

OPTIMISING SUBURBAN LINKAGES IN BAKU: POLICY RECOMMENDATIONS ON ELECTRIC VEHICLE-BASED CARPOOLING SCHEME

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ABSTRACT

The urban population is rapidly growing, with projections indicating that 70% of the global population will reside in urban areas by 2050. This trend has led to suburban expansion, characterized by low-density, automobile-dependent development patterns. In cities like Baku, Azerbaijan, car dependence poses significant challenges to sustainable urban development. Despite efforts to promote public transport, the city remains highly reliant on cars, leading to issues such as traffic congestion, environmental pollution, and social inequality. This paper analyses the problems associated with car dependence in Baku and proposes a policy mix to address them, focusing on formalizing and incentivizing carpooling schemes. The proposed policies aim to decrease air pollution, enhance passenger safety, and reduce urban car dependence by promoting multi-modal transport options and improving suburban linkages. However, successful implementation will require public and private partnerships, involving stakeholders, and the public, as well as careful consideration of technical feasibility and data availability. Ultimately, these policies represent a step towards achieving sustainable urban development in Baku and other cities facing similar challenges.

Keywords: Carpooling, suburban linkages; Electric vehicle-based carpooling; Sustainable urban development; car dependence

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INTRODUCTION

Currently, the urban population is growing exponentially and by 2050, 70% of the total world population is forecasted to be settled in urban areas (World Bank, 2023). As the urban areas grow, for high-quality and affordable settlement, people move to suburbs, which are “the areas on the edge of a large city where people who work/study in the city” (Cambridge Dictionary, 2024). However, the increased demand for suburban settlement further stimulates urban linkage requirements and car demand and challenges social, economic and environmental aspects of life resulting in unsustainable resource use (Purvis, Mao, & Robinson, 2019).

Therefore, this paper discusses the optimisation of suburban linkages in the highly concentrated city of Baku, Azerbaijan, on the southwest shore of the Caspian Sea. Despite affordable public transport, the city is highly dependent on car use with a growing demand for informal carpooling mechanisms (Valiyev, 2022).

In the first two sections, the paper defines existing problems related to car dependence and public transport in global scheme and identifies suburban linkages in Baku. The next parts are dedicated to the possible policy recommendations addressing the initially defined problems in Baku and their potential outcomes.

1. PROBLEM ANALYSIS

As previously outlined, growing urbanisation together with being an indicator for the economic development, increases transport need of local habitants and therefore, car dependence and higher living standards. However, this dependence challenges the pillars of sustainability and results in decreased quality of life. The next section is dedicated to the analysis of the challenges associated with car dependence and represents Azerbaijan as a case study for the purposes of this paper.

1.1. Challenges of car dependence

Definitions of suburbanisation cover “the peripheral expansion of cities with low-density, discontinuous and automobile-dependent urban development patterns” (Bruegmann, 2001; Scott & Marshall, 2015). As per definitions, suburbanisation requires efficient and flexible transportation infrastructure. However, due to a) insufficiency of public transport alternatives; b) last-mile connectivity concerns, therefore multi-purpose trips; d) limited time availability car dependence has vastly increased (Wiersma, 2020; Guzman, Arellana, & Alvarez, 2020; Allen & Farber, 2021). Figure 1 comprehends points triggered by car dependence and causing unsustainability in urban development.

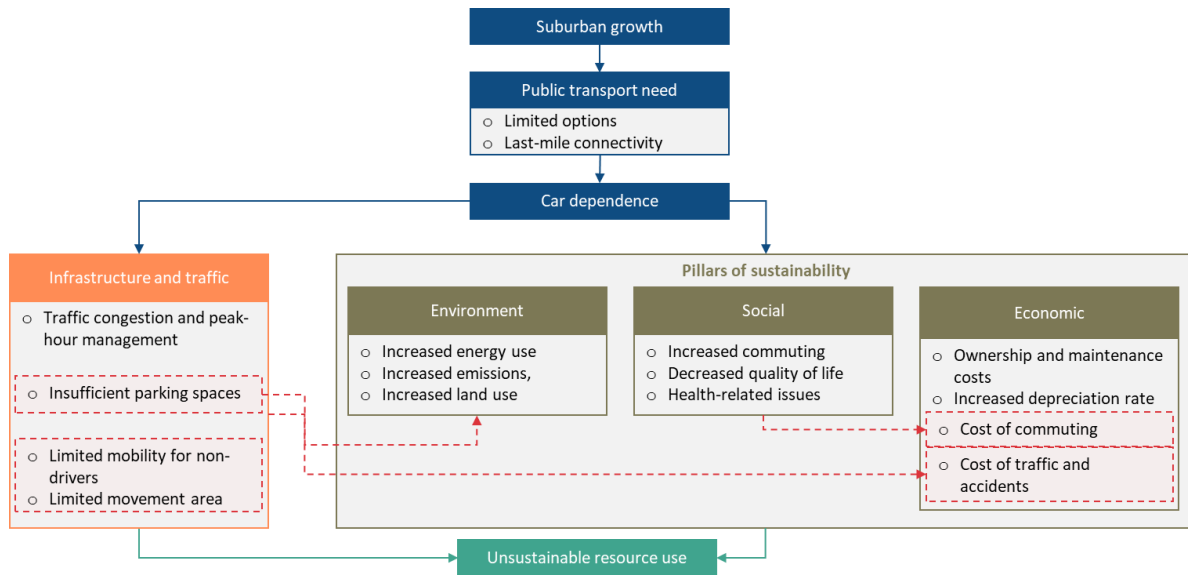


Figure 1: Effects of suburban growth and transport needs

Source: Built on below-given points

Generally, car dependence effect assessment requires consideration of initial infrastructure and traffic-related factors, such as a) traffic congestion and peak-hour management framework requiring additional resource use in the form of workforce, time, and money (Afrin & Yodo, 2020); b) the insufficient parking spaces and increased land use, as cars are in use about 5% of their lifespan, remaining parked for the rest of the period (Ceder, 2021); c) limited mobility for non-drivers such as daily travel and obstacles in social activity engagement (Allen & Farber, 2021) (Figure 1). Therefore, these pre-determined infrastructure and traffic issues have direct and indirect linkages to the pillars of sustainability. Similarly, consideration of sustainability pillars, which are the intersecting pillars of environment, economy and social factors for decision-making, define further challenges of car dependence (Purvis, Mao, & Robinson, 2019).

First, environmental challenges of car dependence are: a) increased energy use for large numbers of vehicles employed and increased emissions, as the cities comprise 70% of global CO2 emissions, mostly from industries and transport (World Bank, 2022); b) increased land use for roads and suburbs as highways, motorways and parking slots for additional vehicles (Ahmadzai, 2020).

Secondly, social factors, which are the negative effects of increased commuting on behaviour and a further increase in car dependence, which iteratively results in increased commuting, and affecting life quality and productivity (Guzman, Arellana, & Alvarez, 2020). Therefore, these factors affect human health by decreasing air quality, increasing inactivity and stress-related issues.

Finally, the economics of car dependence has higher interconnections with previously-defined challenges: a) increased costs of car ownership and maintenance through which social inequality is stimulated by the under-representation of low-income groups (Allen & Farber, 2021); b) higher infrastructure depreciation and costs regarding intensive road use; c) trade-off costs for increased commuting; d) traffic accident costs, which are related to the initially discussed infrastructure and traffic factors.

All of these factors stimulate resource use insufficiencies for suburban linkages and urge for enhancement. Policies addressing efficient and sustainable linkages mention various transport options, including carpooling (Guzman, Arellana, & Alvarez, 2020). Carpooling, as a type of ride-sharing is “the service that allows drivers to share rides with other passengers” (Qadir, Khalid, Khan, Khan, & Nawaz, 2018). As a contemporary solution for transport needs, carpooling covers previously defined problems, such as a) reduced energy consumption and GHG emissions by ride sharing; b) private and public cost savings addressing economic considerations; c) reduced parking needs, travel time and increased convenience (Shaheen, Cohen, Randolph, & Michael, 2019).

Emerging economies with fast-growing suburbanisation tend to have informal carpooling mechanisms, which are sometimes referred to as casual/flexible carpooling (Shaheen, Cohen, Randolph, & Michael, 2019). One such case is Azerbaijan, in which informal carpooling systems exist, even if there are multiple affordable public transport options, which are discussed below.

1.2. Azerbaijan and its urban transport

Azerbaijan, due to its historical evolution is concentrated in Baku. As a result of the convergence of the production and service facilities in Baku, the city with its suburbs (Absheron and Sumgait City) is inhabited by 32% of the total population with a higher population density (table 1).

Table 1: Population density indicators for Azerbaijan and Baku, 2023

1/1/2023	Azerbaijan	Baku
Territory, km ²	86 600	4 200
Population, thousand person	10 127	3 194
Population density, km ² /person	117	5 152
The lower limit of urban density, km ² /person	1 500	1 500
Difference, times	0.08	3.43

Source: The State Statistical Committee, 2023; UN Statistics Division, 2023

Moreover, agricultural innovations exaggerate urban movements to Baku, which increase car ownership significantly with the number of cars per 1000 residents escalating from 55 to 143 since the early 2000s (Valiyev, 2022). This rise results in the aforementioned challenges for the urban development of the city.

Currently, the government is undergoing several policies with targets of a) replacing around 300 million private trips with sustainable options by 2025 as covered by the “Mobility Transformation Program in Azerbaijan” (MDDT, 2023); b) transitioning Baku to a sustainable, polycentric urban area with public transport prioritisation, which is settled in the “Baku city General Plan 2040” (State Committee on Urban Planning and Architecture, 2023). Despite being in the planning stage, these policies address shortcomings of existing actions as mentioned in news, public opinion and articles, which are as follows:

- Bus – the existing fleet is being replaced by electric buses and bus lanes are connecting suburbs (around 21 bus lanes operate in Baku) (MDDT, 2023). However, a) lanes are not properly obeyed by drivers (more than 40 thousand drivers were fined in 2022) and lanes are only available in peak hours (Avtosfer.az, 2021; Sputnik.az, 2022);

- Parking – more than 17,000 parking spaces were organised on fee (MDDT, 2023). However, these spaces decrease the availability for pedestrian areas, increase costs for drivers and are still not sufficient for urban car dependence;
- Micro-mobility infrastructure – although current plans include investments and support for micro-mobility (cycling and scooters), special lanes are only in central locations, parking infrastructure is not available and multi-modal and micro-mobility-friendly public transport options are needed to use these lanes (Safarov, et al., 2023);
- Subway – although interval decreasing is targeted, underground are not available in suburbs only suburban trains operate in some of the suburbs. These suburban trains, however, do not suffice existing passenger demand and cover peak hours only;
- Taxi – increase in the number of operators and comparable taxi fees to public transport, and demand for taxis has risen in recent years. However, considering individual use and contribution to emissions they are inefficient to use, and safety measurements are lacking including driver knowledge and technical aspects (MDDT, 2023).
- Although these factors are expected to be covered with the new strategies, preliminary recommendations to stimulate multi-modal transport and efficient linkages of suburban areas are made in this paper, which indeed affect resource use as described in Figure 1.

2. SUGGESTED POLICY MIX

2.1. General view on the policy mix

Due to increasing population concentration, car dependence and its negative implications in Baku are increasingly growing. The government has taken initiatives to address these challenges and also households have an informal carpooling system, sometimes referred to as a “1-manat” taxi that originates its name from the average price of the service (~0.50 GBP). Although this informal agreement is widely known, direct policy coverage of the particular issue is not in place for now, which is also a policy choice (McCormick, 1998). This paper proposes a policy mix for formalising carpooling scheme in Baku with the objective of decreasing air pollution from the transport sector (22% of the total in 2022 (SSC, 2023)).

To achieve the objective of the proposed policy mix, 3 principal plans have been developed to address the existing challenges within the informal mechanisms of carpooling and therefore, contribute to the resource use efficiency associated with the existing scheme:

- a) Expanding electric vehicle (EV) usage to decrease emissions;
- b) Increasing passenger travel safety;
- c) Decreasing urban car dependence by stimulating multi-modal transport – road transport comprises 87% of total transport in 2022 and increasing suburban linkages – convenient transport access in Baku in 2022 was 80%, which is a promising indicator for strengthened linkages (SSC, 2023).

The detailed design and implementation of the policy mix are addressed in the next section.

2.2. Policy design and implementation

Currently, transportation governance is solely managed by the Ministry of Digital Development and Transportation of the Republic of Azerbaijan (the Ministry), which oversees multiple state-owned companies managing transport in different modes. Therefore, considering this institutional framework, central management by the Ministry is proposed to a) mandate a carpooling licence for operation and b) launch and manage an app connecting drivers and passengers. The licence requirement is proposed to solve the following challenges of sustainable transport and associated costs (figure 1):

2.2.1. EV expansion:

Decreasing air pollution from car dependence is not limited to decreasing the number of trips, but also includes decarbonisation of trips – expansion of EVs. To stimulate the EV demand, in addition to the value-added tax exemption, the government has eliminated import tariffs on EV imports from January 2023 (State Customs Committee, 2022). The proposed carpooling policy expands these stimulations by the progressive licence pricing instrument. That is, including carbon pricing element (correcting actions for greenhouse gas emissions (World Bank, 2023)) to the licence fee determination by proposing higher fees on conventional vehicles, zero or discounted fees (covering only licence issuance costs) on EVs. In a proposed scheme, fee pricing, including EV criteria incorporation will led by the Chamber of Accounts, which is the supreme audit and highest financial control authority of the Republic of Azerbaijan.

2.2.2. Enhanced safety measures:

2.2.2.1. Traffic safety

Although vehicles are subject to the mandatory annual technical inspection, for highly-utilised vehicles as taxis, or informal carpooling, annual inspection is limited. Despite having a licence fee, incorporating specific criteria for technical inspection could made be mandatory for a safe scheme, which will indeed help to decrease the death rate indicator per 1 million passengers in traffic accidents, which was 8.3% in 2022 (SSC, 2023).

2.2.2.2. Crime and offence

For crime prevention, detection, safety and security enhancement video surveillance should be set as a requirement with enhanced data security of passengers (The Welsh Government, 2021). Therefore, a central management app that is available for oversight agencies and passengers would make journeys trackable and safer.

For the proposed policy framework, as general technical inspection, specific technical inspection and video surveillance infrastructure requirements would potentially be overseen by the Main Traffic Police Department of the Republic of Azerbaijan.

2.2.3. Increased suburban linkages:

Formalisation of the carpooling system will have a bidimensional effect:

2.2.3.1. Optimizing integration between underground and suburban railway networks and expanding their potential

The existing public transit network (rail and underground) only comprehends central locations without covering all suburbs (Figure 2). Although suburban rail networks exist in some places,

they are limited in supply exceeding their daily passenger transportation capacity (6 390 passengers) by almost 3 times (17 377 passengers), according to the calculations shown in Appendix 1. This indicator indeed explains decreased service quality and increased car dependence (Azərtac.az, 2022; Qafqazinfo.az, 2023). On the other hand, as the network is limited, areas that are outside of the scope in Figure 2 rely only on buses, private cars and to address their demand, carpooling is an effective solution. The proposed policy covers these challenges:

(a) Issuing licences by the Ministry based on the driver's preference location: Mandating licences to be renewed annually, operation location can be made to be amendable during the annual renewal and licence-holders be allowed to operate only in specified areas. This indeed, would likely to assist in carpooling supply concerns.

(b) Controlling the number of drivers operating in the same area through pricing instruments, that is directed by the Chamber of Accounts, a) if a service shortage occurs, drivers could be subject to the decreased licence fees in high-demand areas; b) vice versa in surplus areas could be applied – drivers would pay higher fees for high-supply areas.

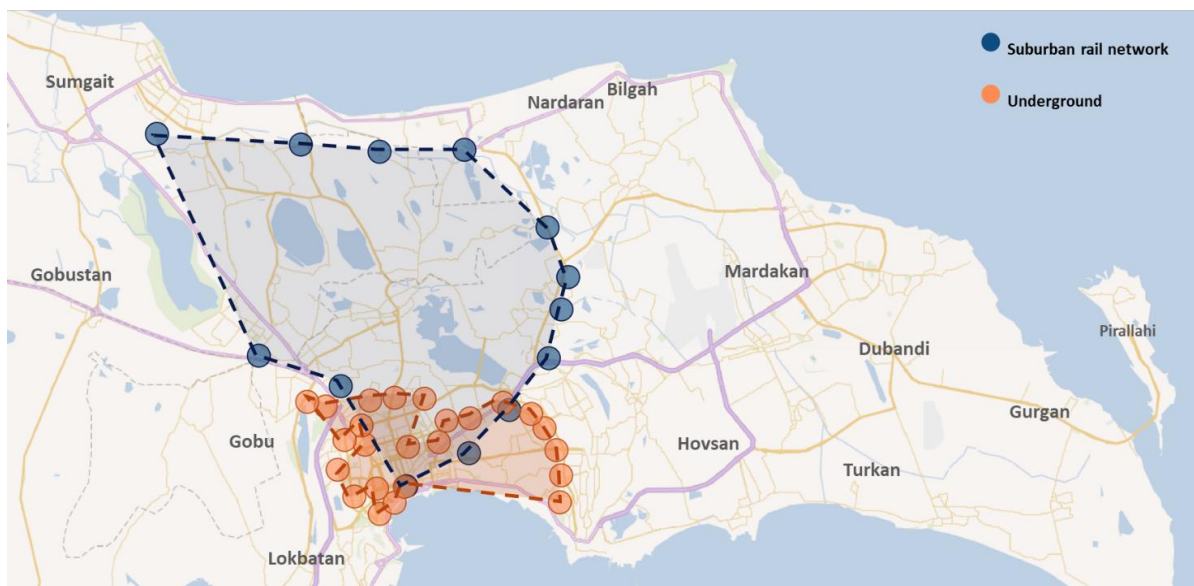


Figure 2: Underground and suburban rail network in Baku and its suburbs

Source: Generated by Power BI; Modified from source: Google Maps, 2024

2.2.3.2. Service pricing

The informal carpooling pricing mechanism is solely based on the market mechanisms, derived from supply & demand interactions and including peak-hour effects. Therefore, the price expresses the best interest of drivers and passengers keeping carpooling demand balanced. However, increased traffic congestion has led to increased informal tariffs that increase passenger dissatisfaction (Yenisöz.az, 2023). This policy proposes to keep pricing at a market-determined level with ceilings and floors applied to limit tariffs considering the mileage. According to Brown, et al., (2017), inflexibility associated with price controls (ceilings and floors) can distort market competition and increase cost-coverage challenges of service providers, however, providing market flexibility for pricing with predetermined upper and lower limits will both protect the interests of drivers with this regard.

3. DISCUSSION

The suggested policy mix was introduced and this part is designed to express internal interactions of and synergies of policy instruments and its external digestion by the society and institutional bodies.

3.1. Interactions of policy instruments and implicit limitations

Figure 3 describes the informal carpooling system in Baku, in which drivers and passengers were free from regulations and bargained on market-determined prices. However, this interaction involved challenges as a) excessive price increases depending on the peak hours and weather conditions; b) driver availability was not guaranteed everywhere; c) safety concerns of passengers.

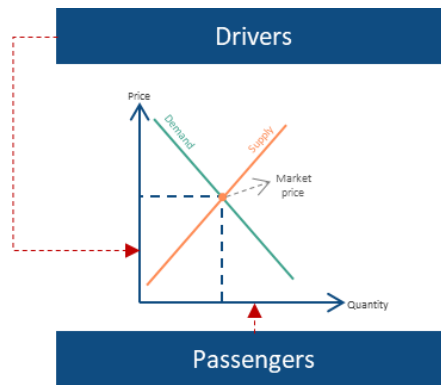


Figure 3: Informal carpooling

However, the proposed policy mix is designed to mandate licence requirements to the drivers addressing these challenges while stimulating suburban linkages, decreased car dependence and accounting for environmental degradation challenges.

Figure 4 is the graphical representation of the suggested policy mix that resembles multi-layered policy interventions.

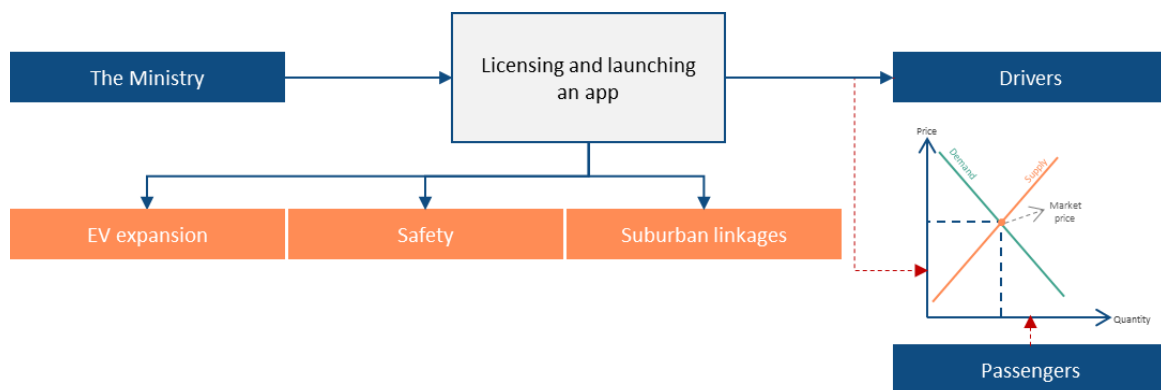


Figure 4: Proposed policy mix

However, although this policy mix is built on the preliminary and qualitative data, the implementation and further adjustments should be made considering the potential effectiveness of the proposal and limitations & challenges embedded to it, which are as follows:

1. The proposal considers innovative standardisation of licence and app-based carpooling system in which direct project support from the Ministry is suggested. However, the smart carpooling mechanism needs quantitative data backup, which will be challenging considering the informality of the sector (Adele & Dionisio, 2020).
2. The proposal follows market-based mechanisms in which stakeholders are subject to optional pricing, a) drivers and passengers are free to decide service prices to which lower and higher limits are embedded; b) licence fees are subject to driver selection, including consideration for EV and location-specific adjustments. Although this flexibility may assist stakeholders, real-time application of semi-regulated pricing may result in market distortions due to information asymmetries of price-setting bodies (Brown, Eckert, & Eckert, 2017);
3. The proposal addresses to the environmental and spatial justice concepts in which land use, urban development and accessibility for all are considered (Kronenberg, et al., 2020). However, the inclusion is preliminary, further identification of technical aspects and quantitative objectives should be considered.

Therefore, considering interactions of these elements and complexities in implementation is mostly associated with the availability of information both for integrative and optimised app launch and reinforcement and control mechanisms for the policy-making institutions. Therefore, the implementation of large-scale social datasets may have additional shortcomings in terms of additional security and management considerations for data privacy and governance (Anthony, 2024).

3.2. External considerations for the policy mix

As it has already been defined in the policy design, the proposed policy includes governing stakeholders in the planning, implementation and reinforcement activities associated with the policy. However, different responsibilities and duties allocated to these bodies may result in institutional conflicts of interest among the Ministry, the Chamber of Accounts, the State Committee for Urban Planning and Architecture, and the Main Traffic Police Department of the Republic of Azerbaijan.

Moreover, as the policy stands for the formalisation of carpooling, optimisation and coordination between policy-setting bodies and reinforcement authorities and the public can be challenging and impede the credibility of the suggested policy (Rye, Monios, Hrelja, & Isaksson, 2018).

Therefore, definition of the vision and the objectives beforehand for all stakeholders could refrain from the potential conflicts of the interests in the field and serve for the best interests of end users.

4. CONCLUSIONS AND OUTLOOK

In this paper, growing suburban areas and resulting car dependence were identified and described considering multiple dimensions as infrastructure and traffic, environment, social and economic requirements. These challenges include increased congestion and costs, decreased quality of life and health impact and environmental destruction. To address these challenges, this paper proposed a policy mix built on the licencing and formalisation of

carpooling scheme in Baku where informal settlement was previously arranged. The proposed policy covers range of challenges involving 3 pillars of sustainability and therefore, infrastructure and traffic requirements. However, the policy is limited considering data availability and public to private interaction obstacles associated with the informality of the sector. Therefore, further investigations including public surveys, policy-setting body integration, technical feasibility studies on carpooling formalisation is recommended to be made. After completion of detailed study on the topic, a comprehensive policy mix can be addressed to the particular concern.

However, existing government outlook on urban development and integrated sustainable transport is promising about the future of carpooling mechanisms as a tool for suburban linkages. Despite its role on decreased emissions, carpooling mechanisms are also type of motorised transportation infrastructure and even if EV-based scheme is proposed, it does not fully alleviate the unsustainability in transport sector (Abutaleb, El-Bassiouny, & Hamed, 2020).

Appendix 1. Daily passenger transportation capacity calculation

#	Category	Source/ calculation	Unit	Figure
A	Passenger transportation for January-September 2023	ADY, 2023	Passengers	4,686,373
B	Number of average daily trips	ADY, 2023	Count	23.7
C	Passenger transportation capacity per trip	Alpha Trains, 2023	Count	272
D	Daily passenger transportation limit	B * C	Count	6,437
E	Daily passenger transportation according to the data	ADY, 2023	Passengers	17,357
F	Difference	E / D	Times	3

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