

## **A NEW COST-EFFECTIVE TYPE OF OFF-STREET CITY PUBLIC TRANSPORT AS A SOLUTION TO THE PROBLEM OF TRAFFIC JAMS IN A LARGE METROPOLIS OF KAZAKHSTAN, THE CITY OF ALMATY**

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**Introduction.** As an affordable public transport, PCC has been widely used in Latin American countries: Colombia, Brazil and Venezuela. Therefore, this article extensively examines the experience of the above countries. In connection with the economic efficiency, profitability and rapid self-sufficiency of PCC, the article discusses and substantiates the issues of including aerial cable cars (ACC) in passenger public transport of the city of Almaty. The following advantages of the PCC speak for this: 1) ability to overcome along and across long-distance water obstacles and any terrain; 2) low construction and operating costs; 3) environmental friendliness; 4) safety; 5) driving speed without traffic jams; 6) significant throughput capacity. All these factors have become determining for the increasing frequency of using cable transport, not only as tourist entertainment, but also in addition to traditional types of transport – buses, cars, railways, trams, etc.

The main issue of the research is how effective the use of PCC is in the city of Almaty as an alternative of public transport. The purpose of the study is to substantiate the economic effect of the use of ACC in domestic circumstances of their operation through a close study of advanced foreign experience, which is already established and real.

**Literary review.** Almaty is the largest and most active city in the country, which is about to become even more populated and mobile. Consequently, the load on public transport and transport infrastructure will grow too. At the same time, requirements for transport speed will increase, since in the modern world the resource of time is especially valued. The city needs to secure public transport as a mass means of high-speed transportation, strengthening its position by increasing accessibility and quality.

Today the transport sector in Almaty is developed, but not balanced, and opportunities for traffic management are limited. Every day there are about 700 thousand cars on the roads of Almaty (of which 230 thousand are commuter vehicles) [1].

It is also necessary to reduce the share of personal vehicles. Today, 40% of Almaty residents prefer to drive a personal car, while 60% travel by public transport,

bicycles, scooters and on foot. Over the past six years, passenger traffic on public transport has doubled, but Almaty residents are not satisfied with its quality. In the first half of 2022, 185 million trips were made on public transport (for comparison, by half-year: in 2019 – 177 million, in the pandemic 2020 – 127.7 million, in 2021 – 157.7 million trips) [1]. In the world's major cities, residents primarily travel by rapid transit, which includes subways, light rail transit (LRT), and buses or trolleybuses (Bus Rapid Transit (BRT)). Regular buses, bicycles, scooters, etc. are used to get to the nearest high-speed public transport (PT) or for short distance trips. That is, high-speed transport (rapid mass transit) is the basis of the transport framework in major cities of the world. In Almaty today the situation is the opposite: regular buses and trolleybuses prevail, and high-speed public transport is in its infancy.

There are 11 metro stations in the city with a track length of 13 km and 15 trains moving on them. Over the past ten years the passenger flow has increased from 30 to 70 thousand passengers per day [1], but further growth is limited due to the fact that the lines duplicate ground routes, and the construction of new stations is proceeding at a low pace.

About 3.5 million [1] Almaty residents and city guests choose to use the BRT line every month, as it is a promising type of public transport, but the project has not been launched in full due to the problems with the design, implementation of intelligent transport systems and the construction of new depots and turning areas. In addition to the underrepresentation of the metro and BRT, the problem is that their lines, as well as the planned LRT line, run parallel to each other and are mainly concentrated in the historic centre area. The north, east, and west of the city remain uncovered. The lack of high-speed public transport, uniformly accessible throughout the city, is a key challenge for the development of Almaty, the answer to which will determine the further evolution of the public transport system and the mutual connectivity of new polycentres.

Today, to get to the metro or BRT, the residents of the north, east and west of Almaty need to take one or more bus trips. It is more convenient to choose the usual long bus route without transfers, which is what happens every day – the bulk of PT passengers in Almaty are transported by ordinary buses and trolleybuses.

Ground public transport has its problems. It is developed in Almaty, but is not efficient enough. The reasons for this are: traffic congestion; the possibilities for modernizing urban PT have been exhausted to optimize traffic flow. Buses and trolleybuses account for the bulk of passenger traffic (about 95%). The average speed of buses on dedicated lanes is 25 km/h, while in the general flow during rush hour they move at a speed of 15-17 km/h, which is inconvenient and time-consuming [1]. Urban environment is comfortable for passengers. Traffic schedules are organized in the way that main bus routes maintain an interval of 7-15 minutes during rush hours, but it is not always possible to maintain it due to traffic congestion, bus derailments, accidents, etc.

The vehicle fleet is depreciated. In 2023, the service life of about 360 mobile units will end, and by 2025 – we will speak of 952 transport units. At the same time, today bus derailments have become more frequent due to technical reasons, up to 300

times a day, which is about 15% of the total number of buses. The wear and tear of rolling stock in municipal and private fleets is relatively the same – about a third. Wear and tear of the vehicle fleet is one of the important reasons for dissatisfaction with urban public transport (quality of interior, seats, availability of air conditioning, etc.). Today there are 154 city PT routes (145 buses and 9 trolleybuses). They are served daily by 2,509 mobile units, of which 1,484 units or 59% are in the municipal fleet, 1,025 or 41% are from private carriers) [1].

We must also note that the number of private carriers in Almaty is excessive compared to other megacities. There are 21 bus depots in the city (20 private and 1 municipal). For comparison: in Moscow there are 5 carriers, in Vienna – 1 [1]. The challenges faced by a large number of carriers are that if the standard contract does not provide for effective management mechanisms, then the problem of fulfilling mutual obligations arises. As a result, it becomes difficult to implement an effective fleet renewal plan, apply effective tariff plans, and mechanisms for redistributing rolling stock between routes. Public transportation is a social sector that is subsidized in almost every city in the world. The volume of subsidies paid to carriers from the city budget of Almaty from 2017 to 2020 amounted to 61.5 billion tenge (\$153.75 million), and compensation for the transportation of preferential categories of passengers since 2016 – 17.4 billion tenge (\$43.75 million dollars), totalling about 79 billion tenge (\$197.5 million) over four years [1].

Despite the fact that the actual fare has increased significantly, Almaty residents have paid 80 tenge for travel for the last 11 years from 07/01/2012 to 08/21/2023 without changes. Then the fare became 100 tenge. But the cost of travel on public transport has increased since August 2017 from 80 to 150 tenge when paying in cash, and from August 21 – to 100 tenge when paying with an Onai card and 200 tenge, but only when paying in cash. The cost of transporting one passenger on a city public transport bus is 250 tenge as of September 2023. The difference is covered by the payment of subsidies to carriers from the city budget [1].

In Almaty, there is a pressing need for the reform of the tariff system and the emergence of a more convenient route network, which will attract new users of public transport, and, due to the growth of stable revenues from the sale of tickets and travel passes, will stabilize subsidies from the budget.

The existing methodology for compensating losses to carriers has significant shortcomings: it does not sufficiently motivate carriers for the quality of service and shifts onto them both risks and excess profits from changes in passenger traffic. There is a low priority for PT traffic. With a total road length of 3,097 km, the length of dedicated lanes for priority ground traffic is about 150 km (about 4.8% - comparable to large world cities, where the average figure is 2.3%) [1]. The possibilities for increasing are limited by the nuances of the legislation: a dedicated lane is allowed to be introduced only if there are three lanes on the road, while in the city there is a shortage of three-lane (main) streets. The effectiveness of existing dedicated lanes is compromised by intersections allowing other traffic into the lane, existing herringbone parking, and problems that arise from unloading goods.

There is a lack of qualified drivers. The shortage of personnel is explained by the natural retirement of older drivers, as well as the inability to attract qualified specialists. The remuneration of a public transport driver is not competitive enough, therefore, it needs a gradual increase, while the working conditions are difficult (the duration of trips noted above, overtime work, lack of sanitary conditions at the final destinations).

From the above-described situation of passenger public transport in Almaty, there is an urgent need for a new type of PT, i.e. for PCC, as an effective tool for solving the transport problem of organizing urban passenger flows.

Inclusion of PCC into the system of urban passenger public transport of the city of Almaty as a full-fledged type of off-street transport: a conceptual approach. The purpose of the study is to substantiate the economic efficiency of PCC when used in the transport network of the largest metropolis of the Republic of Kazakhstan.

There are 2 PCCs in Almaty and they are used exclusively for tourism purposes. This passenger cable car connecting the centre of Almaty with Mount Kok-Tobe was built in 1967. After reconstruction in 2015, the length of the new gondola road is now 1620 m, 6 supports (the old cable car had 3 supports), 17 comfortable cabins, each with a capacity of 8 people, providing a capacity of 750 people per hour, with the possibility of increasing to 5 thousand people per hour. The journey from the lower to the upper station takes 5 minutes. The cost of a round-trip lift is 5,000 tenge (\$11.18 at the exchange rate to the tenge as of June 2023 [1]).

The Medeo-Chimbulak (Shimbulak) cable car is also called a gondola. It was built quite recently – in 2011 – using up-to-date equipment. Despite the fact that the capacity of the entire mechanism is 2000 people per hour, in the same time (if 8 people travel in each cabin) the road can transport 3680 people. The cost of a round trip on the Medeo-Chimbulak cable car (more precisely, a ride) is about 4,500 tenge (\$10). But these prices are not for public transport in Almaty, where a trip with a card costs 80 tenge (\$0.18 at the exchange rate to the tenge as of June 2023) and a single ticket costs 150 tenge (\$0.34), with the cost of one trip being 224 tenge (\$0.5) before the price increase in August 21, 2023, which was mentioned above. The difference is compensated from the budget, since all types of urban public transport, such as the metro and buses, are subsidized.

The construction of 3 PCC lines is proposed in the new master plan for the development of the Almaty metropolis by 2040. Unfortunately, they will repeat the path of the 2 above-mentioned PCC lines, i.e. they are considered to be entertainment projects for transporting willing people and tourists in small quantities and, accordingly, with high travel costs, which does not solve the problems of traffic flows. Thus, it is noted that the first route of the cable car can run along the bed of the Bolshaya Almatinka River behind the Sayran bus station to the eco-post. The approximate length is 4.5 km, and passenger traffic in 2030 could be only 4.1 thousand passengers per day, not per hour. “The second route runs along the bed of the Esentai River, from the M. Auezov Theater to the area of the Sunkar international ski jump complex. The length is 3.5 km. The potential demand by 2030 is also estimated at 4.1 thousand passengers and the same per day. The third route connects

the existing cable car "Palace of the Republic – Koktobe" with the Medeu sports complex," the document says.

The document also states that it will provide for transport connections between the centre and the southern part of the city in the cramped conditions of the ongoing development. The centre and southern parts of Almaty are the most prosperous areas in social terms. Naturally, people there will not use PCC, but will use personal transport. Therefore, these new lines are provided for visiting city attractions. Although the laying of the PCC in the northern direction, along the beds of the 3 rivers, Bolshaya, Malaya Almatinka and Esentai, of the metropolis solves the problem of transport mobility in socially disadvantaged areas of the city of Almaty. It was the social aspect that played the main role in the mass use and successful functioning of PCC in Latin American countries. In this regard, the majority of reviews from ordinary residents of the metropolis are characterized as negative in the New General Plan of the metropolis until 2040 published on the portal "Open Legal Entities". The Plan is under discussion, which is not surprising, as reported by the NUR.KZ correspondent.

That means, that nothing is said in the new master plan about integrating the "lower" and "upper" parts of the city, nor about reducing traffic jams and improving the environmental situation. It was representatives of the "lower" part of the city who made up the majority in the social protests that occurred in early January 2022, where the number of victims, according to official data, was 238 people. Almaty city officials do not take this extraordinary event into account when developing new master plans for the metropolis. For example, the leadership of Medellin, the second largest city in Colombia with a population of about 2.5 million people, at one time insisted and still adheres to this rule that the construction of the ACC has always been "a socially motivated project and a way to spread the benefits of MetroCable, (local title of PCC) to the poorest and most inaccessible areas of the city. The project was therefore designed to demonstrate that the government had taken responsibility for these areas and had a "symbolic purpose of repaying a historical debt." This situation had a beneficial effect in 2009-2014 on increasing investments in informal settlements in Medellin to improve transport mobility and living conditions of local residents. This project was successfully implemented as the Northeast Urban Comprehensive Project (Blanco and Kobayashi, 2009) [2].

We can recall that the Shanyrak microdistrict in Almaty was also considered an informal area, i.e. illegally built. The authorities made attempts to demolish it in 2006, but were met with discontent from local residents. One cannot help but conclude that the problems of disadvantaged areas of Almaty and Medellin are very similar. The construction of PCC covering the northern part of Almaty, as the experience of a Latin American city shows, improves the employment of the population of disadvantaged areas, thanks to transport mobility. This has effect on reducing crime and strengthening social sustainability.

Having studied the Colombian experience in using the PCC, it is advisable to draw the following conclusions regarding the use of the cable car in Almaty. The city of Almaty is characterized by very dense, complex and since recently dangerous

traffic, leading to systematic loss of life. Considering the main types of road traffic accidents (RTA) in Almaty for the period from 2017 to 2021 inclusive, it should be noted that most often fatal accidents were of the “Hit-on-pedestrian” type. Over 5 years, the number of road accidents of this type amounted to 9,626 units, in which 9,682 people were injured and 369 people died. At the same time, in just 5 years there were 20,565 road accidents, 24,285 people were injured and 598 people died [1].

It has already become a byword to talk about Almaty traffic jams. For example, driving 5-7 km through the city centre during the rush hours will take at least one or two hours. Besides, if it is snowing and icy, you can get stuck for 3-4 hours. With the number of cars in Almaty increasing annually, experts predict a transport collapse in the near future unless fundamental decisions are made in this area.

All of the above indicates the ineffectiveness of organizing road traffic in large cities. Unfortunately, the allocation of special lanes for public passenger transport does not help. That is, it solves the problem of city traffic to some extent, but it is not entirely optimal, because creates certain difficulties for all road users in general.

A way out of this situation could be a special state program for the construction of PCC as the future of the urban transport infrastructure of the Almaty metropolis. It is known that the world's very first passenger transport on cable traction was built back in 1873 in San Francisco, and it still operates unchanged. Cable cars really flourished in the late 19th and early 20th centuries due to the exploration of the Alps by tourists. Those who wished could reach the mountain peaks in a matter of minutes. This circumstance caused an increase in tourist flows in the area, the arrival of additional capital and an increase in the revenue of local municipal budgets. Today, PCC is the only profitable type of public transport, all the rest are unprofitable. But, unfortunately, our officials are attracted to projects on a cosmic scale – the more expensive the better. The construction of the PCC turned out to be tens or even hundreds of times cheaper than the similar construction of roads, railways and light rail trams, not to mention the construction of the metro, where building one kilometre costs at least several hundred million US dollars. Although, its commissioning in 1863, for the first time in the world, caused the phenomenal growth of the city of London and its transformation into the largest metropolis on the planet with a population of millions. If you think about it, these billions of dollars in savings, expressed in the currencies of the world's leading countries are just fantastic for emerging markets, which include Kazakhstan.

In large metropolitan areas, land is an expensive asset. For example, during the construction of highways, to resolve such issues, a lot of time is spent on legal proceedings and the allocation of large financial resources from the budget to purchase land from the owners. For example, this concerns the construction of the Great Almaty Ring Road (BAKAD). By Decree of the Government of the Republic of Kazakhstan dated November 28, 2006 No. 1127, this project was included in the list of objects proposed for implementation under the concession mechanism. Due to the global financial crisis, in August 2009, by the decision of the akimat (mayor's office) of Almaty, the construction of BAKAD was suspended for an indefinite period. In 2018, construction of the road was resumed, as announced on the website

of the Prime Minister of the Republic of Kazakhstan. Construction of the road was planned to be completed in 2021, but later commissioning was postponed to 2023. The total cost of the project is \$743 million, of which \$543 million is for construction, \$200 million is for the purchase of land plots (Construction was completed at BAKAD and the launch took place on June 16, 2023 (Russian) (Access date: June 16, 2023).

Cableways have a number of advantages over existing modes of transport, namely:

- minimal impact on the environment: no emissions of harmful substances, minimal noise and vibration;
- relative energy consumption for movement (up to 40 km/h) is 5-10 times lower than that of a modern car;
- to lay the route, no more than 0.1 hectares of land per kilometre of track with infrastructure is required;
- no construction of embankments, excavations, tunnels, powerful overpasses, crossovers and viaducts that disturb the landscape is required;
- it has an increased resistance to the effects of natural disasters: earthquakes, floods, landslides, tsunamis, etc.;
- fare is at the level of traditional types of public transport;
- the cost of building a route with infrastructure is 2-5 times cheaper than that of modern railways and roads;
- the need for building materials and structures, the volume of excavation work, the consumption of ferrous and non-ferrous metals, etc. is minimal;
- rolling stock provides comfort and convenience for passengers, including people with disabilities, elderly citizens and passengers with children;
- the transport system ensures traffic safety through redundancy;
- capacity of one route is up to 6.0 thousand passengers/hour in each direction;
- the cable car route does not depend on the landscape, does not have intersections with ground transport at the same level;
- the distances between intermediate supports, depending on the topography, can be up to several kilometres;
- construction period is 2-3 years for up to 10 km of track, while parallel construction and commissioning of sections of the route in stages is possible;
- commercial areas may be located at cable metro stations;
- station design is easily integrated into the architectural appearance of urban areas;
- the cable metro cabin has up to 32 seats.
- The arguments listed above indicate that cable transport is quite promising, which reflects the prerequisites for its development that are currently emerging in the world [3].

**Conclusion.** So, all the benefits mentioned above make it possible to ask the question. Why not use these similar technologies to optimize traffic flows on the

plane in the city of Almaty? At the very least, it is advisable to build the PCC along or above the river beds of the Bolshaya and Malaya Almatinka and the Esentai River.

So, as it was said above, the first route of the aerial cableway (ACC) can run along the bed of the Bolshaya Almatinka River behind the Sairan bus station to the eco-post. The approximate length is 4.5 km, and passenger traffic in 2030 could be only 4.1 thousand passengers per day, not per hour. We propose to extend it to the Almaty flea market (the name of the largest popular trading market of the Republic of Kazakhstan) with a length of up to 8 km, which would significantly reduce traffic on the streets of Almaty. It is necessary to install 3 more transfer stations between them. From the eco-post (the first PCC station) to Al-Farabi Avenue (the second PCC station), where there are many people wanting to disembark to visit the city park named after the 1st President of the Republic of Kazakhstan, then the large Mega shopping and entertainment centre and densely populated microdistricts nearby. At the third stop behind the Sayran bus station, passengers could change on Abaya Street, which is located nearby in a 5-7 minute walk, to the underground metro and would spend much less time traveling around the city as a whole. These subway and other public transport interchange projects have been successfully implemented in Colombia and Venezuela. Time is the most expensive resource in the world and at all times! The Sairan bus station is located right on Tolebi Avenue, which is also a major main street of the metropolis and in 2030 a light rail tram (LRT) is planned to be launched from east to west through the entire city with dense passenger traffic of many thousands. The last fourth stop will be in the area of many trading markets, popularly called “Flea Market”, where there are also disadvantaged residential neighbourhoods Shanyrak, Dorozhnik, etc. As a result of this proposal, passenger traffic would be 40-50 thousand people according to the most conservative estimates, and not 4.1 thousand passengers per day, as in the document published on the Open Legal Entities portal. About 100-120 buses could be replaced. The fare on weekdays could be set within a reasonable range of no more than 150-200 tenge. On weekends, it could be set within 500-700 tenge, taking into account the round-the-clock traffic of the ACC.

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## РЕФЕРАТИ ABSTRACTS

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**Рахімбаєв А.Б., Кабашева М.Р., Калгулова Р.Ж. Рукавишников Ю.В.  
НОВИЙ РЕНТАБЕЛЬНИЙ ВИД ПОЗАВУЛИЧНОГО МІСЬКОГО  
ГРОМАДСЬКОГО ТРАНСПОРТУ ЯК РІШЕННЯ ПРОБЛЕМИ ЗАТОРІВ  
У ВЕЛИКОМУ МЕГАПОЛІСІ КАЗАХСТАНУ МІСТІ АЛМАТИ**

Нині у світі характеризується новим етапом розвитку науково-технічної революції, що з пошуком альтернативних і відновлюваних джерел енергії, як із напрямів, тобто. із зеленою енергетикою. У цьому ключі йде пошук альтернативних позавуличних видів транспорту без використання вуглеводневої сировини. У цій статті розглядається необхідність використання пасажирської підвісної канатної дороги (ППКД) як повноцінний громадський транспорт найбільшого мегаполісу Республіки Казахстан міста Алмати з населенням 2 млн. чоловік. У перспективі до 2030 року передбачається збільшення кількості жителів міста до 2,5-3 мільйонів. Саме місто знаходиться в гірській улоговині Заїлійського Алатау Тянь-Шаню і вичерпало в центральній його частині територіальні можливості розширення. Автомобільний парк особистого транспорту становив 2022 року 700 тис. машин, їх 230 тисяч авто з передмість [1]. Дорожня мережа перевантажена багатогодинними пробками у години пік та громадський транспорт явно не справляється зі своїми функціями з доставки пасажирів. Дані тенденції притаманні більшості мегаполісів усього світу. Тому стали потрібні нові, більш ефективні рішення, і тоді фахівці з транспортних мереж згадали про старі повітряні канатні дороги (ВКД).

**Ключові слова:** легкорельсовий транспорт, підвісна пасажирська канатна дорога, собівартість, карта «Онай».

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Rukavyshnikov Yu. A NEW COST-EFFECTIVE TYPE OF OFF-STREET  
CITY PUBLIC TRANSPORT AS A SOLUTION TO THE PROBLEM OF  
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The world today is characterized by a new stage in the development of the scientific and technological revolution, associated with the search for alternative and renewable energy sources, one of which is green energy. In this vein, there is a search for alternative off-street modes of transport which do not use hydrocarbon raw materials. This article discusses the need to use the passenger cable car (PCC) as a full-fledged public transport in the largest metropolis of the Republic of Kazakhstan, the city of Almaty with a population of 2 million people. In 2030 perspective, the number of city residents is expected to increase to 2.5-3.0 million. The city itself is located in the mountain basin of the Trans-Ili Alatau Tien Shan and has exhausted its territorial expansion opportunities in its central part. The personal transport fleet amounted to 700 thousand cars in 2022, of which 230 thousand were the cars from the suburbs [1]. The road network is overloaded with hours-long traffic jams during rush hours, public transport being clearly unable to cope with its functions of delivering passengers. These trends are typical for most megacities around the world. Therefore, new, more efficient solutions have become necessary, and transport network specialists remembered the old aerial cable cars (ACC).

***Key words:*** light rail transit, passenger cable car, cost, Onai card.

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