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# Housing Cost Dependence on Transport Accessibility Territory

*Sharov Maksim Igorevich*

## Abstract

The study the housing cost dependence on the transport accessibility of the territory of the city will improve the efficiency of the route network and will lead to a reduction in overall transportation costs. The research algorithm consisted of the following stages: data on transport accessibility were systematized; calculation of time costs assessed transport accessibility by city zones; the dependence of the cost per square meter on the time cost of movement is obtained. When assessing the impact of transport accessibility on the housing cost it is important to pay attention to the remoteness from the central part of the city, the proximity of highways, the system of access roads; the proximity of public transport stops with a large number of routes connecting different zones.

**Keywords:** urban planning, transport accessibility, Cost of Housing

## 1. Introduction

The development of urban areas requires integrated and sustainable territorial development focused on ensuring a safe and favorable environment for human life, Limiting the negative impact of various activities on the environment and ensuring the protection and rational use of natural resources in order to safeguard the interests of present and future generations. The development of urban passenger transport and green mobility is therefore an important issue.

Priority development of urban passenger transport is ensured both by urban planning solutions and by technical solutions. In modern urban development theory and practice, the most effective solutions for the development of urban passenger transport systems include:

- urban planning for urban passenger transport, including the creation of an attractive and convenient environment for public passenger transport infrastructure;
- development of areas adjacent to high-capacity passenger transport corridors;
- multifunctional use of land to reduce the need to travel long distances.

As the accessibility of urban passenger transport increases, so does the attractiveness of the city as a whole, resulting in a greater concentration of service enterprises and other places of work.

Urban population, thousand people	Travel times, min
2000	45
1000	40
500	37
250	35
100	30

**Table 1.**  
*Standard travel times to work places in cities.*

In the general practice of urban planning and transport, accessibility is determined by various factors, including:

- accessibility of transport;
- availability of public services;
- creating the necessary number of public spaces.

Transport accessibility refers to the normative measure of travel time between different points within cities and agglomerations. In the design of the road network, one of the important parameters determining the required quality of the urban road network is the time between any two points in the city [1].

Transport accessibility of urban and regional areas is one of the most important economic characteristics.

In this connection, it is necessary to point out the need to develop up-to-date criteria and standards for assessing accessibility. Since Soviet times, the Russian Federation has had building regulations and norms (SNIP 2.07.01–89, SP 42.13330.2016) [2], which establish time-consuming requirements for travel to work. Even in cities with more than one million inhabitants, 90 per cent of working people are not required to spend more than 45 minutes traveling from their place of residence to their place of work (one way) (**Table 1**). The established travel time standards need to be calculated to obtain intermediate values based on the number of urban residents. In addition, the standard states that daily commuting from other locations to a downtown place of work is permitted, but not more than two times.

The improvement of transport infrastructure is an essential tool in the implementation of regional policies for sustainable development, it also makes it possible to reduce disparities in the spatial development of different urban centers and agglomerations and to increase the attractiveness of remote and sparsely populated areas [3, 4].

## 2. Methodology

However, improvements in transport accessibility influences the cost of housing in the area. For example, the price of an apartment in the city of Moscow near metro stations may differ by an order of magnitude from apartments located at a sufficient distance, with a analogous type of residential development. The recent opening of the Central Moscow Diameter has already led to an average increase in housing prices of 13 per cent. In this case, it is important to have tools for calculating and forecasting the cost of housing on the basis of the accessibility of the territory. This chapter presents a study of the impact of transport accessibility on the cost of a square meter of housing on two different types of cities in the Irkutsk region of the

Russian Federation. Also, two different methods were used to estimate transport accessibility of the territory, in one case - data of the questionnaire population, in the second - the method of transport modeling using the software of PTV "VISUM".

The city of Angarsk plays an important role in the system of interregional transport corridors linking the European part of Russia and Western Siberia with the regions of the Far East. Angarsk is an industrial city. The territory of Angarsk is heterogeneous, with different socio-economic, infrastructural and environmental conditions determining the basic directions and functional priorities of the territory's development. In general, Angarsk plays a large role in the economy of the Irkutsk region and contributes greatly to the development of the region's competitive advantages. Underestimation of the problem of determining transport demand and the relevance of transport infrastructure to the social and economic needs of city residents is one of the causes of economic difficulties and negative processes, such as out-migration due to poor quality of life. The development of transport accessibility in Angarsk is an important condition for improving the quality of life of the inhabitants.

The spatial planning of the city makes it possible to form a promising residential development in the south-western part of the city of Angarsk, as well as new quarters of medium, low-rise and individual residential development in the southern and western parts of the city. The construction involves, first and foremost, the development of land through the construction of multi-floor housing units in the western part of the city in two neighborhoods and in the eastern part of the city in three quarters. Therefore, ensuring the required level of transport accessibility for the developing area of the city is a very urgent task.

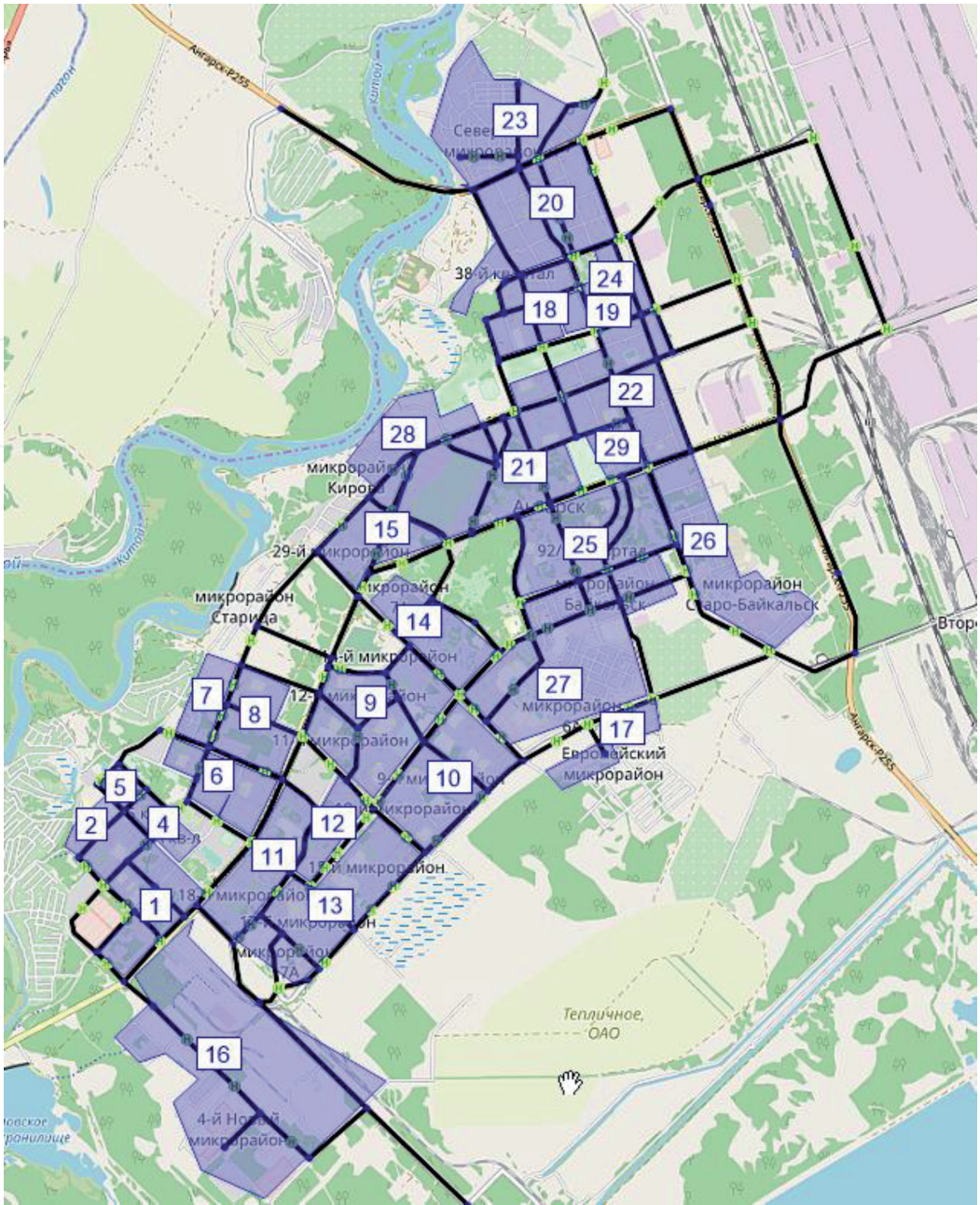
The main residential development of the city of Angarsk is concentrated in its center, while the industrial zones are located along its south-eastern, southern, south-western and western periphery. At the same time, new green areas of great breadth are maintained and formed between them and the residential territory, providing ecological and esthetic comfort of the residential territory. The road network of the city of Angarsk is based on the need to provide stable, as safe and as short as possible communication points, places of work and rest.

In assessing transport accessibility, the most important task is the transport zoning of the territory. To achieve this, the following data are needed:

- population in the zone;
- maps of the terrain;
- number of places of residence and places of work
- availability and location of basic cultural and amenities facilities
- list of streets and characteristics of the carriageway
- traffic patterns on the road network;
- transport and housing costs.

Transport zoning has two main characteristics: the number of zones into which the territory is divided and the size of those zones. The number and size of zones are determined on the basis of the objectives of the study and the required accuracy of the results. Due to the fact that the assessment of accessibility in the city of Angarsk was carried out using computer simulations, the division into transport zones was more detailed than in the city of Irkutsk (**Figure 1**).





**Figure 1.**  
*Transport zones of the city of Angarsk.*

When carrying out transport zoning, the following rules should be observed:

1. Traffic and pedestrian accessibility inside the zone should be taken into account.
2. In defining the boundaries of the zone, it is necessary to combine the choice with administrative boundaries (if any). Available statistical information can then be used.
3. The selection of zones should take into account territories of the same purpose: (residential, industrial, recreational).

In this study, in order to achieve the objectives of assessing transport accessibility and its impact on housing costs, we select areas in such a way that the development covers a sufficiently large area, for example, a few neighborhoods. When dividing into zones we try to take into account the type of construction (lots with

a large housing stock, lots with two- or three- floor houses with wooden floors, single- floor houses).

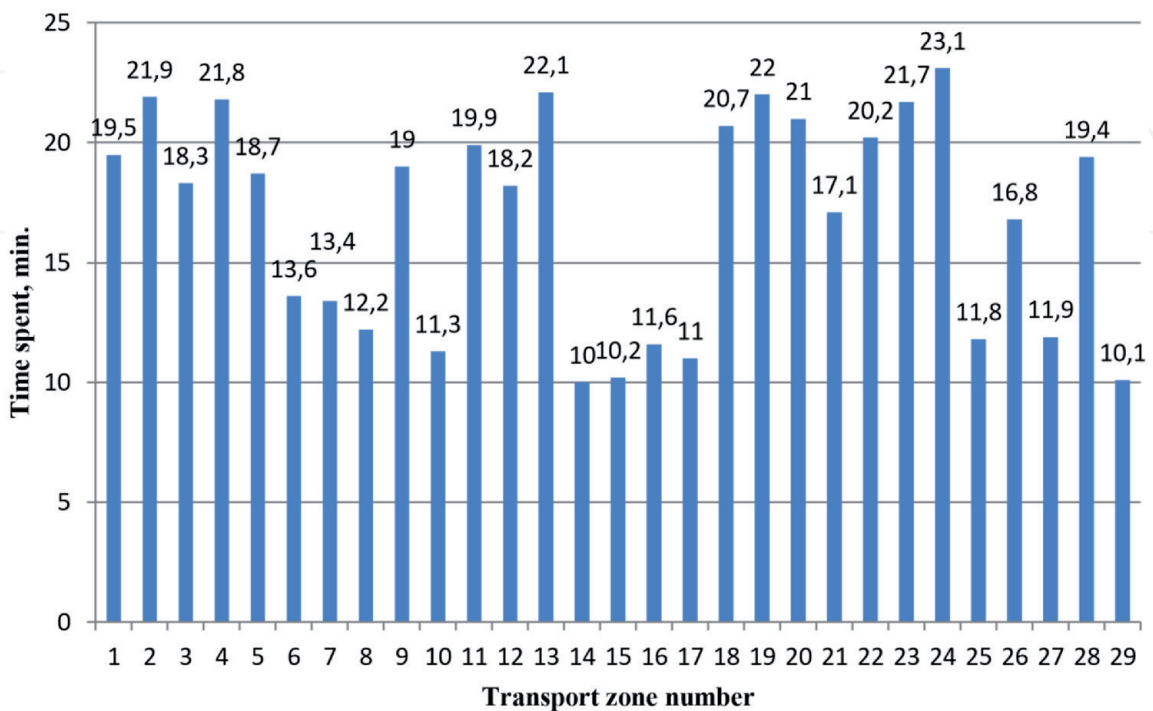
One possible method of processing the data obtained in the study is the calculation of a time-use matrix, which made it possible to determine the accessibility of urban areas. The creation of the transport model and the assessment of transport accessibility based on it were carried out with the help of the software product “VISUM” [5].

Then we analyze each area separately and get the average time spent moving around the area. The following groups were identified: high availability to 13 minutes; average availability from 13 to 17 minutes; low availability of more than 17 minutes (**Figure 2**).

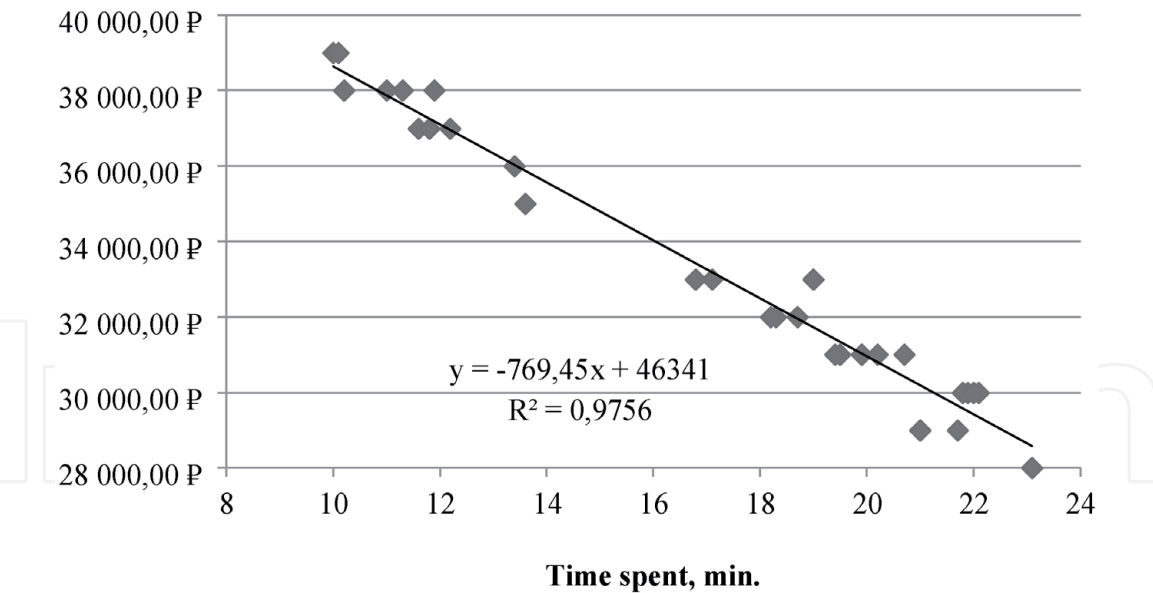
The data obtained make it possible to estimate the impact of transport accessibility on the cost of 1 sq. m. dwellings. There is virtually no alternative definition of the link between transport affordability and the cost of sq. m. as this is one of the main parameters of housing value formation. Analyzed the real estate market of the city of Angarsk, examining the value of sq. M / p on sites avito.ru and domclick.ru, which are currently one of the most popular electronic sites for housing sales, average cost of 1 sq. m for 2020. The dependence of price policy on zone division is illustrated in **Figure 3**.

In assessing the impact of transport affordability on housing costs, it is important to pay attention to a number of aspects [6–11]:

- Distance from the city center;
- Proximity to motorways;
- An advanced system of access roads;
- Proximity of public transport stops with a large number of routes connecting different zones;
- Availability of parking spaces, parking areas or garage cooperatives;



**Figure 2.**  
*Distribution of travel time by transport zones in Angarsk.*



**Figure 3.**  
*Dependence of the cost per square meter on the time cost of movement.*

- Proximity to cultural and social places (kindergartens, schools, health centers, supermarkets);
- Exposure to noise, vibrations and exhaust.

Most often in studies on this topic, authors focus on estimating the distance from the city center, as it is there that all the main objects of gravity are concentrated. Accessibility is measured by the time needed to travel from a given point in a city to the external borders of the central region. The accessibility rating makes it possible to create a reasonable zoning of the city.

As the level of accessibility decreases, the cost of travel to the central part of the city increases and the cost of a square meter decreases gradually. The analysis showed that dwellings located in zones 8, 10, 14, 15, 16, 17, 25, 27, 29 will have the highest level of comfort in terms of transport accessibility, the least comfortable dwellings in areas 1–5, 9, 11–13, 18–24, 28 zones (**Figure 4**).

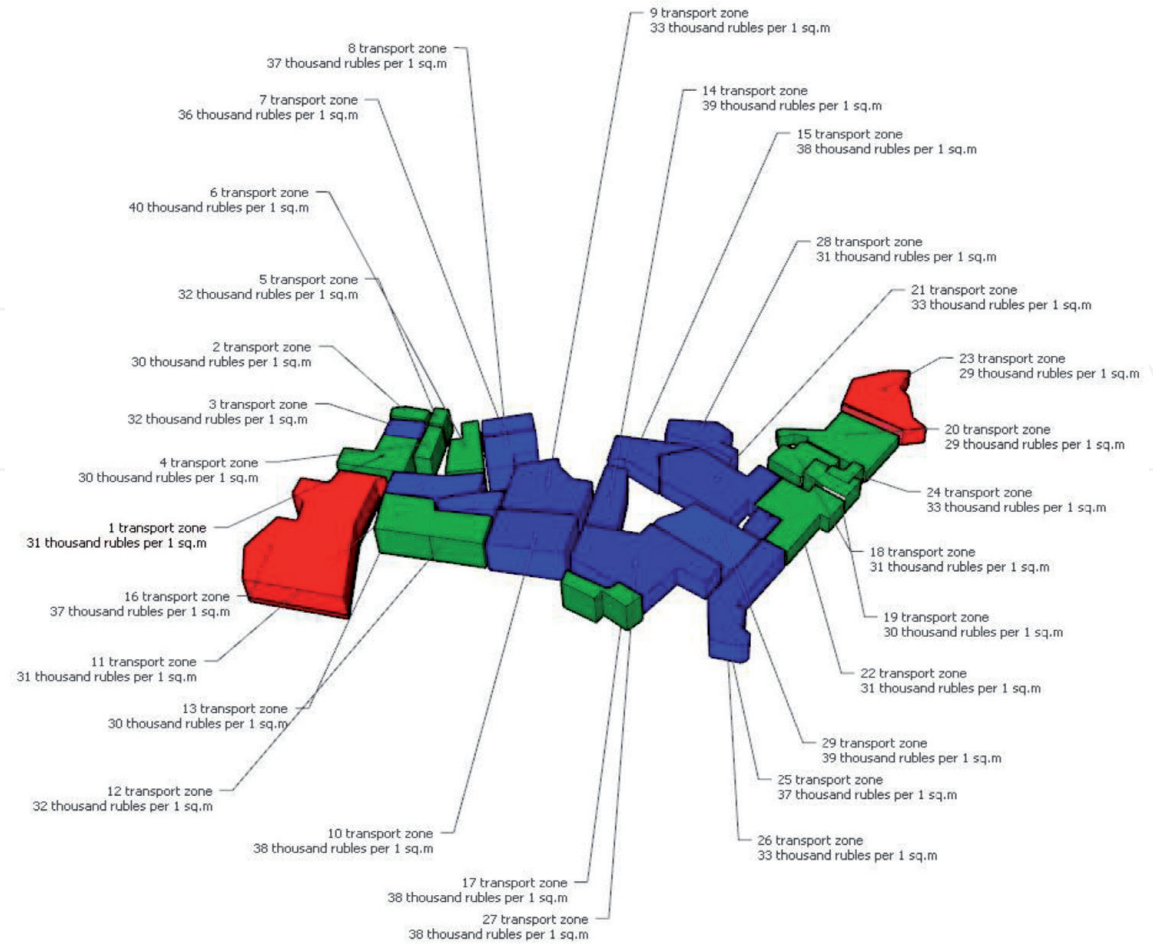
However, it is worth noting that although transport zones 6, 7, 26 have average transport accessibility, the cost per square meter is over 33,000 rubles, this is due to the fact that the buildings are in good condition and people living in these areas, use private transport. On the basis of an analysis of the average market value of a square meter, it can be concluded that dwellings located in the central part of the city are the most attractive.

On the basis of the analysis, a correlation has been established between the time costs of travel and the cost of a square metre of residential property in the city of Angarsk. A trend line was drawn and an equation of this line was obtained (**Figure 3**) to explain the functional relationship between the cost of a square meter and the time spent on labor moves.

With the increasing remoteness of the residential building from the geographical center of the city, the level of transport accessibility of the territory decreases, and as a result, the cost of one square meter decreases. So, in particular, the difference in the housing costs in the area with the best transport accessibility is higher by 28% than in the remote territory.

In the city of Irkutsk, a different method of assessing transport accessibility was applied, based on a questionnaire survey of the population.





**Figure 4.**  
*Cost per square meter for transport zones in Angarsk.*

Irkutsk is a city located in Eastern Siberia in Russia, the administrative center of Irkutsk Oblast, one of the largest cities in Siberia. Founded in 1661, Irkutsk is included in the list of historical settlements of Russia. The population of Irkutsk is about 623,000 (2019), the area - 277 sq. km.

Today's Irkutsk originates from a fortified settlement laid by the Russian explorer Yakov Pokhabov in the summer of 1661. The territory on the bank of the Angara River at its confluence with the Irkut River (hence the name of the settlement) was favorable for agriculture and cattle breeding. The waterway provided communication with the Yenisei River and Lake Baikal.

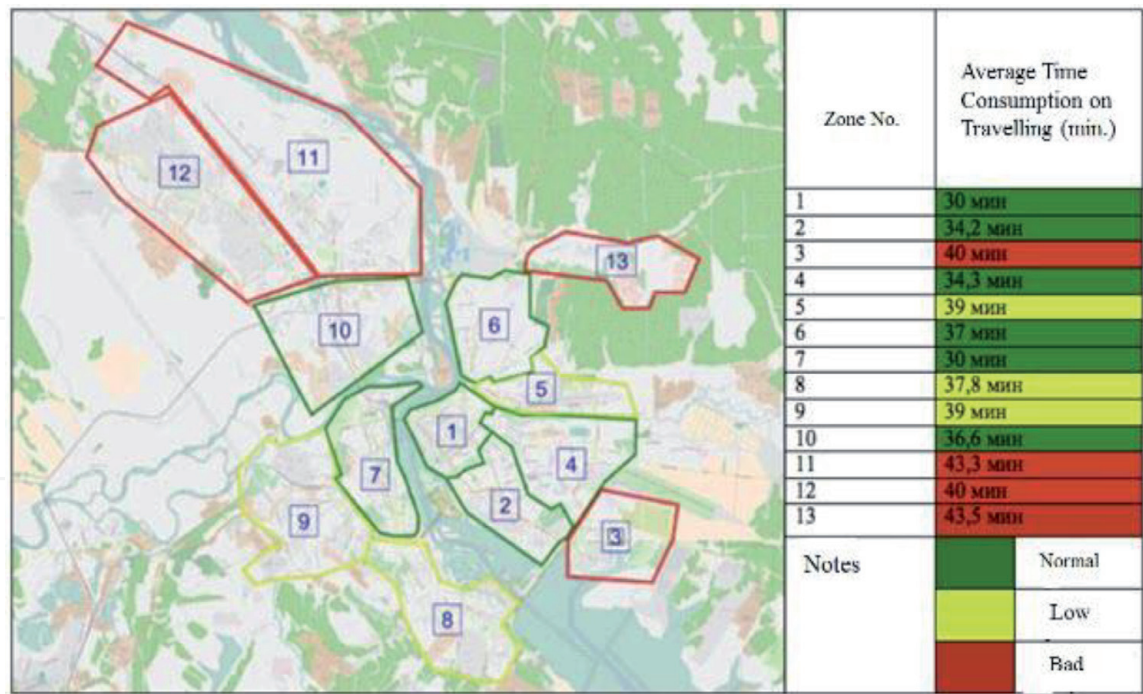
Unlike modern Angarsk, Irkutsk has a historically developed road network, and it is also divided by the Angara River. The Angara River divides Irkutsk into the right-bank and left-bank parts. The length of the river within the city is 29 km, the width under the Old Angara Bridge in the city center is about 300 meters.

In such conditions, changes in the parameters of transport accessibility can lead to rather complex and expensive solutions.

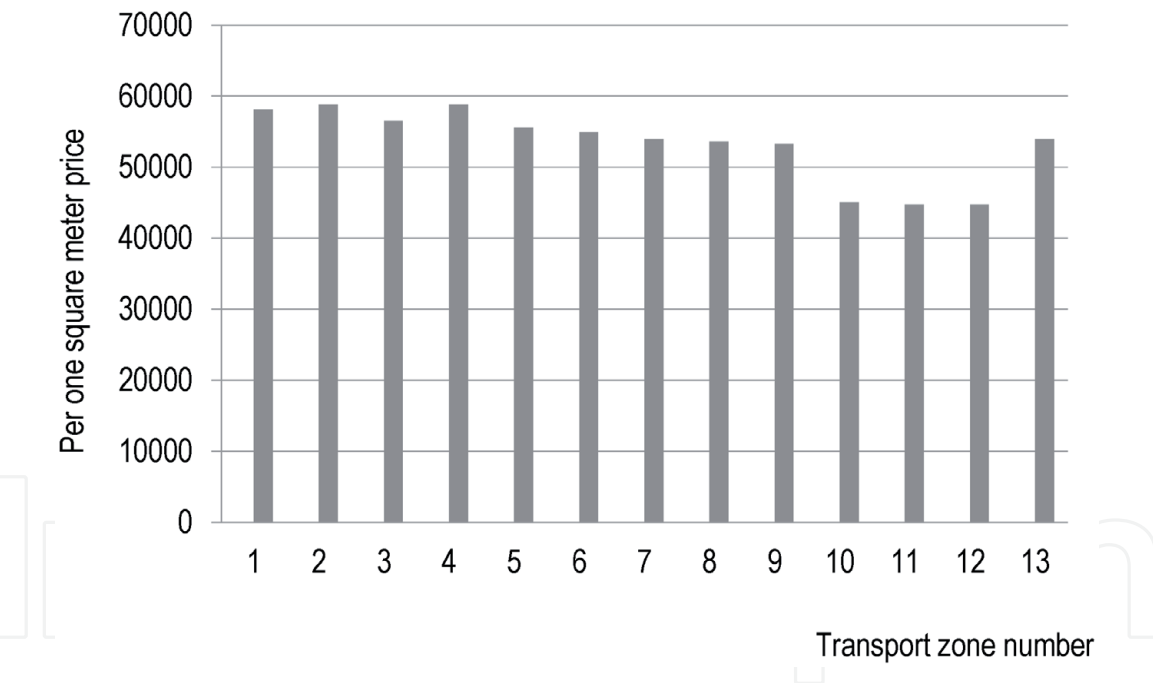
The results of the questionnaire survey carried out by the IRNITU Transport Laboratory in Irkutsk showed [5, 12–14] that even the existing town planning standard of 38 minutes per one travel is realized only by 50%. In general, the results of the estimation of the enlarged zones of the city of Irkutsk are presented in **Figure 5**.

Having analyzed the housing market of the city of Irkutsk, the average per one square meter price in newly built houses and at the pre-owned market is defined (**Figure 6**).





**Figure 5.**  
*Average time spent on a one-way work trip in Irkutsk.*



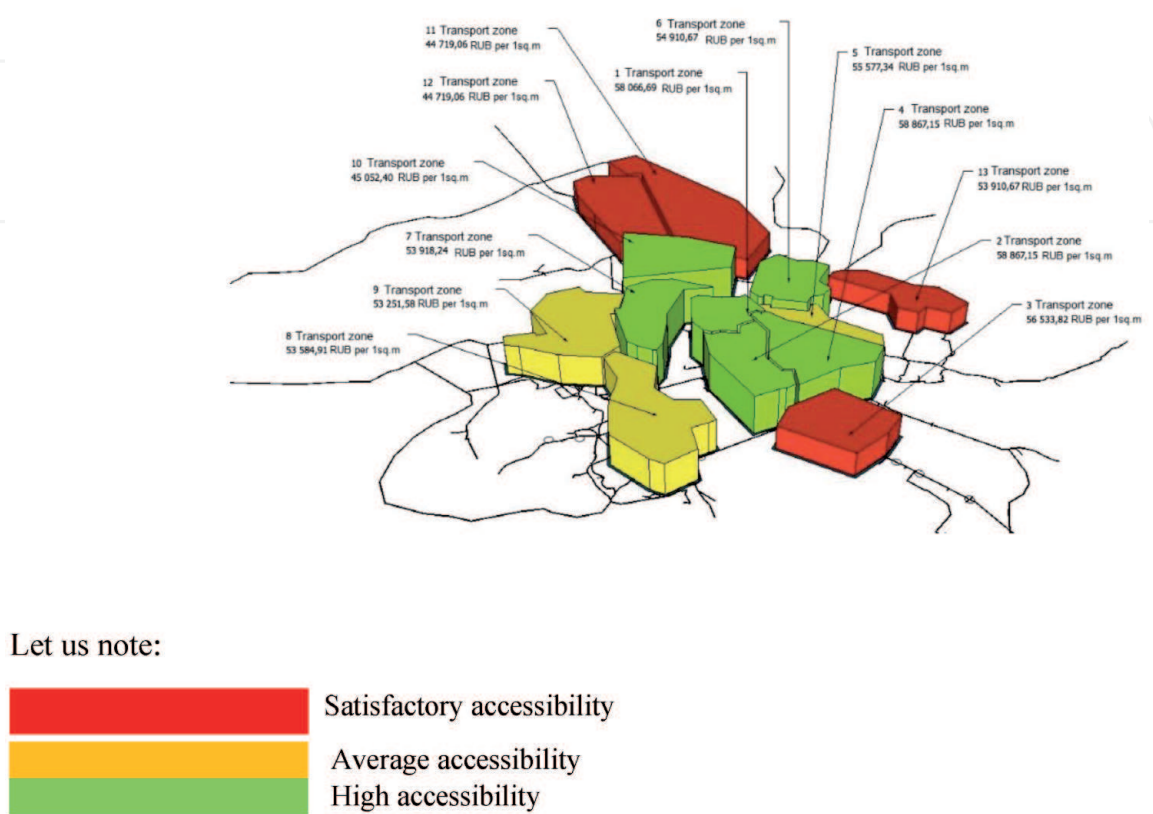
**Figure 6.**  
*Average price per one square meter according to transport zones in Irkutsk.*

The analysis showed that residential buildings located in 1, 2, 4, 6, 7, 8 and 10 zones will have the highest level of comfort in terms of transport accessibility, residential buildings located in 3, 5, 9, 11, 12 and 13 zones (**Figure 7**) – the least one. Accordingly, the location of the object will determine their cost.

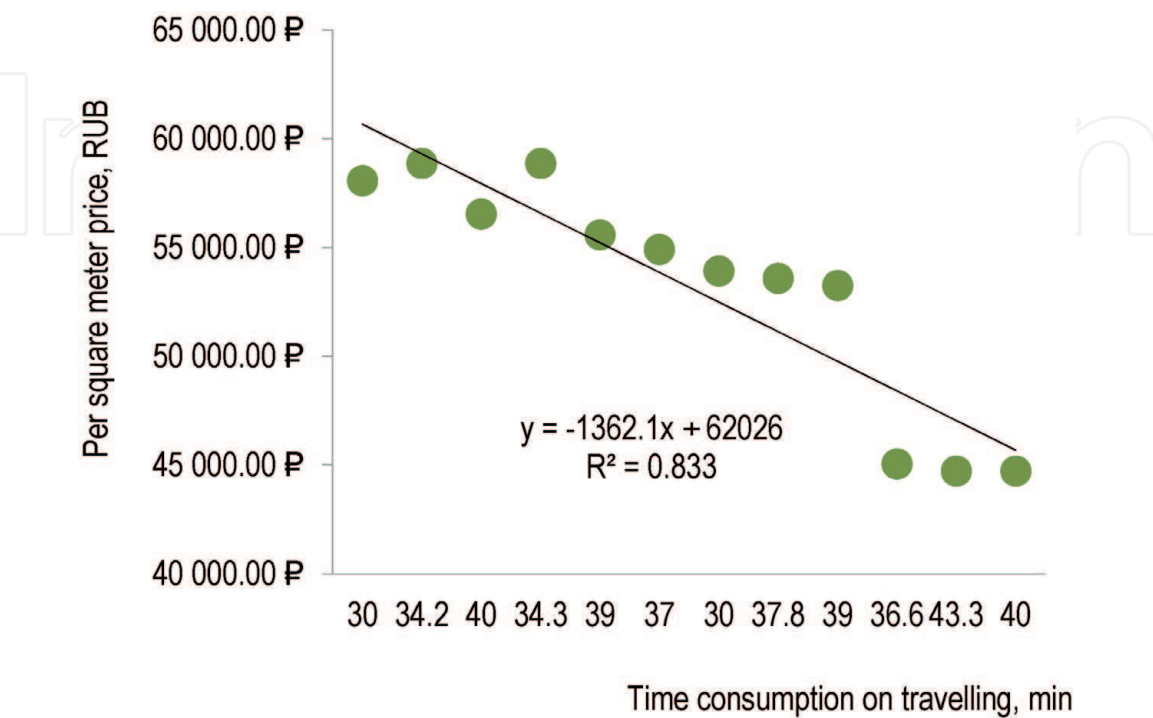
However, it should be noted that, despite the fact that the transport accessibility is low in the third transport zone, per one square meter price amounts to RUB 56 533.82; it is explained by the fact that the building is mostly elite, and people living in the area use individual means of transportation.

Based on the analysis of the average market per one square meter price in a newly-built and pre-owned residential fund, it can be concluded that residential buildings located in the central part of the city are the most attractive.

Based on the analysis, the time consumption on traveling and the per square meter price of residential real estate in the city of Irkutsk was determined. For a functional explanation of the dependence of the per square meter price on the time consumption on traveling for labor purposes, a trend line was drawn up and the equation of this line was defined (**Figure 8**).



**Figure 7.**  
Per square meter price according to transport zones in Irkutsk.



**Figure 8.**  
Dependence of the per square meter price on the time consumption on traveling.

Going beyond the boundaries of the geometric center decreases the value of the property. However, the value of the object increases due to the benefits of location (transportation hubs, objects of social attraction) and causes an increase in its value.

The validity and reliability of the results can be confirmed by representative sample sizes, verification of experimental results by generally accepted statistical criteria.

### **3. Conclusions**

In conclusion, it can be said that studies on the assessment of urban transport accessibility, which improve the quality of service of the transport network and make use of these data for operational management and transport planning, are vital.

The study identified the rules to be followed in transport zoning, indicators to be taken into account when assessing transport accessibility. The more data available, the higher the quality of research. The level of detail is determined on its own; Most often, the zone includes several neighborhoods of the same type and series of developments.

The need to ensure stable functional connections of the central residential territory with peripheral zones (centripetal connections), as well as the need to organize peripheral connections, create a spatial basis for the development and transformation of the existing transport and architectural-planning structure of cities.

Depending on the availability of data on income and expenditure of the population, the relevance of information on the organization of the road network increases, and the possibility of obtaining the most realistic assessment of transport accessibility with the definition of areas, requiring the development of a route network to be covered by urban passenger transport.

As a result, it can be concluded that increasing the accessibility of the territory is a key factor in economic growth. The availability of tools for detailed and accurate accessibility assessment is currently one of the most important research studies in transport planning.

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