Mediterranean city: constructing a social attractor (the example of Barcelona)

I A Chikharev¹, I N Tikunova² and E A Fedorova²

¹ Department of Management of Science-Intensive Sectoral and Regional Projects, National Research Nuclear University MEPhI, Moscow, Russia
² Faculty of Geography, Moscow State University named after M.V. Lomonosov, Moscow, Russia

E-mail: ichikharev@yandex.ru

Abstract. The paper analyzes the experience of Barcelona in constructing a city as a social attractor, an area to which the global socio-economic system gravitates. The role of positive changes in the urban environment, the introduction of intelligent technologies of urban management, linking the city with global flows in ensuring the attractiveness of the Mediterranean city are consistently analyzed. The authors define the fundamental structure of the Mediterranean urban attractor, including openness and accessibility of the sea, internal and external transport accessibility, comfortable urban environment, introduction of smart city technologies and connectivity with the global economy.

Key words: Barcelona, Mediterranean, urban environment, smart city, appeal of the city, attractor.

1. Rationale

The Mediterranean has attracted people for thousands of years. During its rich history, the Mediterranean has been a part of many civilizations and empires. This was facilitated by the unique geographical position of the region at the junction of three parts of the world: the Mediterranean Sea served as an intermediary between Europe, the Middle East and Africa, and Mediterranean cities acted as the nuclei of the formation of the European and later world economies. To this day, Mediterranean cities play a significant role in the political and economic life of the world community, possessing enormous potential and strategic importance.

The rationale of the study of the leading Mediterranean cities arises from the fact that today the Mediterranean is again actively involved in new global communications; mainly due to Russia's return to the region after the reunification of Crimea and Sevastopol [1], as well as the deployment of China's transcontinental project "the Belt and Road Initiative" [2].

The study of the leading Mediterranean cities is important from the point of view of the tasks for establishing transnational relations between Russia and the macroregion; not only at the state level, where political restrictions are in effect, but at the level of municipalities and regions, many of which tend to acquire greater independence from national governments.
At the level of the urban environment, the experience of the leading Mediterranean cities is important for use in post-conflict reconstruction and development of Syrian, Libyan and post-Ukrainian Crimean cities.

2. Research progress and status
Mediterranean cities became the subject of large-scale historical research primarily in the works of F. Braudel, who assigned cities a leading role in the development of the "world-economy" [3] and made an attempt to classify Mediterranean cities [4]. To date, the study of a Mediterranean city has developed as an independent area of research in urban studies and urban planning [5, 6]. Special attention is paid to the problem of the sprawl of Mediterranean cities [7]. At the same time, their systematic study is rarely carried out, attention is paid only to certain aspects of urban development (environmental, technological, tourism).

3. Methodology
In this paper, for the study of a Mediterranean city, the methodology for studying complex open systems (synergetics) is applied, namely the concept of an attractor as a certain area to which all possible trajectories of the system are attracted (converge). It can be assumed that the global system thus gravitates towards the Mediterranean, namely, towards Mediterranean cities as attractors of economic, human and information flows. The geo-economic appeal of the region is evidenced by the development of the New Silk Road project, which will connect the largest regional center of the economy (South and East Asia) and the Mediterranean as a gateway to the global economy. In terms of human flows, the top 50 most visited cities in the world include 5 Mediterranean cities (Rome, Istanbul, Antalya, Barcelona and Venice). At the same time, Istanbul, Antalya and Barcelona acquired this status only in the last two decades. Thus, it is possible to talk about the social construction of the attractor. Based on the Barcelona development case study, we will try to summarize the main elements of this construction.

4. Research results
Barcelona is the capital of the autonomous region of Catalonia and the province of Barcelona. In 2018, the population of Barcelona was about 1.6 million, with an overall trend towards an increase in the number of inhabitants. Barcelona is a major container port on the Mediterranean, ranking 44th in the world in terms of the capacity of shipped cargo (3.42 TEU). Barcelona has a developed industry (although it accounts for about 6% of the GDP). The city has automobile factories SEAT and NISSAN, chemical and textile enterprises. Barcelona is a major tourist destination with a rich cultural heritage and favorable climatic conditions. It is one of the five most visited cities in Europe. In addition, Barcelona is actively developing as a commercial, financial and technological center of Spain. Companies such as Amazon, Facebook and Schibsted have opened their headquarters in Barcelona. GDP of Barcelona in 2018 amounted to 81.2 billion euros. Barcelona hosts major international exhibitions (Mobile World Congress, Smart City Expo World Congress, IoT Solutions World Congress, etc.). The political significance of the city in the region is evidenced by the fact that the headquarters of the Union for the Mediterranean is located in Barcelona.

In the annual CIMI (Citi in Motion Index) ranking, compiled annually by IESE Business School, University of Navarra, Barcelona is ranked 28th in the world with the second position in Spain with 72.25 (the nearest Spanish cities in the ranking: Madrid - 24th and Valencia - 61st). CIMI is calculated to assess the effectiveness of urban governance and includes an assessment of nine parameters of a city: human capital, social stratification, economic development, urban governance efficiency, environmental condition, transport network development, urban planning, international recognition and technology adoption. Barcelona scores particularly well in urban governance, urban planning, international recognition, transport network development and technology adoption. According to the tenth edition of the Innovation Cities Index 2016/2017 from the Australian analytical agency "2thinknow", Barcelona was ranked 13th in the...
ranking of the best cities in the world and 5th in Europe in terms of innovation among 500 cities in the world. Barcelona has improved its position by fourteen places since 2015/16. The agency drew particular attention to the fact that of the six cities that took the leading positions in the ranking, Barcelona did it faster, from 56th in 2014 to 13th in 2017.

A set of indicators of the socio-economic position of Barcelona and their positive dynamics makes it possible to identify a number of factors favorable for the development of the city as a social attractor:
1. Favorable economic and geographical position on the coast of a strategically important marine object;
2. Favorable climatic conditions;
3. High quality of life in the city;
4. Active urban policy;
5. Willingness of big business to invest in the development of the urban environment;
6. Promotion of the international brand of the city;
7. Introduction of innovative technologies into the urban environment;
8. Use of tourist potential (cultural and educational tourism in winter, recreational tourism in summer, as well as business, sports, scientific and cruise tourism all year round).

We examine the main factors influencing the attractiveness of Barcelona for living. First is climate. Barcelona is located in the most comfortable climatic zones for human life: the subtropical Mediterranean zone. The average temperature of the coldest month (January) is about 10°C, the average temperature of the warmest month (July) is about 25°C. A comfortable temperature in winter and a small annual temperature range (about 15°C) allows the body to avoid stress caused by the need to adapt to the constantly changing temperature regime.

Another important indicator of climate that affects health is atmospheric pressure. A sharp change in atmospheric pressure entails an increase in the number of hypertensive crises and a deterioration in the health of patients with atherosclerosis. It is believed that a daily pressure change in no more than 800 Pa can insignificantly affect the well-being of weather-sensitive people, and a change in up to 400 Pa is the most favorable. The daily change in atmospheric pressure in Barcelona with a probability of less than 10% lies in the range of 800 Pa or more, which makes the city favorable for the life of weather-sensitive segments of the population [5].
In addition, the proximity of the sea is a positive factor for people with chronic lung diseases, as the air keeps the humidity throughout the year and contains iodine.

Secondly, the attractiveness of the city is ensured by a positive transformation of the urban environment. Barcelona is a port city that has been connected with sea and maritime activities throughout history. Because of this, already in the 19th century the coastline of Barcelona had lost its natural appearance as the entire coastal area was built up with industrial facilities, warehouses and berths. In fact, the urban environment of Barcelona was cut off from the sea. Ideas for improving the appearance of the city began to appear already in the 1980s, but the city did not have enough funds for their implementation. The turning point was the decision to host the XXV Summer Olympic Games in Barcelona in 1992 and the related funding. In preparation for the Olympics, the coastal line was cleared; beaches, walking routes, circuit roads, the Olympic Village and the Lewis Companys stadium on the Montjuïc hill were built. In addition to the visible positive changes in the city, the reconstruction of the coastal area has allowed many architects to find work. Thus, citizens of Barcelona and tourists have got free access to the sea and recreational resources. This reconstruction can be called the starting point for a large-scale transformation of the urban environment in Barcelona.

Another significant project in Barcelona is the 22 @Barcelona Innovation District, created in Barcelona to deepen cooperation among local business, international business and government. This synergy is designed to accelerate the innovation process in the city. The old area of Poblenou (200 hectares), located in close proximity to the city center, was selected for the project. The project was developed in 2000, and by 2010, 7000 companies, enterprises and shops were located in the innovation area, 114,000 square meters of green spaces were planted. Thanks to the creation of the innovation district, the number of jobs in science-intensive industries (ICT, biomedicine, energy, design, media) has increased and the city's housing stock has expanded. The close location of innovative science-intensive clusters has simplified their interaction and increased their efficiency. The number of residents of the district by 2010 increased by 23%.

Fig. 2. The 22 @Barcelona Innovation District
Fig. 3. Old and new buildings in the 22 @Barcelona Innovation District

The 22 @Barcelona Innovation District is not only an office center, but also a modern public space. Renowned architects were invited to create a comfortable and innovative look for the area along the restored Avinguda Diagonal Boulevard. For example, the Media ITC building, designed by Enrique Roulet-Geli (Cloud9 Architectural Bureau). The facade of the building is made of polytetrafluoroethylene (ETFE), which protects from the active action of sunlight, while allowing light to pass through. The building is equipped with photovoltaic cells and a rainwater recycling system, which can reduce the carbon dioxide emissions from its use by 95 percent. Iconic public spaces such as the Diagonal Mar Park and Poblenou Central Park were also built.

Fig. 4. The Media ITC Building

A successful example of urban planning policy can be the project for the reconstruction of the area of Cerda Square (1996-2000). Prior to the reconstruction, the Ronda del Mig highway ran through the middle of the city, which caused environmental problems in the area (high level of noise and air pollution). According to the project, the reconstruction was carried out, including the transfer of the highway to the underground and the creation of a public space (length 2.2 km) on the surface instead of it.
Among the most large-scale projects can also be called the construction of the new intermodal station La Sagrera, which began in 1994 and is not completed to this day. The station is planned to be a connecting hub between high-speed trains, suburban trains and regional trains. The estimated capacity is 100 million passengers per year. In addition to railway transport, a bus station, car parking and a subway will be located in the station area. La Sagrera will play an important role in the infrastructure of two districts: Sant Martí and Sant Andreu, which are separated by railways. The connection between the districts will be possible due to the construction of the underground complex (except for the station building and two levels of platforms) and improvement of the ground area. The planned area of the underground system is 38 hectares, the planned area of the ground public space is 44 hectares, the planned area of new facilities is 20 hectares.
The Sants district reorganization project (2004-2010) is also worth mentioning. The aim of the project was to improve the infrastructure near the railway tracks and reduce the noise level from the railway transport. To implement the project, a 700 m long concrete structure was built over the railway tracks, which is currently landscaped and used for walking. There are steps, elevators and escalators on both sides of the structure, thus connecting the two parts of the city, previously separated by railways.

Fig. 7. The construction process of aboveground concrete structure in the Sants district

Fig. 8. Reconstructed district of Sants

Mention should be made of such large projects as the project for the transformation of the Llobregat river delta (expansion of the port and airport, construction of new railways and road access to them, diversion of the river, construction of treatment facilities), the project for the transformation of the mouth of the Besos river (creation of a park on the seashore, construction of public spaces), the project for the
construction of an artificial reef park to restore the biodiversity of the seabed of the coast. Also, the city is undergoing systematic greening of streets, an increase in pedestrian zones and the transformation of coastal areas.

Thirdly, the Barcelona’s attractor "works" thanks to the active implementation of smart city technologies. "Smart city" is the concept of integrating multiple information and communication technologies (ICT) and the Internet of Things (IoT) into urban systems in order to improve the quality of citizens’ life and solve urban problems. Smart technologies are used to tackle problems such as road traffic, crime, water and air pollution, waste recycling, power generation, and more.

In 2011, Barcelona adopted a new urban strategy "Barcelona, City of People", aimed at introducing innovative technologies into the urban environment to improve the efficiency of urban management, stimulate economic growth and improve the well-being of citizens. The main goal of the adopted strategy was to consolidate the city's resources and direct them to increase the efficiency of the urban environment. The strategy is divided into 22 programs covering all areas of urban management. The main role in achieving this goal was played by the creation of a telecommunication network and the city platform CityOS for collecting and accumulating relevant information (air quality, temperature, noise level, road traffic, energy efficiency, etc.), which can be used jointly in management issues, and also for predicting and preventing emergencies. The City OS was developed with financial support from the European Regional Development Fund for Catalonia under the Cataluña ERDF 2014-20 OP program aimed at accelerating economic growth in Catalonia and Europe, as well as developing a green economy. The Barcelona City Council has partnered with US-based technology company CISCO and other technology partners to create open source Sentilo software using data from the Spanish Libelium's Wasp mote sensors. Wasp motes sensors collect information and transmit it to the Sentilo platform via ZigBee and 802.15.4 at 868 MHz and 900 MHz, as well as Wi-Fi, BLE and 3G / GPRS. It's worth noting that since Sentilo software is open source, it can be adopted by any city or business.

Based on this technology, i.e. with the help of data aggregated from sensors, the city government was able to optimize water consumption in public areas, improve the operation of public transport by providing information on roads in real time, create a smart parking system that shows the availability of free spaces, etc. In January 2014, the Barcelona Deputy Mayor Anthony Vives, making a speech at the International Consumer Electronics Show (CES), stated that Barcelona saves $58 million annually through water management technology, and the parking management system brings the city $50 million. Vives also noted that 47,000 new jobs have been created in Barcelona thanks to the "Smart City" program.

In addition to developing a smart city platform, a number of other innovative technologies have been introduced in Barcelona. Street lights throughout the city were replaced by LEDs equipped with sensor technology, which made it possible to control them remotely and adjust their brightness. The brightness of the lights changes depending on the time of day and weather conditions (humidity, temperature, air pollution level). Also, these lights are Wi-Fi access points, which increase the performance of the mobile network. Barcelona has been equipped with an intelligent waste disposal system that with the help of vacuum sucks waste into underground storage facilities. This allowed the government to monitor the level of waste in different parts of the city and optimize its collection. It also reduced noise, odor and logistic problems associated with garbage trucks. The collected waste is used to generate energy for the heating system.

In 2014, Barcelona was officially recognized as a smart city by the European Commission and received the first European Capital of Innovation award for "introducing the use of new technologies to bring the city closer to citizens".

After the success of the smart city strategy, Barcelona did not stop in its development, but, on the contrary, launched a more active smart city policy aimed at improving the quality of life of its citizens. Barcelona's Technological Development Plan ensures that the city has the necessary technological
infrastructure for its effective management. Technology is designed to meet the needs of all citizens and address the problems of housing, unemployment, social inequality, health care, electricity and mobility. The goal is the open management of technology and digital information.

Some new projects:
1. C-ITS app. The free app is for car drivers, motorcyclists and cyclists to improve road safety. During the trip, the application notifies about road conditions, changes in speed limits, road signs, parking opportunities. The app syncs with popular navigation apps (like Google Maps). The app currently supports 45 km of roads in the city.
2. Program to reduce the gap in Internet accessibility between city districts. For these purposes, the city government works on improvement of the infrastructure and even conducts educational seminars in the most disadvantaged districts.
3. Superblocks. Groups of streets where a pedestrian has a priority right and the vehicle speed is limited to 10 km/h. The streets are equipped with benches, picnic tables, ping-pong tables, bike racks, etc. The goal of superblocks is to reduce air pollution, noise pollution and increase green spaces.
4. Emission-free bus route based on Irizar and Solaris buses.
5. Automated trains in the metro (without drivers)
6. NaviLens system in metro and ground transport, created for visually impaired people. Information from special signs is scanned through a mobile application and reproduced on a smartphone. In 2019, the system was on 50% of all city routes, in 2020 it is planned to cover 100% of routes.

![Superblock](Fig. 9. Superblock)

5. Conclusions and discussion
Barcelona is truly a vibrant city on a global scale, with a policy of introducing innovations to the urban environment and transforming urban landscapes. This is evidenced by more than a dozen completed projects for the reconstruction of depressed districts of the city, carried out over the past 30 years, as well as the successful implementation of smart city technologies, which have already brought the city significant economic benefits and awards in international competitions. The Barcelona government focuses on increasing the influence of the population on the processes taking place in the city through the use of a smart platform. For doing this, the city government is actively working on digitalization of all segments of the population, including the socially vulnerable ones. A number of commercial and state enterprises and institutions provide assistance in the implementation of projects to improve the urban environment, as well as funding comes from the European Union as part of the EU development strategy. However, not the least role in the formation of the attractiveness of the city for life is played by its extremely favorable geographical position on the shores of the Mediterranean Sea in favorable climatic conditions.
Thus, the basic structure of an urban Mediterranean attractor includes the following elements (which are combined with the "classic attractors": cultural environment and sports):

1. Open, accessible and comfortable sea coast.
2. Transport accessibility, both external and intracity.
3. Inclusion in global information and economic processes.
4. Intelligent, high-tech and green urban environment.

6. References

[1] Nechaev V D, Chikharev I A, Irkhin A A and Makovskaya D V , 2019 Framework of the geostrategic atlas of the greater mediterranean Vestnik Moskovskogo Universiteta, Seriya 5: Geografiya, 2019(1), pp 67-74

[2] Stoletov, O V, Chikharev I A, Moskalenko O A and Makovskaya D V 2019 Geoinformation support of the Mediterranean branch of the Silk Road InterCarto, InterGIS 25 pp 102-113

[3] Braudel F 1992 Time of the World (Moscow)

[4] Braudel F 2002 The Mediterranean and the Mediterranean World in the Time of Philip II (Moscow)

[5] Leontidou L. 2002 The Mediterranean City in Transition: Social Change and Urban Development (Cambridge)

[6] Leontidou L 2019 The Wiley Blackwell Encyclopedia of Urban and Regional Studies (Blackwell)

[7] Catalan B, Sauri B and Sierra P 30 April 2008 Urban sprawl in the Mediterranean: Patterns of growth and change in the Barcelona Metropolitan Region 1993–2000 Landscape and Urban Planning 85, Issues 3–4 pp 174-184