Formation of sustainable development of bicycle and pedestrian zones in a modern city

Alyona Manakin\textsuperscript{1}\,\{0000-0003-0397-4639\} and Veronica Nikolaeva\textsuperscript{1}\,\{0000-0002-3240-5833\}

\textsuperscript{1}Industrial University, Tyumen, 625000, Russia
E-mail: kravchuk.95@bk.ru, nikole1995@mail.ru

Abstract. The article is devoted to the current theme of bicycle and pedestrian space development in the developing city, as well as to attracting residents to the landscaped parts of the city for active recreation. The authors consider various types of activity, the implementation of which requires landscaped and safe areas, as well as enumerate the positive aspects associated with the introduction of active recreation in the daily life of residents, therefore, improve the quality of life and increase investment attractiveness of the region. The aim of the study is to substantiate the significance for the city of Tyumen of the creation and combination of the cycling and pedestrian zones, which shall contribute to the welfare in the sphere of the active recreation of citizens. The methods of the study are the following: analysis of the population dynamics in the city of Tyumen, which affects the socio-economic development of the region; analysis of the structure of the central part of the city of Tyumen, indicating the lack of greenery; consideration of the option of bicycle lane placement near the street Dzerzhinsky city of Tyumen.

Keywords: cycling, gardening, ecology, cycle paths, transport infrastructure, pedestrian traffic.

1 Introduction

Providing the city residents with a high level of services and quality of life is one of the primary tasks of the state. The main condition for improvement of living standards in the city environment is constancy of development, rational introduction of attracted financial resources, attractiveness of the region for investments, and also creation of the most accessible social and public benefits for the city population. The purpose of the study is to substantiate the significance for the city of Tyumen of creating and combining a bicycle and pedestrian zone, which will contribute to the welfare in the sphere of active recreation and provision of services to citizens.

The main objectives of this work can be formulated as follows: to consider the demand for non-motorized means of transport in the city of Tyumen; to trace the activity of citizens of the city; to draw conclusions about the need to improve the transport infrastructure aimed at the development of a network of bicycle and pedestrian traffic.

2 Methods

Social and economic development of a region directly depends on positive population growth dynamics. Today Tyumen is one of the few cities in the Russian Federation that amazes with its attractiveness and pace of development of social, transport and service infrastructure \cite{1}. The population of the city of Tyumen at the end of 2019 was 788 666, which is 2.6 \% more than the previous year \cite{2}. The analysis of the population dynamics in the city characterizes the population growth with the slightest outflow over many years. The result of the analysis is shown in the figure.
Figure 1. Dynamics of the population of the city of Tyumen, people.

This positive trend contributes to the development of the city and the interest of local authorities in improving the quality of social and public services provided. At the same time, it should be noted that «in the conditions of unstable and rapidly changing environment, the ability of ... executive authorities to properly assess in real time the current environmental situation in the region and make high-quality managerial decisions to minimize man-made risks» [3], which threaten social stability, economic efficiency and sustainable development of cities becomes particularly important. In addition, with population growth, there is a problem of congestion in the transport system, which requires development and most active attraction of attention to the city's bicycle and pedestrian infrastructure. The world experience shows positive examples of the introduction of a network of bicycle lanes into the transport structure of the city, while the Russian Federation is in the formative stage.

In the course of the research the analysis of modern works on the theme of improvement and creation of comfortable urban environment for the residents was conducted. Most authors pay attention to the fact that comfort is the main requirement for planning pedestrian and bicycle spaces. Typical examples are problematic, too narrow sidewalks, which force pedestrians and cyclists to move along the carriageway, violating traffic rules and neglecting their own safety [4].

Maximilian Nawrath, Ingo Kowarik, Leonie K. Fischer used an online survey as a research method to check how different levels of urban green spaces are related to the attractiveness of streets for cycling [5].

In the modern world, the basis for attracting interest and competitiveness to a city (country) is the level of development and attractiveness for investment, therefore, cities strive to develop a territorial feature that is not very common in the world. Authors A.I. Romanova, D.S. Romanov, O.V. Maksimchuk and A.V. Voronin, in their article entitled: «Basic Principles of Innovation Management in the Urban Economy of Smart-City», distinguishes the concept of «smart city» as popular. «The key direction in the formation of the «smart city» is its spatial development. The principles of accessibility, openness and comfort of urban space, which create the conditions for the interaction of its residents, are replacing the principles of industrial, technocratic minimalism. Hence the task of municipalities to form a fundamentally new public space» [6].

The following authors have paid attention to this topic: A.V. Berval, A.I. Romanova, E.A. Dobroserdova, T.A. Yelokhov. In the article «The use of «smart» technologies in the field of municipal services» they examined the use of «smart» technologies. «The article analyzes the main aspects and main directions of use and development of innovative management methods. The Russian and foreign experience of using «smart» technologies to manage the road and... economy of cities was studied» [7].
With regard to cycling, the concept of a «smart city» is feasible. After arranging in the city the main base necessary for the movement of residents of the city on bicycles, it becomes possible to introduce programs such as bike rental, which will provide services, thereby, benefit both the city authorities and residents.

Bicycles in the European Union are already a common mode of transport. It is used both for business and leisure purposes to travel safely and comfortably from any part of the city. The Netherlands is rightly considered to be the most cycling country, as this mode of transport is accepted as a priority at the state level. There are 16.6 million bicyclists in the country. The cities of the country are equipped with brightly coloured bicycle lanes, signs and traffic lights, as well as parking spaces for bicyclists. Switzerland is the next largest country in terms of creating laws to resolve differences between motorists and cyclists. In Copenhagen, the capital of Denmark, special handrails for hands and feet are installed for comfortable cyclists' movement and rest. In Japan, due to the lack of bicycle parking spaces, a bill has been passed that regulates the creation of underground seismic-resistant bicycle parks. In China, a bicycle is used as a taxi, and in the USA the developed bicycle infrastructure has proved itself in the sphere of delivery [8].

For the Russian Federation, the experience of bicycle transport development in the Scandinavian countries is most interesting, as there are similarities in climatic conditions. Therefore, it is necessary to draw on this experience in the planning and design of bicycle infrastructure [9].

In the Russian Federation at the moment, for the development of bicycle transport infrastructure in a number of large cities there are draft laws regulating construction and development programmes for 10-20 years.

Residents of Russia's regions prioritize a city for migration according to one important criterion - the living standards of the population in the migration region. This idea was deepened by A.A. Muzafarov, who considers the city to be ideal if it pays attention to the following factors: ensuring civil rights and improving living conditions; reflection in the city policy of the way of life and thoughts of its residents; taking into account the interests of all those who work, live and rest in the city [10].

The development of a continuous and comfortable cycling and walking network can serve as an incentive for the development of urban entertainment sites.

Bicycle is one of the most sustainable ways to travel in urban space, as it is environmentally friendly, economical, highly accessible and mobile. Sustainable transport is about reducing carbon dioxide emissions and other pollution. Mobility lies primarily in the absence of traffic congestion and the formation of a comfortable and modern urban environment [11]. The priority in development is to reduce the load on road infrastructure and form a sustainable understanding of the priority of cycling and pedestrian movement in the city.

The Tyumen Oblast Government is aimed at the city's territory development and improvement. It is confirmed by the adoption of the Program for the Complex Development of the Transport Infrastructure for 2018-2040. The document helps to form the measures for the construction and reconstruction of the city's transport artery, which should subsequently lead to an increase in capacity in the areas where citizens are most active [12]. One of the Program's activities is development of a network of bicycle paths and expansion of the city's street space for pedestrian traffic.

3 Results and Discussion

The city of Tyumen is still a promising city in terms of cycling infrastructure, but is already very visible in terms of cycling life, because at the moment the city plans to build bicycle lanes not only in places of recreation, but also on the main streets. The general length of bicycle lanes is unknown, but activity of inhabitants can be traced thanks to portal «Strava Global Heatmap» where inhabitants mark sites of the activity on a city map [13]. If we look at human activity using the map shown in the picture, we can see with the naked eye that people are interested in active recreation and non-motorized movement.
For clarity, let's look at some of the most relevant types of activity in the city – cycling, running and winter sports.

The first type of activity is bicycle transport. Nowadays the conditions for residents going by bicycle cannot be characterized as safe and comfortable. There is a small number of built cycle lanes, forcing cyclists to overcome their designated route. Citizens have to use not specially designated areas, and on a pedestrian area or highway with violation of traffic rules. Despite a fairly long winter, bicycles are the most popular mode of movement for citizens, both for work and training purposes, and for active recreation.

Bicycle transport is a complement to public passenger transport, providing mobility for short distances [14].

The interest in the development of bicycle transport by the municipal authorities of the city and its demand among the residents is characterized by the development of a system of “bicycle cartridges” by the Department of Road Infrastructure and Transport of the city of Tyumen. This programme is planned to build 36 terminals and 256 bicycle racks [15].
Figure 3. Map of activity of citizens of the city who prefer bicycle transport.

Routes of the city residents on the map of activity characterize the greatest activity in areas close to bridges over the river Tura, which connects the sleeping areas of the city with its central part. This trend suggests that locals are more comfortable to travel by bike to the city centre over bridges than by car. In addition, the bridge areas often experience morning congestion due to an increase in the flow of cars into the city centre, which prevents a comfortable and short-term journey from home to the office or educational institution. The dynamism of the residents is also noticed in the vicinity of city parks and adjacent areas, which indicates active leisure time in their free time from work and study.

Advantages of switching to bicycle transport [16]:
- reduction of harmful emissions;
- reduction of noise level, which is relevant in sleeping areas of the city;
- reducing traffic congestion and increasing the time it takes for vehicles to cross the main streets;
- no congestion in parking spaces;
- bicycle maintenance is more economical than a vehicle;
- bicycle infrastructure provides an additional incentive for development of related industries aimed at active recreation of the city residents;
- high mobility of this type of transport

The second type of activity is running.

On the map of activity this type of activity of citizens is the second in demand. Running has a significant disadvantage compared to other types of activity - it is fatigue and inability to travel long distances. Thus, running has a purely recreational and entertaining character. There are few areas with running activity on the map. Most of them are located in residential areas with convenient infrastructure for running, in parks and groves, as well as on the embankment of the river Tura.
The third type of activity is winter sports.

This type of movement implies the presence of a certain prepared area for active rest of the city residents. The places where people congregate in winter on the map of the activity are observed only in parks and recreation centers, as well as in stadiums specially designated for this type of sport.
Thus, by results of consideration of three most actual kinds of movement and ac-tive rest of citizens, it is possible to draw a conclusion that the bicycle has a num-ber of advantages over other types of activity in spite of the fact that it also has a lack in difficult use of bicycle transport in a winter season.

Due to the focus of the Tyumen City Administration and the development of a pedestrian zone project in the historical center of Tyumen, we will consider the option of placing a bicycle path near Dzerzhinsky Street. At the moment there is a two-lane road on the street, which serves the residents of the city to move around the historical center. But there are more and more suggestions to make the street a pedestrian zone.

The street is characterized by a large number of monuments of wooden architecture, decorated with unique carvings. The number of buildings with the status of architectural monuments is 32 units. The street has a length from the main street of the city - Herzen street to the bridge Chelyuskintsev.

Particular attention in the street reconstruction is proposed to landscaping, as previously until 1926 this street was called the Garden and was famous for its centuries-old gardens. We propose to supplement the project by creating a bike path on the section of Dzerzhinsky Street, which will be harmoniously intertwined with colorful and multifaced lines of sidewalks, as well as with recreation areas and fountains.

A pedestrian street in the city will open up new opportunities for tourism development, economic growth and improvement of the quality of daily life of citizens by creating stable pedestrian traffic. Any dead-end or randomly created street is doomed to failure and local importance for the residents. And the network of spaces for pedestrians is more conducive to the movement of people on foot. In addition, it will increase the interest of citizens in history.

According to the concept of the proposed project, the following areas are distinguished:
- a public business zone with a youth theatre, which includes an open area for walking and recreation;
- pedestrian zone - a street closed to traffic and adapted for pedestrian traffic, which includes a garden boulevard, an alley of merchants, a zone of cafes, platforms and places for short-term rest;
- a courtyard area - areas by the street with thematic areas: the city of craftsmen, a merchant's yard, a courtyard with a café and a playground.

The analysis of the structure of the central part of Tyumen city shows that there is a lack of greenery in it. The scheme of planting greenery in the territory of Tyumen is shown in the picture.

![Figure 6. Scheme of planting greenery in the central part of Tyumen city.](image)
The theme of the diversity of street space in the city is relevant and increasingly appears in the works of young scholars. For example, in their work "The modern approach to design of street space" authors Evgenia Prelovskaya and Alexey Levashev offer so-called "street classes", which are various landscaped and green parks and squares.

The developed network of footpaths will allow to improve comfort of movement which is necessary both to people with the limited possibilities, and elderly people. The issue of urban comfort for older people is not new. So the authors of the article "Walking for the elderly? A Study of Walking Opportunities and Barriers in a Large Suburban Municipality in Canada" explores the relationship between the environment and walking for a small group of older people. Substantive interviews using a photo-voice approach have shown that a city's high-quality and safe infrastructure can promote physical activity among older people.

The scheme of planting greenery in the central part of Tyumen indicates the main green areas of the city center: Tsvetnoy Boulevard, Central Square and the embankment of the river Tura. A pedestrian zone along Dzerzhinsky Street can form a single green route with these areas, and within this route a system of bicycle paths can be organized.

4 Conclusions
Summing up the above, we can say that many citizens do not choose comfortable slow motion from home to work place by private car, but active and fast movement by bicycle. Running, in turn, has a persistent disadvantage - the inability to travel long distances, and winter sports people are engaged in seasonal and specially designated facilities.

The city authorities are aimed at considering and implementing the most suitable projects for the city on the social and cultural development of the city, as well as on the introduction of a continuous network of comfortable bicycle paths in the city. This synergy: the desire of residents for active rest and the desire of municipal authorities to make the city more active will lead to a positive result.

References
[1] Filimonova L A, Skrigalovskaya Y G and Devyatkin Y A 2019 To issue of territory renovation
[2] Office of the Federal State Statistics Service for the Tyumen Region, the Khanty-Mansiysk Autonomous Okrug-Ugra and the Yamalo-Nenets Autonomous Okrug, https://tumstat.gks.ru/ (last accessed 2020/03/14)
[3] Filimonova L A and Skvortsova N K 2017 On Issue of Algorithm Forming for Assessing Investment Attractiveness of Region Through Its Technospheric Security Clause 3.1.16.
[4] Corazza Maria Vittoria, Di Maseio Paola and Moretti Laura 2016 Managing sidewalk pavement maintenance: A case study to increase pedestrian safety Journal of Traffic and Transportation Engineering 3(3) pp 203-214 DOI: 10.1016/j.jtte.2016.04.001
[5] Nawrath Maximilian, Kowarik Ingo, Fisher Leonie K 2019 The influence of green streets on cycling behavior in European cities Landscape and Urban Planning 190 103598 DOI: 10.1016/j.landurbplan.2019.103598
[6] Romanova A I, Romanov D S, Maksimchuk O V and Voronin A V Basic Principles of Innovation Management in the Urban Economy of Smart-City International Journal of Engineering and Technology 7(4) pp 412-415 DOI: 10.14419/ijet.v7i4.38.24593
[7] Berval A V, Romanova A I, Dobroserdova The use of «smart» technologies in the field of municipal services E A and Elokhova T A 2017 International Journal of Engineering and Technology 14(7) 23
[8] Kozikova A A 2016 Bicycle culture in large cities of Russia and abroad Young scientist 29 pp 93-95
[9] Naruta Ya S, Ovchinnikov V S 2016 Historical aspects of the development of bicycle tourism International Student Scientific Herald 6 98
[10] Muzafárov A A 2010 Comfortability of living in the city Economy of the region, Kazan 257
[11] Evseeva A I 2017 Monitoring bicycle traffic in a city Public Administration 64 pp 82-108
[12] On approval of the program for the comprehensive development of the transport infrastructure of the city of Tyumen for the period 2018–2040, http://docs.cntd.ru/document/550135337 (last accessed 2020/03/14)
[13] Global activity map in Tyumen, https://www.strava.com/heatmap#7.00/-120.90000/38.36000/hot/all (last accessed 2020/03/09)
[14] Korostyleva N V, Nesterenko E V 2016 The development of bicycle infrastructure in cities as a way to reduce the negative impact of transport infrastructure on the urban environment Bulletin of the Volgograd State University of Architecture and Civil Engineering. Series: Construction and Architecture 45(64) pp 146-157
[15] Department of Road Infrastructure and Transport, http://www.tyumen-city.ru/vlast/administration/departaments/education/ (last accessed 2020/02/16)
[16] Borovsky O N 2017 The development of bicycle infrastructure as a solution to the transport and environmental problems of the modern city Russian Entrepreneurship 15 pp 2267-68
[17] Raktim Mitra, Herthana Siva and Mark Kehler 2015 Walk-friendly suburbs for older adults: Exploring the enablers and barriers to walking in a large suburban municipality in Canada. Journal of aging studies
[18] Shelmakov P S. and Shelmakov S V 2012 The development of cycling in the Russian Federation Successes of modern natural sciences 6 pp 183-184
[19] Matveev V V 2012 The role of the state in the formation of mechanisms for the development of infrastructure areas of economic activity Economic Sciences 1 pp 266-271
[20] Bezuglaya E V 2013 The value of social infrastructure for the socio-economic development of the region Young scientist 10 pp 272-274