlar tomonidan modellashtirish yordamida sinab ko'rilgan va kerakli natijalarga erishilgan[11-17].

Uzoq yillar davomida olib borilgan tadqiqotlarda avtomobil yo'llarini ko'chuvchan qumlardan himoya qilishning mexanik usullari, hukmron shamollar yo'nalishi va tezligini o'zgarishi, yangi konstruksion yechimlar va innovatsion materiallarni inobatga olgan holda aniq muhandislik va amaliy yechimlari keltirilmagan. Har bir alohida holat (avtomobil yo'li bo'lagi) uchun himoya vositalarining uzoq muddat samarali ishlash imkoniyatini beruvchi qurilish-texnologik parametrlarini asoslashda havo-qum massasi harakatini virtual aerodinamik laboratoriyada modellashtirish amaliyoti qo'llanilmagan.

<sup>a</sup>  <https://orcid.org/0000-0002-3798-407X>

<sup>b</sup>  <https://orcid.org/0000-0003-0566-3260>





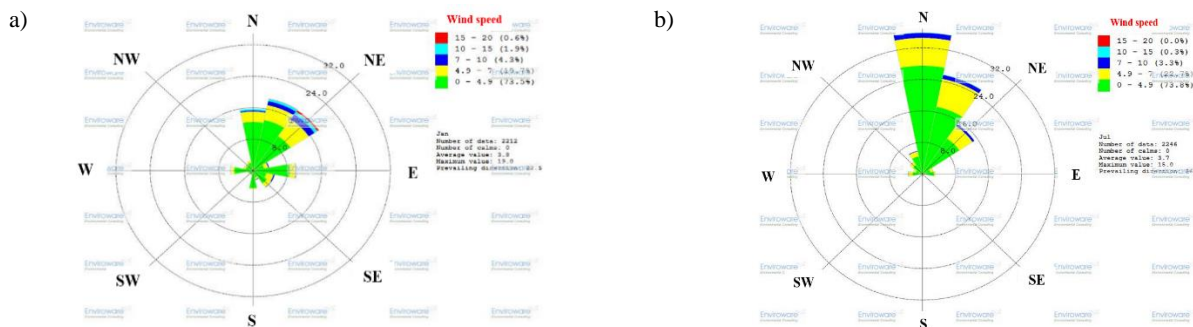
## 2. Qo'llanilgan materiallar va uslublar

O'zbekistonning qumli cho'l hududlaridan o'tgan avtomobil yo'llarida harakat xavfsizligi va yo'l infratuzilmasi barqarorligiga xavf tug'diruvchi salbiy holat-qum ko'chishi bilan bevosita bog'liq bo'lgan jiddiy muammoga duch kelmoqda. Ushbu muammolarni hal qilish maqsadida tajriba uchastkasida o'ziga xos iqlim va tuproq sharoitidan kelib chiqqan holda, yo'llarni harakatlanuvchi qumlarning ta'siridan himoya qilish uchun vertikal to'siqlarni o'rnatgan holda hamda ularni virtual aerodinamik

laboratoriyada modellashtirish orqali foydalanishni ko'rib chiqamiz.

Tajriba uchastkasi avtomobil yo'lining ma'lum bo'laklarida qumlarni ko'chishiga olib keladigan shamolning yo'nalanishi va tezligini aniqlash maqsadida o'lchov ishlari amalga oshirildi.

Real vaqt rejimida olingan hamda hududdagi gidrometeorologik o'lchov stansiyalaridan olingan ma'lumotlar qayta ishlanib, hududdagi shamolning yo'nalanishi va tezligi tahlil qilindi. Ushbu ma'lumotlar qayta ishlanib, shamolning tezligi yillar, oylar va yo'nalishlar kesimida tahlil qilindi. Bu tahlillar yordamida hududda esayotgan hukmron shamollarning yo'nalanishi 22.5 gradusga o'zgariganligi aniqlandi (1-rasm).



1-rasm. Shamolning "dinamik guli" sxemasi:

a) Yanvar oyi uchun; b) Iyul oyi uchun.

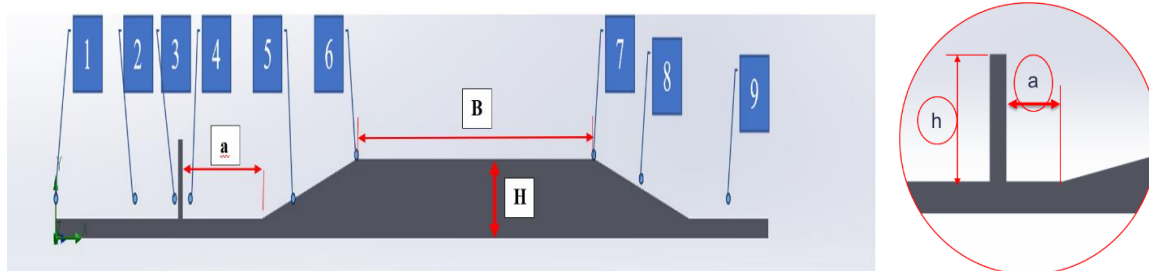
## 3. Natijalar

Vertikal to'siqlarni sinab ko'rish uchun qum yoki chang ko'p bo'lgan hududlarga xos bo'lgan atmosfera sharoitlarini simulyatsiya qilish uchun maxsus vositalardan foydalanigan holda bajarish mumkin.

Ushbu maxsus vositalar to'siqqa yo'naltirilgan zarrachalar oqimini yaratadigan qum oqimi generatorini o'z ichiga oladi. To'siqni sinov uchun boshqariladigan muhitni

ta'minlaydigan tunnelga o'rnatilib sinaladi. Sinov paytida to'siq shamol, bosim va kuch kabi turli xil yuklarga tekshiriladi.

Yo'l bo'ylab havo-qum aralashmasini o'tkazish jarayonini modellashtirish standart SOLIDWORKS Flow Simulation dasturi yordamida yo'lining quyidagi parametrlari va himoya tuzilmalarining davriy o'zgarishi bilan amalga oshirildi (2-rasm).



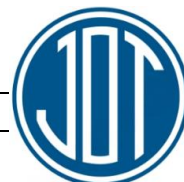
2-rasm. Yo'l kesimining hamda unda o'rnatilgan qumdan himoya qiluvchi to'siqning hisobiy ko'rinishi:

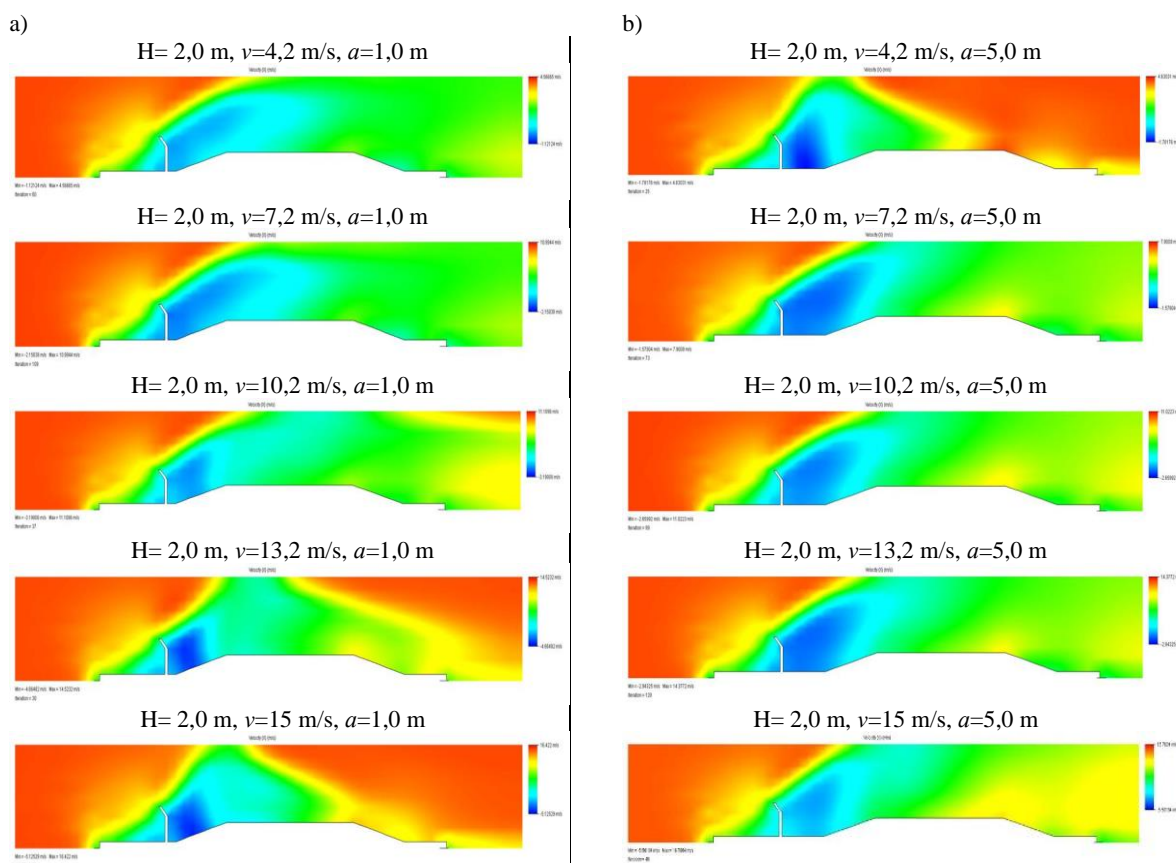
H - yo'l ko'tarmasining balandligi ( $H=1.5$  m); B - yo'lining eni ( $B=15.0$  m); a - yo'l poyi ostigan to'siqgacha bo'lgan masofa ( $a=1.0$  yoki  $5.0$  m) h - to'siq balandligi ( $h=2,0$  m).

Hisob-kitoblarning aniqligini va natijalarning ishonchligini oshirish uchun dastlabki ma'lumotlarning har bir o'zgarishi uchun takrorlash soni 100 yoki undan ko'p marta bo'lgan. Shamolning yo'nalanishi va shuning uchun havo-qum oqimi yo'lining o'qiga perpendikulyar deb taxmin qilingan.

Foydalanilishi kerak bo'lgan to'siqning optimal ko'rinishini aniqlash uchun turli xil havo oqimi tezligi va qum zichligi bo'yicha sinov o'tkaziladi. Sinov natijalari to'siqning konstruksiyasi va materialini inobatga olgan holda uning atmosferada harakatlanuvchi qumlardan himoya qilish samaradorligini yaxshilash uchun qanchalik samarali ekanligi baholanadi.

Tadqiqot o'tkazish davomida vertikal shakldagi to'siqlarning 2 xil ko'rinishini maxsus tayyorlangan virtual aerodinamik laboratoriyada modeli hosil qilinib, hududlar uchun turli xarakterli bo'lgan qiymatlar kiritilib tekshirildi. Ushbu sxemalardagi natijalardan shamol-qum oqimining to'siq oldida va undan keyin harakatlanish trayektoriyasini tahlil qilish mumkin (3-rasm).

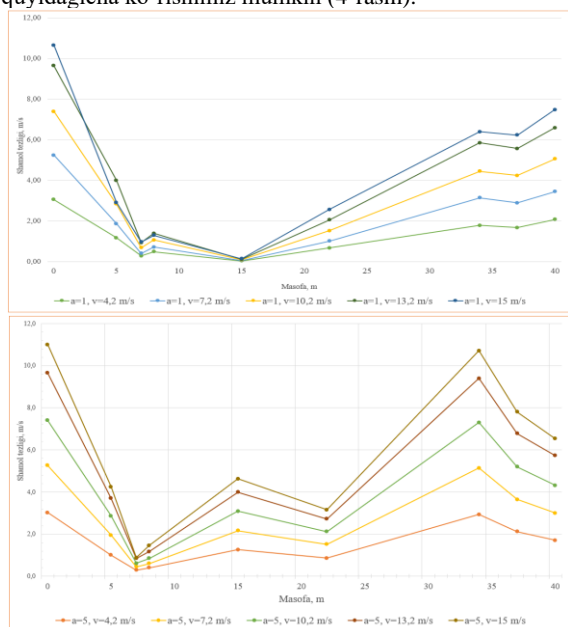




**3-rasm. Vertikal to'siq (devor yoki temir beton konstruksiya) o'rnatilganda shamol tezligining turli qiymatlarida to'siq atrofida shamol-qum oqimi o'zgarishining qirqimda ko'rinishi**

a) a=1 metr bo'lganda; b) a=5 metr bo'lganda.

Shuningdek, shamol-qum oqimini nazorat nuqtalari sifatida berilgan nuqtalardagi tezliklarini o'zgarishini quyidagicha ko'rishimiz mumkin (4-rasm).



**4-rasm. Vertikal to'siq (devor yoki temir beton konstruksiya) o'rnatilganda shamol tezligining turli qiymatlarida to'siq atrofida shamol-qum oqimi tezligi o'zgarishi**

Havo-qum oqimi tezligi zonasi taqsimotining olingan egri chiziqlari (izolinialari) tahlili shuni ko'rsatadiki:

- havo-qum oqimining yuqori tezlikli zonasini oqimli zamin bo'ylab taqsimlash himoya strukturasi o'lchamiga bog'liq;
- himoya inshooti hajmining oshishi bilan yo'l tubining chetida havo-qum oqimining tezligi 3,4 m/s dan 8,5 m/s gacha oshadi, bu esa qumni ushlab turmasdan o'tkazishni osonlashtiradi;
- yo'l yuzasi bo'ylab havo-qum oqimining tezligi himoya inshootining o'lchamlarini 3,8 m/s dan 5,4 m/s gacha oshirish bilan ortadi, bu esa qumning o'tkazilishiga yordam beradi.

### 4. Xulosa

Yo'llarni ko'chuvchan qumdan himoya qilish uchun vertikal to'siqlarni modellashtirish tajriba uchastkasida yo'l harakati xavfsizligini ta'minlashda muhim qadam hisoblanadi. Ishlab chiqilgan modellar keyingi tadqiqotlar va amaliyotga tatbiq etish, tabiiy sharoiti o'xshash hududlarda infratuzilma muammolarini hal etishda innovatsion yondashuvlarni joriy etish uchun asos bo'lib xizmat qilmadi.

Ko'p yillik izlanishlar natijasida cho'llarda transport vositalarini qum ko'chishidan himoya qilishning turli uslub va usullari ishlab chiqildi va taklif qilindi. Himoya usullarining xilma-xilligiga, ushbu usullarning yetarli darajada o'rganilishiga va ularning natijalarini amaliyotga keng tatbiq etilishiga qaramay, qumli cho'llarda transport



infratuzilmasi obyektlari va inshootlarini qum bosishidan himoya qilishning samarali usuli ishlab chiqilmagan.

Zamonaviy amaliy dasturiy mahsulotlar yordamida amalga oshirilgan hisob-kitoblar natijalari va taqdim etilgan xulosalarni umumlashirish quyidagi xulosalar chiqarishga imkon beradi:

- yo'llarni qum ko'chishidan himoya qilishning mexanik usuli o'z imkoniyatlarini hali saqlab qolgan;

- himoya vositalarining geometrik o'lchamlari uning atrofida hosil bo'ladigan va harakatlanadigan ikkilamchi havo-qum oqimining tezligiga sezilarli ta'sir ko'rsatadi;

- himoya vositasining qurilish-texnologik parametrlarini kichrayishi oqibatida yo'l yuzasida cho'kib qoladigan qum miqdori ortib boradi;

Mahalliy xomashyodan foydalanishga asoslangan samarali va resurslarni tejaydigan, transport infratuzilmasi obyektlari va inshootlarining xavfsiz ishlashini ta'minlash uchun mahalliy xususiyatlarni hisobga olgan holda texnologiyalarni ishlab chiqish dolzarb vazifa bo'lib qolaveradi. Ushbu maqola qumni siljitishning murakkab muammosini hal qilishga va shunga o'xshash muammolarga duch kelgan hududlarda yo'lni muhofaza qilishning moslashtirilgan yechimlarini ishlab chiqishga intilayotgan tadqiqotchilar, siyosatchilar va muhandislar uchun qo'llanma bo'lib xizmat qiladi.

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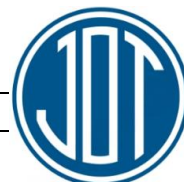
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## Mualliflar bo'yicha ma'lumot/ Information about the authors

Saidburkhan Toshkent davlat transport universiteti,  
Djabbarov / texnika fanlari doktori, professor.  
Djabbarov e-mail: [\\_saidhon\\_inbox.ru](mailto:_saidhon_inbox.ru)  
Saidburxan tel.: +998901852934  
Tulaganovich ORCID: <https://orcid.org/0000-0002-3798-407X>

Khurshidbek Toshkent davlat transport universiteti,  
Abdullaev / texnika fanlari bo'yicha falsafa doktori  
Abdullayev (PhD).  
Xurshidbek email: [Mr.Khurshidbek93@mail.ru](mailto:Mr.Khurshidbek93@mail.ru)  
Dilshodbek tel.: +998909700067  
o'g'li ORCID: <https://orcid.org/0000-0003-0566-3260>



## Methodological approach to the strategy of operation, maintenance and repair of locomotives

M.N. Masharipov<sup>1</sup>, Sh.A. Umrzoqova<sup>1</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** The described approach, in our opinion, most correctly reflects the mechanism of the locomotive operation process itself, and therefore the relationship between these concepts. It is advisable to consider repair and maintenance as components of a broader concept, such as technical operation. Important for the transition to maintenance and repair according to the condition are the issues of the correct interpretation of the terms of the strategy on establishing the relationship between the strategies of operation (use) maintenance and repair of rolling stock. As the analysis has shown, there is still no unity of views on these issues. The proposed methodological approach to solving these issues does not pretend to be complete and complete. However, it can be used by specialists for further active work in this direction.

**Keywords:** strategy, development of locomotive construction, information, pre-failure condition, plan.

## Методологический подход к стратегии эксплуатации, технического обслуживания и ремонта локомотивов

Машарипов М.Н.<sup>1</sup>, Умрзокова Ш.А.<sup>1</sup>

<sup>1</sup>Ташкентский государственный транспортный университет, Ташкент, Узбекистан

**Аннотация:** Изложенный подход, на наш взгляд, наиболее правильно отражает сам механизм процесса эксплуатации локомотивов, а следовательно, и соотношение между этими понятиями. Ремонт и техническое обслуживание целесообразно рассматривать как составные части более широкого понятия, такого как техническая эксплуатация. Важное значение для перехода на обслуживание и ремонт по состоянию имеют вопросы правильной трактовки терминов стратегии об установлении взаимосвязи между стратегиями эксплуатации (использование) технического обслуживания и ремонта подвижного состава. Как показал проведенный анализ, из этих вопросов нет еще единства взглядов. Предложен методологический подход к решению этих вопросов не претендует на полноту и завершенность. Однако он может быть использован специалистами для дальнейшей активной работы в данном направлении.

**Ключевые слова:** стратегия, развития локомотивостроение, информация, предотказное состояние, план.

### 1. Введение

От своевременного выбора соответствующей стратегии в значительной степени зависит своевременность и правильность выбора необходимой технической политики развития локомотивостроение на многие годы.

Важное значение в методологическом плане имеет вопрос о используемых терминах при решении задач по обслуживанию и ремонту локомотивов. В выполненных исследованиях и специальной литературе по эксплуатации сложных технических объектов последнее время все чаще стал применяться. Стратегия должна отражать прежде всего идеологическую направленность действий и принятую при этом концепцию.

Исходя из этого, применительно к понятию техничного обслуживания и ремонта локомотивов,

термин стратегия в самом общем понимании может быть определен следующим образом.

### 2. Методология

В целях поддержания работоспособности существующего локомотивного парка “Узбекистан темир йуллари” АО и локомотивного депо “Узбекистан” промежуточный норматив технического обслуживания, текущего и капитального ремонта тепловозов, электровозов и подвижного состава во всех локомотивных депо (табл.-1) [1] и эксплуатационные данные отказы рам тележек и основной рамы кузова электровозов 3ВЛ80с ВЛ80 (рис. 1) [11] анализировались вероятностно.





Таблица 1

**Промежуточный норматив технического обслуживания, текущего и капитального ремонта тепловозов, электровозов и подвижного состава во всех локомотивных депо [1]**

Тип локомотива (тип движения)	Интервал технического обслуживания							
	ТО-2	ТО-3	Текущий ремонт тыс.км/ сут.( месяц)				Капитальный ремонт	
			ТР-1	ТР-1к	ТР-3	ТР-4	КР-1	КР-2
1	2	3	4	5	6	7	8	9
<b>Локомотивы, тянущие грузовые и пассажирские поезда</b>								
3ТЭ10М/2ТЭ10М/ 2ТЕ116 (Пассажирский)	48	17	30 тыс.км	150 тыс. км	300 тыс.км	-	600 тыс.км	1200 тыс.км
3ТЭ10М/2ТЭ10М(Пассажирский и грузовой)	24	17	30 тыс.км	150 тыс. км	300 тыс.км	-	600 тыс.км	1200 тыс.км
2ТЭ10М/ 2ТЕ116 (Пассажирский)	24	17	30 тыс.км	150 тыс. км	300 тыс.км	-	600 тыс.км	1200 тыс.км
2ТЭ10М междугородный/ помощник/ Аренда)	48	30	50 тыс.км	150 тыс. км	300 тыс.км	-	600 тыс.км	1200 тыс.км
ТЭП70БС (Пассажирский)	96	-	50 тыс.км	-	800 тыс.км	-	1600 тыс.км	-
Уз ТЭ16М (2,3,4 секционный грузовой)	48	10 с.км	50 тыс.км	-	300 с.км	600 с.км	1200 с.км	-
<b>Локомотивы/ электровозы для маневровых работ</b>								
ТЭМ2	7 сут.	$\frac{25}{50}$	$\frac{6 \text{ мес.}}{12 \text{ мес.}}$	-	2,5 год	-	$\frac{7,5 \text{ год}}{15 \text{ год}}$	15 год
ЧМЭЗ	7 сут.	$\frac{25}{50}$	$\frac{6 \text{ мес.}}{12 \text{ мес.}}$	-	2,5 год	-	$\frac{7,5 \text{ год}}{15 \text{ год}}$	15 год
ВЛ60к	7 сут.	-	30 сут.	-	24 мес.	400 тыс. км	$\frac{600 \text{ тыс. км}}{6 \text{ год}}$	$\frac{2100 \text{ тыс. км}}{12 \text{ год}}$
<b>Электровозы, тянущие грузовые и пассажирские поезда</b>								
2ВЛ60к	72	15	30 сут.	60 сут.	24 мес.	400 тыс. км	$\frac{600 \text{ тыс. км}}{6 \text{ год}}$	$\frac{2100 \text{ тыс. км}}{12 \text{ год}}$
3ВЛ60к	72	20	40 сут.	80 сут.	24 мес.	720 тыс. км	$\frac{800 \text{ тыс. км}}{6 \text{ год}}$	$\frac{2400 \text{ тыс. км}}{12 \text{ год}}$
ВЛ60к (Пассажирский)	48	10	20 сут.	40 сут.	24 мес.	400 тыс. км	$\frac{600 \text{ тыс. км}}{6 \text{ год}}$	$\frac{2100 \text{ тыс. км}}{12 \text{ год}}$
ВЛ80с	72	15	30 сут.	30 сут.	24 мес.	720 тыс. км	$\frac{800 \text{ тыс. км}}{6 \text{ год}}$	$\frac{2400 \text{ тыс. км}}{12 \text{ год}}$
Узбекистан (Пассажирский и грузовой)	96	$\frac{25 \text{ тыс. км}}{3 \text{ мес.}}$	$\frac{100 \text{ тыс. км}}{1 \text{ год}}$	400 тыс.км	600 тыс.км	-	2000 тыс.км	3000 тыс.км
Узбекистан-Й (Пассажирский)	96	$\frac{25 \text{ тыс. км}}{3 \text{ мес.}}$	$\frac{100 \text{ тыс. км}}{1 \text{ год}}$	400 тыс.км	800 тыс.км	-	2000 тыс.км	3000 тыс.км
Уз-Эл (Пассажирский и грузовой)	96	$\frac{25 \text{ тыс. км}}{3 \text{ мес.}}$	$\frac{100 \text{ тыс. км}}{1 \text{ год}}$	400 тыс.км	600 тыс.км	-	2000 тыс.км	3000 тыс.км
Уз-ЭлР (Пассажирский и грузовой)	96	$\frac{25 \text{ тыс. км}}{3 \text{ мес.}}$	$\frac{100 \text{ тыс. км}}{1 \text{ год}}$	400 тыс.км	600 тыс.км	-	2000 тыс.км	3000 тыс.км
ЗЭС5К (грузовой)	240	-	$\frac{50 \text{ тыс. км}}{6 \text{ мес.}}$	250 тыс.км	500 тыс.км	-	1000 тыс.км	3000 тыс.км





2Уз-ЭлР	240	25 тыс. км 3 мес.	100 тыс. км 1 год	400 тыс.км	600 тыс.км	-	2000 тыс. км	3000 тыс.км
2Уз-УЙ (Пассажирский)	96	25 тыс. км 3 мес.	100 тыс. км 1 год	400 тыс.км	600 тыс.км	-	2000 тыс. км	3000 тыс.км
Электрички								
ЭР9Е, ЭР2	48	5 сут.	40 сут.	80 сут.	24 мес.	4 год	600 тыс. км 4 год	1800 тыс. км 8 год
Афросиёб (Пассажирский)	6 тыс. км 4800 – 7200	42 тыс. км 33600 – 50400	126 тыс. км 100800 – 151200	252 тыс. км 201600 – 30200	504 тыс. км 403200 – 604800	126 тыс. км 806400 – 1209600	2016 тыс. км 1612800 – 241900	4032 тыс. км 3225600 – 4838400

Таблица 2

### Классификация информации для получения соответствующей стратегии технического обслуживания и ремонта локомотивов

Характер информации	Информация	
	Априорная	Апостериорная
Совокупность локомотивов	За наработкой	По состоянию с контролем уровня надежности
Отдельный локомотив	По наработке, что установлен для отдельного локомотива	По состоянию с контролем параметров

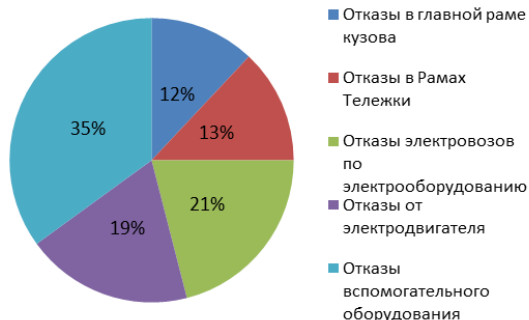


Рис. 1. Распределение отказов электровозов ВЛ80 и ЗВЛ80с по данным локомотивного депо “Узбекистан” и “Узбекистан темир йуллари” АО преимущественно в период 2017-2022 гг.

По результатам исследования были сделаны следующие общие выводы:

1. Всего по механической части электровозов ЗВЛ80с и ВЛ80 в период с 2.02.2017 по 11.10.2022 зафиксировано 153 неисправности (100%) возникают вследствие усталостных трещин:

а) в основном каркасе кузова - 20,747% (в том числе в поперечинах кузова - 9,43%; в продольных стержнях кузова - 7,547%; на центральной балке рамы кузова – 3,77%);

б) в рамах вагона - 54,71% (трещины в поперечине рамы вагона - 18,86%; в продольной балке рамы вагона - 24,53%; контур рамы коляски трещины - 11,32%);

в) в колесах тачек (11,32%).

### 3. Результаты

Как основной признак, характеризующий стратегию технического обслуживания и ремонта технического объекта, целесообразно применять характер информации о надежности и техническом состоянии, что используется при назначении периодичности и объемов регламентных работ. Эту информацию можно разделить: по времени получения и использования – на априорную (полученную к опыту) и апостериорную – (полученную при проведении опыта) по источникам получения – на информацию о совокупности объектов и об отдельном объекте. При этом под опытом понимается серийная эксплуатация объекта. Объединение всех видов информации дадут нам стратегии технического обслуживания и ремонта (табл.-2).

Стратегия технического обслуживания и ремонта за состоянием (стратегия по состоянию) существенно отличается от стратегии обслуживания и ремонта по наработке (стратегии по наработке). Они отличаются не только в самом характере технологических процессов технического обслуживания и ремонта, но и в распределении ресурсов, необходимых на развитие производственно технической базы, отвечающей требованиям той или другой стратегии.

Стратегия по состоянию предполагает обеспечение высокого уровня эксплуатационно ремонтной технологичности локомотива, создание в достаточных объемах эффективных средств диагностирования, неразрушающий контроль, развитие производственно-технической и экспериментальной базы, эксплуатационных и ремонтных предприятий локомотивов. Стратегия по наработке предусматривает развитие экспериментальной базы предприятий промышленности и обеспечение на этой основе обоснованных ресурсов для выполнения ремонта каждой серии локомотивов. Другими словами, стратегия по состоянию направлена на усовершенствование эксплуатационных свойств локомотивов и развитие ремонтной базы.

Основным принципом стратегии обслуживания и ремонта по состоянию можно считать принцип соблюдения строгой плановости при проведении форм технического обслуживания и ремонта. Однако запланирована здесь лишь часть стандартных регламентированных операций по наработкой, работы по техническому диагностированию и контроля составляющих локомотива и сама периодичность их выполнения.

Задачи использования индивидуальных



возможностей узлов локомотивов в отношении их работоспособности при эксплуатации конструкторскими организациями на этапах создания локомотивов и разработки программы их технического обслуживания и ремонта. В зависимости от имеющихся возможностей определения предельного состояния работоспособности составляющих локомотива в процессе эксплуатации принятого критерия для установления сроков их замены на локомотивах различают стратегии эксплуатации (использования) ресурса (срок службы), до отказа и в предотказное состояние.

Стратегия обслуживания и ремонта, естественно связанные со стратегиями эксплуатации локомотивов (табл.-2), для каждой из которых можно выбрать вполне определенные, отличающиеся наибольшей эффективностью, стратегии технического обслуживания и стратегии ремонта (обозначены знаком «+»). Из табл.-2 следует, что для стратегии эксплуатации локомотивов до истощения ресурса (срок службы) наиболее эффективной является стратегия технического обслуживания по наработке. При выполнении ремонта локомотивов возможны стратегии по наработке и техническим состоянием, но это зависит от типа локомотива и уровня его контроля пригодности при ремонте.

Соответственно для локомотивов, эксплуатируемых по стратегии до отказа, наиболее эффективны при обслуживании стратегии по состоянию с контролем уровня надежности, а при ремонте так же, как и для ресурсных узлов, стратегия за наработкой и техническим состоянием отсюда и следует, что отдельные узлы, установленные на современных локомотивах, можно эксплуатировать, обслуживать и ремонтировать, как правило, только по одной из указанных стратегий.

Для функциональных систем и локомотива в целом наиболее вероятно применение всех указанных в табл.-3 стратегий или так названной “смешанной” стратегии.

Таблица 3

## Стратегии технического обслуживания и ремонта

Стратегия технического обслуживания и ремонта	Стратегия эксплуатации (использование)		
	К отработке ресурса (срока службы)	К предотказному состоянию	До отказа
Техническое обслуживание			
За наработкой	+	-	-
По состоянию с контролем параметров	-	+	-
По состоянию с контролем уровня надежности	-	-	+
Ремонт			

За наработкой	+	-	+
По техническому состоянию	+	+	+

Переход на обслуживание и ремонт локомотивов по состоянию требует решения ряда методологического плана. Прежде всего, должны быть найдены и соответствующим образом узаконены правильные соотношения между такими понятиями, как эксплуатация, техническое обслуживание и ремонт.

Если же для транспортного средства принята стратегия эксплуатации до предотказного состояния, то необходимым и обязательным условием ее осуществления на практике есть принятие стратегии обслуживания данного типа локомотива за состоянием с контролем параметров и стратегии ремонта по техническому состоянию. Если же наоборот, то локомотивы обслуживаются по контролю параметров и наиболее эффективной стратегии эксплуатации (использования) таких локомотивов станет стратегия к предотказному состоянию.

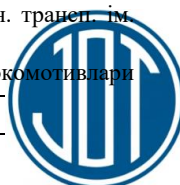
Применение программ обслуживания и ремонта по состоянию основано на обеспечении высокого уровня надежности и эксплуатационной технологичности транспортных средств, глубоком знании характеристик надежности функциональных систем и их составляющих в процессе эксплуатации, четкой организации информационного обеспечения, широком использовании бортовых и стационарных средств и методов контроля технического состояния [2-10].

## 4. Заключение

Стратегия – совокупность принятых принципов, правил и управляющих воздействий, определяющих комплексно развитие эксплуатационных свойств конструкций локомотивов, методов технического обслуживания и ремонта. Данное определение стратегии направляет на необходимость системного подхода к решению проблемы повышения эффективности технического обслуживания и ремонта, нацеливает на совместные согласованные действия в рамках единой программы всех учреждений и предприятий создающих, эксплуатирующих и ремонтирующих локомотивы.

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## Информация о авторах/ Information about the authors

Машарипов Маъсуд Нуъмонжонович / Masharipov Ma'sud Nu'monjonovich	Ташкентский государственный транспортный университет, Доктор технических наук, Доцент декан факультета Экономики
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Умрзокова Шохзода Ахроржон кизи Umrzoqova Shohzoda Ahrorjon qizi	Докторант Ташкентского государственного транспортного университета
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## Drawing up a road plan in difficult sections

A. Artykbaev<sup>1</sup><sup>a</sup>, M.M. Toshmatova<sup>1</sup><sup>b</sup>

<sup>1</sup>Tashkent state transport university, Tashkent, Uzbekistan

**Abstract:** The railway is the busiest transport and properly designed and used will further improve efficiency. For this reason, this article gives the most convenient transition model in the section of rail lifting from one plane to another. That is, in order for the movement of the train in the ascent section to be smooth, the trajectory in the turn section must be an arc of a circle. The plane in which the train stands should be an attempt at this circle. It is optimal that the upper plane is also in the wobbling position along the circular arc on the lifting part.

**Keywords:** railway plan, rail track, steepness, radius of contact, angle of rotation, profile of carriage movement.

### 1. Introduction

Drawing up a railway plan depends on the terrain conditions, consists of rectilinear parts and curved parts connecting rectilinear parts [1], [2]. A simple version of a curved part is a scheme where both straight parts belong on the same horizontal plane. We consider it difficult when the straight part is laid on horizontal planes at different levels. This variant also splits into two

- a) angle between straight parts is equal to zero,
- b) angle between straight parts

In this article, we will draw a curve equation describing the location of the railway and road plan path.

### 2. Content

The longitudinal profile of a railway line is the projection of its axis onto a vertical surface, which is then turned onto the plane [3], [4].

The ideal longitudinal profile is a straight line on a horizontal plane. But the geological and topographic features of the area through which the railway is traced cause the direction of the road to change or move to another level of the horizontal plane. These changes may occur simultaneously or will be repeated several times. In this case, the railway plan is considered complicated.

One simpler view of the difficult part of the road is to raise the level of the railway to some height  $\delta$ , while the direction of the road does not change. This is indicated in Figure 1.

Here  $\alpha$  and  $\beta$  are different horizontal planes, the distance between them is  $\delta$ . The projection of the straight part  $b$  onto the horizontal plane  $\alpha$  is denoted by  $b'$  and it belongs to  $\alpha$ , the straight line  $b'$  is a continuation of the straight line  $a$ .

For lifting  $\delta$  railway, there are strict conditions that provide the technical possibility of moving the train along this road [5-7]. The rise of road  $\delta$  is associated with the overcoming by the railway of various kinds of high-altitude obstacles in the vertical plane. Depending on the direction, movement  $\delta$  may indicate go or descent.

Usually on the railway, the rise or descent is called the steepness of the road [8], [9].

Sections of a profile of unambiguous slope are called a longitudinal profile element. In this diagram, segment  $AB$  is a longitudinal profile element.

Slope steepness  $AB$  is considered to be the main characteristics of the longitudinal profile.

Slope steepness is measured by the ratio of lifting (lowering) height  $\delta$  in meters as a horizontal projection of its length  $l$  – in kilometers [10].

The length of the profile element is usually measured not by the hypotenuse  $AB$  of the triangle  $ABC$ , but by the leg  $AC$ , that is, by the projection  $AB$  on the horizontal plane  $\alpha$ .

We are interested in the optimal mathematical model of the longitudinal profile. Therefore, parameters  $\delta$  and  $AC = l$  are considered to meet all technical and economic requirements.

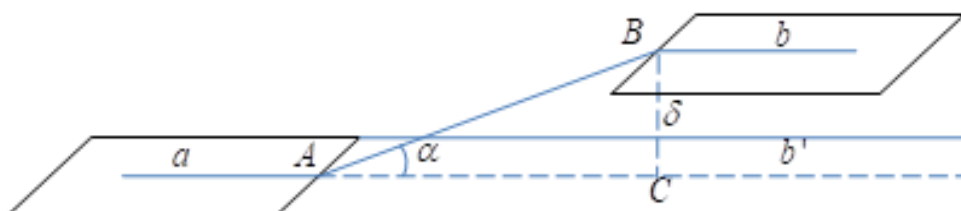
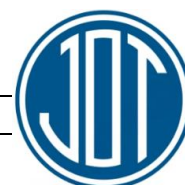


Fig. 1. Raising the level of the railway to height  $\delta$ .

<sup>a</sup>  <https://orcid.org/0000-0001-6228-8749>

<sup>b</sup>  <https://orcid.org/0009-0006-2781-9325>



We offer the most optimal version of the longitudinal profile, which ensures the most continuous movement of the composition without changing the speed of movement.

To do this, enter the Cartesian coordinate system, the abscissa coinciding with line  $a$ , select the origin  $O$  in the middle of segment  $AC$ , then  $AO = OC$ . The direction of the  $Oy$  axis perpendicular to the horizontal  $\alpha$  plane. Then the considered points have the following coordinates  $A(-\frac{l}{2}, 0), C(\frac{l}{2}, 0)$ . The intersection of  $AB$  with the axis has coordinates  $D(0, \frac{\delta}{2})$ . Equation of the line  $b$ :  $y = \delta$ .

Select the curve connecting points  $A$  and  $D$  ( $D$  and  $C$ ) so that it is defined by one arc of the circle. Moreover, at point  $A$ , line  $a$  should be tangent to this circle. This means that its center must lie on line  $x = -\frac{l}{2}$ . We will put a similar requirement for arc  $DC$ . At points  $B$ , line  $b$  will be tangent to the circle connecting points  $D$  and  $B$ . At point  $D$ , these two circles must have a single tangent. Then we have at point  $D$  a smooth transition from arc  $AD$  to arc  $DC$ . Note that the center of the circle expressing arc  $DC$  belongs to line  $x = \frac{l}{2}$  and is located symmetrically to the center of the circle of arc  $AD$  relative to point  $D$ .

Define the center of a circle  $E$  having an arc  $AD$  satisfying the above conditions. Segment  $AD$  is the chord of this circle. Therefore, the centre  $E_1$  must lie on a straight line  $T_1$  which is perpendicular to the length  $AD$  and which runs in its middle.

Let's calculate the equation of the line  $AD$  as a line passing through points  $A(-\frac{l}{2}, 0)$  and  $D(0, \frac{\delta}{2})$ .

$$AD: y = \frac{\delta}{l}x + \frac{\delta}{2}, \quad R = \frac{\delta}{l}$$

The middle of chord  $AD$  has coordinates  $(-\frac{l}{4}, \frac{\delta}{4})$ . The equation of line  $T_1$  perpendicular to the line is defined as a line passing through point  $(-\frac{l}{4}, \frac{\delta}{4})$  and perpendicular to line  $AD$ . From the condition of perpendicularity, the angular coefficient of the line  $T_1$  is determined from equality  $R = -\frac{1}{R_1} = -\frac{l}{\delta}$ .

Then equation  $T_1$  has the form

$$y = \frac{\delta}{l}x + \delta$$

Define the coordinates of the center  $E_1$  as the intersection of the lines

$$\begin{cases} x = -\frac{l}{2}, \\ y = \frac{\delta}{l}x + \delta. \end{cases}$$

Then  $E_1$  has coordinates  $(-\frac{l}{2}, \frac{3l^2 + \delta^2}{4\delta})$

The radius of circle  $R_1$  is equal to the distance between point  $E_1$  and axis  $Ox$ , therefore

$$R_1 = \frac{l^2 + \delta^2}{4\delta}$$

The equation of the circle to the center at point  $E$  and radius  $R$  is

$$\left(y - \frac{l^2 + \delta^2}{4\delta}\right)^2 + \left(x + \frac{l}{2}\right)^2 = \left(\frac{l^2 + \delta^2}{4\delta}\right)^2$$

From this one can obtain the equation of arc  $AD$

$$y = \sqrt{\left(\frac{l^2 + \delta^2}{4\delta}\right)^2 - \left(x + \frac{l}{2}\right)^2} \tag{1}$$

This equation makes it possible to determine the coordinate of arc  $AD$  with sufficient accuracy, given the values of parameters  $l$  and  $\delta$ .

In a similar way, you can define a circle equation in which  $DB$  is an arc.

The equation of arc  $DB$  is

$$y = \sqrt{\left(\frac{l^2 + \delta^2}{4\delta}\right)^2 - \left(x - \frac{l}{2}\right)^2} \tag{2}$$

It is easy to prove that the arcs defined by equation (1) and (2) intersect at point  $D(0, \frac{\delta}{2})$  and at this point both curves have a single tangent.

The arcs defined by equations (1) and (2) may be referred to as the transition portions of the longitudinal profile of the railway line. Then point  $D$  is an inflection point. Besides, arc  $AD$  will be concave, and arc  $DB$  will be convex part of transition part. In this case, the transition part of the longitudinal profile is considered half of the entire rise.

When the lift  $AB$  is protracted, i.e. the length  $l$  is sufficiently large and the steepness determined by the value  $\delta$  is relatively large, the inflection point  $D$  can be replaced by segments  $D_1D_2$  so that the straight line  $D_1D_2$  is tangent to both parts of the transition part defined by equation (1) and (2).

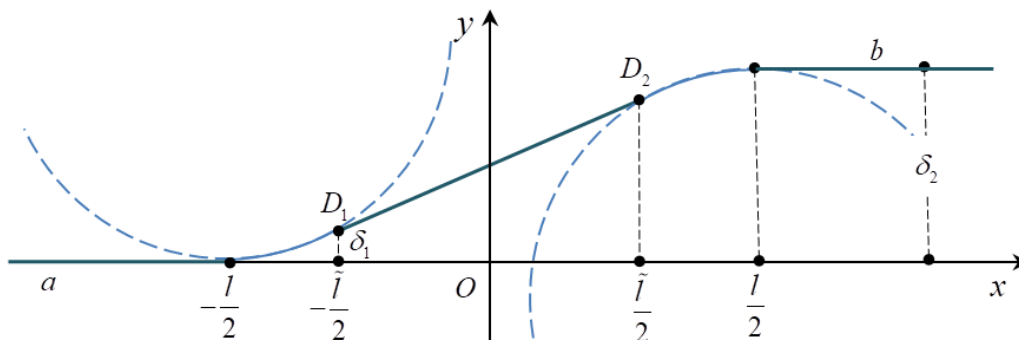


Fig. 2. Connection type with sufficiently large gap between lifts



In this case,  $\delta_1$  and  $\delta_2$  are determined by the choice of interval  $\left(-\frac{l}{2}, \frac{l}{2}\right)$  and the condition of parallelism to chord  $AD$ .

### 3. Conclusion

When the ends of the rectilinear part of the railway track plan belong to different horizontal planes, the distance between which is  $\delta$ , the steepness of the road appears [11-13]. To ensure a smooth transition from a horizontal straight line to a straight line with a given steepness, the arcs of the circles defined by equation (1) and (2) can be taken as the transition part of the longitudinal profile of the railway line. When the lifting part of the road is protracted, that is,  $l$  is large enough, the inflection point can be replaced with a straight segment determined with the specifications.

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### Mualliflar bo'yicha ma'lumot/ Information about the authors

Artybaev Abdullaaziz	Tashkent state transport university. Professor of the department of Higher Mathematics. E-mail: aartykbaev@mail.ru Tel.:+99891 136 13 31 <a href="https://orcid.org/0000-0001-6228-8749">https://orcid.org/0000-0001-6228-8749</a>
Toshmatova Mokhiniso Murodulla kizi	Tashkent state transport university. Basic doctoral student of the department of Higher Mathematics. E-mail: toshmatova_mm@mail.ru Tel.:+99890 007 50 10 <a href="https://orcid.org/0009-0006-2781-9325">https://orcid.org/0009-0006-2781-9325</a>

