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Towards the Creation of a Web-based Platform "Bike Sharing" in the Local Transport System

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Abstract. Every day there are more and more new services, which differ significantly from their predecessors in functionality, speed, user interface, in addition, support and updating of old services. All this determines the relevance of the implementation of the web-based national platform "Bike sharing" and is a reason to pay special attention to the possibility of creating a city cycling system and its mobile support by creating a mobile application. The aim of the study is to form a conceptual approach for creating a Web-based platform "Bike sharing" to meet the diverse transport needs of cities and their users based on the formalization of the components of business processes. The tasks of the work are: analysis of foreign experience of city bicycle rental; identifying the advantages and disadvantages of existing bicycle rental systems; description and research of business processes based on existing systems. The article presents the concept of renting city bicycles based on foreign experience in the operation of transport infrastructure, the stability of the technology platform, optimization of bicycle distribution). During the research, IDEF0 notation diagrams show business processes of city bicycle rental systems (activity of bicycle rental service, customer registration, service payment), based on existing services. The effect of such business processes will be characterized by studying an array of security documents of different countries and open sources of scientific and technical information in order to identify among them a description of a technical solution similar to the studied, which will be the basis of promising.

Keywords: Bike Sharing, Business Processes, Local Transport System, Modeling, Service.

1. General formulation of the problem

The amount of new knowledge in the last century is growing exponentially. To quickly find information and use it correctly, many WEB-services and applications are created, which greatly facilitate the search and sorting of information. Every day there are more and more new services, which differ significantly from their predecessors in functionality, speed, user interface, in addition, support and updating of old services. Currently, the most promising type of economic activity in which IT technologies are introduced is tourism, which cannot be realized without the provision of services in the field of transport rental, including cycling.

There are various services for renting a bike. Such services allow to raise the popularity of cycling, to involve people in an active rhythm of life in order to improve the physical condition of the person as a whole, meet the needs of cyclists. In addition, in most European countries, special bicycle paths, bicycle areas, parking lots have been developed, and special state programs have been introduced to promote this type of transport. All this determines the relevance of the implementation of web-based national platform "Bike sharing".

2. Analysis of recent research and publications

The development of the scientific approach has been influenced by the work of domestic and foreign scientists and practitioners who study and solve problems of transport infrastructure development and ensure its sustainable operation. Among theme are Banister D. [1], Berechman J. [1], Danuta Tarka [2], J. Bicura, S. Bogachova, B. Danilishina, G. Deyli, V. Ivanova, G. Mayer, D. Medous, M. Mesarovich, E. Pestel, O. Shubravska etc. In their works, scientists focus on a systematic approach to the development of transport infrastructure in stimulating the processes of economic growth of the territories of different administrative-territorial divisions of the state. This creates the conditions necessary to ensure the mobility of people, goods and information. This is an important factor influencing the competitiveness of the economy, influencing its openness and innovation. The historical development of public transport is presented in the works Paul J. DeMaio [3]. The author notes that cycling programs for public use have been successfully implemented in European cities since 1995, but in the 21st century Smart Bikes are gaining popularity, which are designed to complement existing transport and encourage greater use of all public transport systems. Factors influencing the choice of general bicycles and electric bicycles are described in detail in scientific work [4]. Much attention was paid to the study of the development of transport enterprises in domestic science during the Soviet period. The study of the problem is complicated by the fact that the works in that period were politicized and ideologized, some lost their economic significance. However, the foundation was laid for the study of new scientific directions of development of transport enterprises of the country. The scientific works of domestic scientists: O. Belarus, I. Burakovsky, A. Kredisov and others are important in regulating the development of domestic transport enterprises. Various methods of assessing efficiency in the form of increasing the competitiveness of the territory, increasing labor productivity, improving the environmental situation and in the whole development of human capital and improving the quality of life play a significant role in improving the work of a smart city and business entities. Domestic scientists are working on the analysis of existing information and analytical solutions for smart cities with various methods of assessing efficiency. So, in the work [5] presented a complex information-analytical solution for improving the efficiency of energy management in municipalities. In [6], the methodology of the primary analysis of the given data is given and the function of the future value. In [7], the criteria for maximum efficiency are presented for the systems of burning business. In [8], an adaptation of the methodology of key indicators of efficiency to the assessment of the efficiency of functioning of systems for ensuring thermal comfort in Budivly is presented. In [9-11], the principle of assessing the efficiency of the implementation of solutions for the heat-modernization of the budget using the well-developed discounted method is presented. In [12], the authorization of the discounted method of estimation of the supply of autonomous energy supply systems is given. In [13], information warehouses have been introduced for the

introduction of energy-saving entry into the business. In [14], the formalization and definition of the optimization criterion in the energy system is given. In [15], a study of modern opportunities for the information use technologies, namely the adaptation of accounting and analytical support in the context of the spread of socio-economic values to improve the well-being of the population. In the works of the authors [16-18] it is determined that active implementation of innovative technologies will give new opportunities, that will open approaches for business-environment to save labor productivity and suitable level of profitability from entrepreneurship. Innovative economy changes traditional approaches to labor organization, as well as social and labor relations, that promotes development of perquisites to overcoming the decreasing of economic indicators, continuous production process at the enterprises, solves the issues of unemployment and labor migration, creates new flexible forms of employment, increases level of state`s competitiveness in conditions of economic globalization.

3. Selection of previously unsolved parts of the overall problem

Market principles of management, the changing economic situation and the imperfect regulatory framework have necessitated the appropriate adaptation of the transport system. In addition, the imbalance in the transport services market and the current pandemic have intensified competition among commercial carriers. There is a mismatch between the volume and quality of supply of transport services to effective demand. As a result, the functioning of the country's transport system is characterized by unsustainable development. Based on this, there is a need to know the depth of the processes and phenomena that occur, and the introduction of new transport systems that will be safe in today's conditions and have a positive impact on the physical condition of man. In this regard, it is necessary to offer the use of a bicycle for daily movements, which is especially advantageous for short distances. According to research conducted in the European Union, the average distance of most traffic in cities does not exceed a few kilometers. In the European Union, half of car journeys are in the 5 to 14 km range. At such distances - given traffic congestion - a bicycle can be faster than a car and public transport. They began to popularize, taking into account the numerous problems associated with their functioning in cities and the emergence of congestion and air pollution.

The use of bicycles is an important element of transport infrastructure in cities, in which the development of this mode of movement is simultaneously perceived as a kind of "cycling revolution". Instead of buying a bicycle, the user of such a system buys the right to use it according to his own needs, so he does not need to service the bicycle, he does not need to worry about its storage or parking. The user can choose different bikes in one day to meet their transportation needs. Therefore, an important task to be solved in this matter is the proper integration of the bicycle system into the urban space. This task should be taken into account at the planning stage of assumptions about the overall strategy of transport in cities, and their proper preparation is the responsibility of local authorities, which are responsible for developing communication policy in these areas. The most important of the identified benefits can be seen in the following aspects [19, 20]: security: constant monitoring of rent, robust construction, regular maintenance, bicycle patrols, dual security system; branding: responding to social demand, promoting a healthy lifestyle, integrating residents, developing trade and

services; efficiency: supplementation of public transport, simplification of planning of city transport services, calmer traffic in the central districts of the city, integration with the tariff of city tickets; ecology: less noise and CO2 emissions, reduction of infrastructure consumption, promotion of green areas; ease of use: easy parking in the area of the bicycle station, the impact on reducing congestion in public transport, the ability to reach even hard-to-reach places by bike; functionality: the first 15-20 minutes of free driving, the first hour cheaper than a ticket for public transport, the fare favorable to the resident, the possibility of using dedicated cards, such as active cards of employees in the field of sports and recreation (eg MultiSport card).

The main problems associated with urban bicycle systems relate to the following elements [21]: changing the mentality and habits of residents, providing conditions for flexible and easy installation of the system, monitoring with the ability to track bicycles in real time, the ability to use the latest mobile solutions (smartphones), programs, NFC technology), technology platform stability, bicycle distribution optimization.

There are currently more than 140 bicycle rental systems in more than 165 countries [22], for example: Amsterdam - Macbike Vondelpark, Barcelona - El Biking, Berlin - Bicycle on Call and Nextbike, Budapest - Bubi, Dublin - Coca Cola Zero Dublinbikes, London - Bicycle rental Barclays, Milan - BikeMi, Paris - big, more than 20 thousand. bicycles, at more than 1800 stations and stops, Stockholm - Stockholm bicycles, Vienna - Citybike Wien, Netherlands, Belgium - Villo, Moscow - Velobike Moscow, Washington - SmartBike, USA (B-cycle), Mexico - EcoBici, China: Wuhan and Hangzhou, where 60,000 bicycles are available for rent.

Therefore, a bicycle can in some situations replace travel by car and public transport. This was the reason to pay special attention to the possibility of creating a city bicycle system and its mobile support by creating a mobile application.

4. Statement of research tasks

The aim of the study is to form a conceptual approach to create a Web-based platform "Bike sharing" to meet the diverse transport needs of cities and their users based on the formalization of the components of business processes.

The task of the work are:

– analysis of foreign experience of city bicycle rental;
– identifying the advantages and disadvantages of existing bicycle rental systems;
– description and research of business processes based on existing systems.

5. Material and research results

Bicycle rental is carried out using a web-based platform "Bike sharing", the essence of which is that for convenient bicycle rental, special rental points have been developed, where everyone has the opportunity to rent a bike. Such systems are called bike sharing.

Bicycle sharing system, which has also been called a way to solve the rental problem, which allows you to rent a bike at one of the automated stations, and after the trip to return the bike to any rental point installed in the same city [23, 24]. The main goals of the bicycle sharing system are, first of all, the development of bicycle infrastructure and the creation of conditions for increasing the number of cyclists by building bicycle infrastructure within the framework of the target program of reforming and developing the city's housing and communal services; promoting the development of small and medium-sized businesses with a focus on

cycling; improving the ecological condition and developing the tourist attractiveness of the city; popularization and encouragement of city citizens to an active and healthy lifestyle. Such systems exist in most major European and North American cities. Their purpose is to provide residents, as well as guests (tourists) of the city with free or cheap bicycles for short-term short trips. The program is at the national level, which combines a typical rental system with several of the above systems, national rail operators or infrastructure partners of the national cycling organization and others to create a system closely related to public transport. These programs usually allow longer rental times of up to 24 or 48 hours, as well as for tourists and cruises. Some German cities with tracks offer bike rental called Call a Bike.

In China (Guangzhou), Guangzhou's private high-speed public transportation system includes bike lanes and a public bicycle system. In some cases, such as the Santander Cycles in London, the bicycle exchange system belongs to the public transport organization itself. In other cases, such as EnCicla in the city of Medellin (Colombia, South America), the division of the bicycle system is linked to other modes of transport, such as the metro.

In addition, bike-sharing cooperates fruitfully with parking operators. Some parking operators, such as Vinci Park in France, rent bicycles to their customers, who park their cars.

One of the largest bicycle sharing systems is the Velib network in Paris, which has more than 1,200 points (stations) and 20,000 bicycles. This network serves about 100,000 trips daily. The stations are located at a distance of 300 meters from each other. An example of bicycle rental in Ukraine is the Nextbike system (see Fig. 1).

The service menu contains brief information on how to interact with the application, locations where the customer can rent a bike, the price of services and news of this service. After registration, the client has the opportunity to pay a season ticket for bicycle rental. This service provides the following opportunities: the ability to search for stations online and book bicycles; reporting; preservation of the city's ecology and accessibility of bicycles for everyone; control the location of the bike with a GPS tracker mounted on the bike.

Despite the fact that this service has an intuitive interface and a fairly developed system, it has some drawbacks. Important disadvantages of the service are not quite modern interface, lack of online customer consultation, lack of possibility to route to rental points and poor optimization of online service. Therefore, we can conclude that the public bike rental "Nextbike" needs improvement, modernization of the user interface, adding the possibility of online customer consultation through a web service, as well as the ability to route to rental points. In addition, a rather useful feature is the offer of routes for cycling using a web service or mobile application.

The lack of a modern and user-friendly interface is one of the most important reasons for improving the existing system. In addition, no less important reason is the lack of national bike sharing systems and any competition, which in turn leads to higher prices and reduced quality of service.

In each system, you can select individual business processes, which makes the process of modeling business processes one of the most important in the project. Business process modeling (BPM) - a formalized, performed according to certain rules description of the sequence of actions of specialists in the form of logical flowcharts that determine the choice of further action based on the situational fact [24]. The purpose of business process modeling is usually: business documentation of the company; preparation of business processes (which

usually begins with an analysis of the actual situation); preparation and automation of IT support for business systems; determination of process indicators.

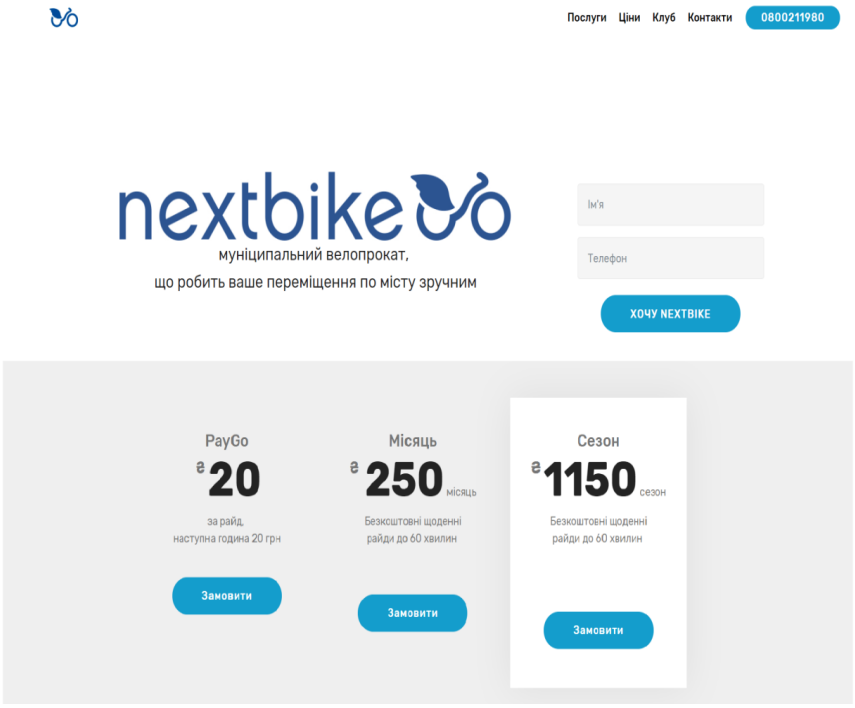

Fig. 1. The main page of «Nextbike»

BPwin was chosen to model the business process. This application allows you to create complex business process models. It supports 3 methodologies IDEF0, IDEF3 and DFD. Each of them is designed to solve its specific tasks. All control signals are displayed in the same way. This model is one of the most progressive models and is used in the organization of business projects and projects based on modeling of all processes, both administrative and organizational. The context diagram of business processes of bicycle rental service in the IDEF0 notation is shown in Fig. 2.

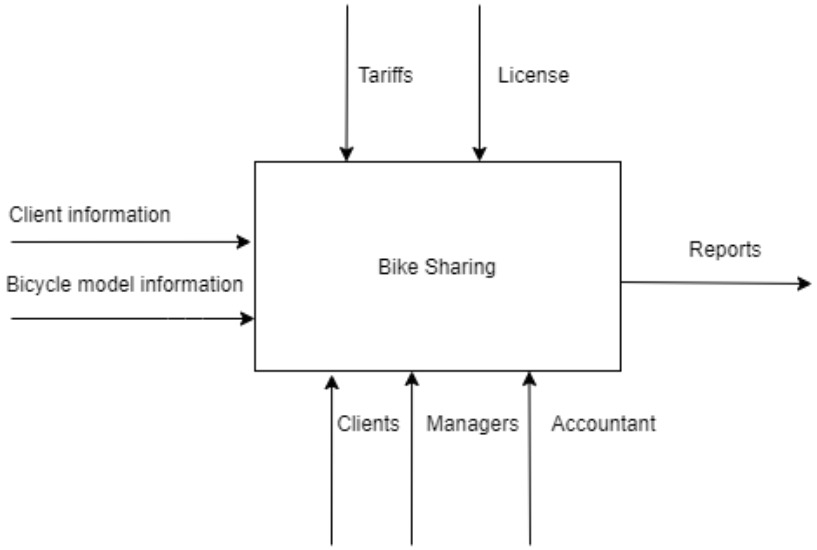

Fig. 2. Context diagram of business processes

This diagram shows the functional unit of bike sharing, namely the rental of a bicycle. The input data of the subsystem are customer data and the bicycle fleet. This data is converted by the functional unit for input production. A specific type of input is control. It is responsible for regulating when and under what circumstances the functional unit is performed. Management in this subsystem are: norms; license. Mechanisms are a resource that directly performs a modeling action. The subsystem that is being developed by the mechanism has the staff of the subsystem. The result of the functional unit is the initial data in the form of rent and report. The following diagram shows in more detail the business process that is being developed (Fig. 3).

The customer who applies for services to the bicycle rental service must provide their data for registration in the service and form their needs in order to choose the required tariff. The next step is to pay the fare and get a unique bike number. In order to confirm the user's intention to rent this bike and unlock it, the customer must scan the barcode on the bike. Based on all the data provided by the client and the actions taken, reporting is formed for the supervisory authorities. In fig. 4 presents a diagram of the second level of the business process "Customer Registration".

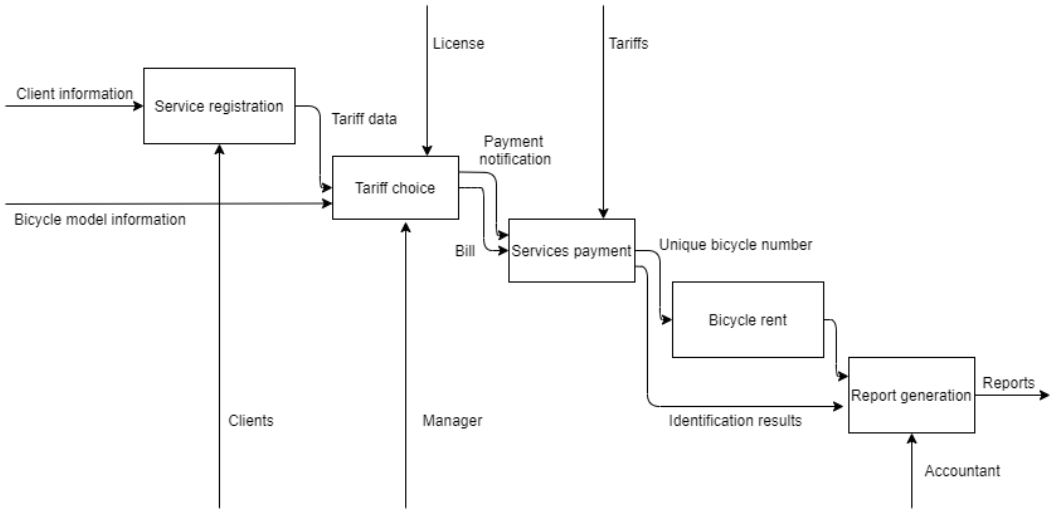

Fig. 3. Diagram of the first level of the business process "Bicycle rental service activities"

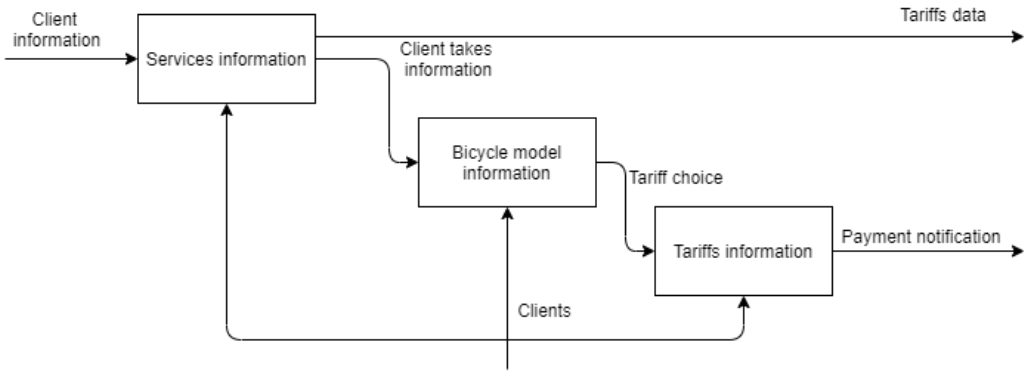

Fig. 4. Second level business process diagram "Customer registration"

To register, the customer must provide the name, contact phone number, e-mail and card details. If the client has already been serviced in the system, he can edit the information in the database, otherwise, the data is entered into the database and a new user is created. In fig. 5 presents a diagram of the second level "Payment for services".

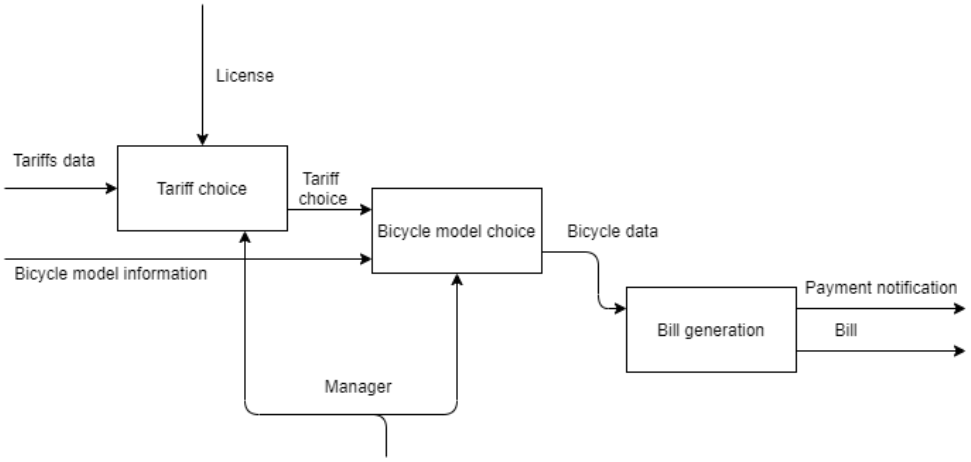

Fig. 5. Diagram of the second level of the business process "Payment for services"

After the client has already registered in the system, the tariff is selected. If the customer has any questions about tariffs, he can contact the manager of the rental station and get a free consultation. The next step is to pay the tariff. After payment, the customer will receive a receipt in the application and a copy to his e-mail, which was specified at the time of registration. After passing the payment stage, the customer begins the identification stage.

After the customer pays the selected tariff, the identification process begins. At this stage, the customer receives a unique bicycle code, which is located at the bike station near the customer. The user must find this bicycle by the number provided and scan the barcode on the bicycle to confirm the bicycle rental. Data Flow Diagram - a design model, a graphical representation of "streams" of data in the information system. The data flow diagram can also be used to visualize data processing processes (structural design). It is considered customary for the developer to first draw a context-level data flow diagram to show how the system interacts with external modules. This diagram is further refined by detailing the processes and data flows in order to show the extensive system being developed [23]. Data flow charts contain four types of graphics:

– processes are the transformation of data within the described system; data warehouses (repositories); external to the system of essence;

– data flows between elements of the three previous types. The context diagram of the bicycle rental service in DFD notation is shown in Fig. 6.

Node.js was chosen as a programming language for the development of the server part of the service, because this language is based on the very popular JavaScript, which provides access to many already integrated libraries that simplify the process of writing code and project support.

A DBMS with sql approach support was used for data storage, as it is planned to store a large amount of structured information. MySQL was chosen for such purposes.

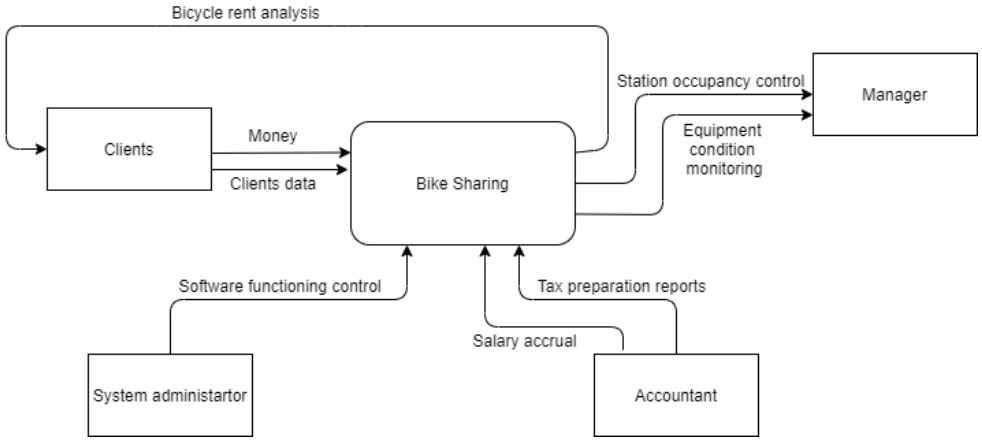

Fig. 6. Context diagram of «Bike Sharing» system

6. Conclusions.

The above research allows us to draw the following conclusions: first, the city bicycle is an increasingly common way to travel in cities, and analyzing the facts about the use of such systems abroad, we can note that such systems are very popular and needed in our society. Such systems allow to save time spent on moving around the city, saving the budget of an individual family, to reduce the load of traffic on the roads of an individual city, to significantly reduce the impact of transport on the environment; secondly, due to the analysis of existing bicycle rental systems, their main advantages and disadvantages were highlighted. The analysis revealed the main business processes of the service, which are presented in the form of IDEF0 notation diagrams, which allows you to illustrate in detail the individual processes. The effect of such business processes will be characterized by studying an array of security documents of different countries and open sources of scientific and technical information in order to identify among them a description of a technical solution similar to the studied, which will be the basis for future research.

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