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BUILDING A CENTRALIZED SMART CITY SYSTEM FOR URBAN MOBILITY MANAGEMENT AND SOLVING PROBLEMS RELATED TO PARKING AREAS, PUBLIC TRANSPORT AND ECO-TRANSPORT PART 3 - SMART CITY INTELLIGENT SYSTEM FOR ENVIRONMENTALLY FRIENDLY TRANSPORT[28]

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Abstract: *The focus of the article is to consider the principles and ideas for building a unified centralized system for urban mobility management and finding intelligent solutions to solve well-known problems in a highly urban environment, building public eco-transport and state-subsidized infrastructure. The basis of this article is the need to create such a centralized system, which consists of many different software applications that communicate with each other via API (Application Programming Interface), collecting data in a central database, performing the necessary computational actions on central servers. , such as fees, tariffs, subscriptions, fines, generation of QR codes for identification or validation, etc.*

Keywords: *Smart City, intelligent parking solutions, public parking lots, blue and green areas, public transport, eco transport, LoraWan network, API and central database, smartphone app, Android, iOS, Centralized system, Web applications, Servers, efficiency , GPS*

INTRODUCTION

For years, the problems with the pollution of the planet, the disturbance of the ecological balance and in particular the ecological problems in the highly urbanized settlements have become more and more painful and critical. There are many environmental organizations around the world, which in one way or another are fighting for the restoration of ecological balance, to reduce environmental pollution, for cleaner air and water (Buehler, R., & Pucher, J. (2017)). Last but not least, the governments of the highly developed countries, which respectively have the most highly urbanized settlements, respectively are the biggest polluters, pay more and more attention to environmental problems and take more and more major measures for a cleaner environment.

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environment and reduction of pollution sources. One of the main sources of pollution, perhaps even the most significant, is modern road transport. In the modern world, we cannot imagine our existence without road transport, whether when we use our personal cars, public transport or freight transport, through which the delivery of each product around the world, which we all use in everyday life, be it food, clothes, equipment, etc. Although the topic of alternative fuels or electrical technologies applicable to the creation of a new generation of environmentally friendly and zero-emission vehicles is becoming increasingly important, they are not yet able to completely replace current Motor Vehicles, which have been using our well-known petroleum fuels and their derivatives for more than a century (Cairns, S., Behrendt, F., Raffo, D., Beaumont, C., & Kiefer, C. (2017)).

Last but not least, in the whole saga of environmental pollution is of course our personal responsibility, our understanding and desire for personal contribution with which we could contribute to reducing the effect of global warming due to transport pollution, which we all one way or another, we are consumers directly or indirectly.

THESIS

Therefore, in many countries, including ours, the construction of appropriate infrastructure for alternative modes of transport in urban environments is encouraged, using environmentally friendly zero-emission vehicles for personal use, such as bicycles and all variants of the increasingly popular electric scooters (Cherry, C., Weinert, J., & Xinmiao, Y. (2009)). Subsidies from the state should not only be expressed in the construction of primary infrastructure, such as the construction and maintenance of numerous bike lanes and city parks, but also in the construction of many publicly accessible bicycle stations with which to rent bicycles and electric scooters, at extremely low and affordable prices.

In several cities in Bulgaria there are already similar systems, such as Burgas and Dobrich, which consist of a dozen bike stations located at convenient hubs and a user of the system, who takes a bicycle or electric scooter from one station, can return to each of the others, depending on where it is convenient, moving from point A to point B.

Such a bicycle station basically always consists of its purely mechanical components such as a docking station with a lock for each bicycle, alternatively for electric scooters, in addition to locking the docking station must also be able to charge the battery of each parked scooter. Of course, bicycles and scooters themselves must be equipped with counter-locking mechanisms and respectively for charging. Also, each bicycle or scooter is equipped with a built-in and inaccessible GPS tracker, through which, in case of theft or illegal detention of a bicycle or scooter to be easily traced and detected, the offender will be subject to appropriate sanctions (TRID. (2017)).

The main element of such a system is information and management KIOSK, which as it is clear from its name in addition to giving complete information about the use of the system itself, information about the methods of payment for the service, the availability of bicycles and scooters both at the current station and and all others, as well as other additional information about city landmarks and tourist attractions, etc.

The information and management KIOSK also communicate with all controllers, who in turn manage the executive mechanisms for unlocking / locking, respectively, when taking / returning a bicycle. Through it, through the information touch display, the user chooses which bicycle / scooter to rent from the available ones, he also chooses the method of payment from the available ones through which to pay for the selected service. Also, the information management KIOSK has a continuous communication with a central management server, which collects all the necessary data for the use of services from each bike station, payments by different payment methods, information from GPS coordinates of the location of each bike or scooter. On the basis of all this information collected in the centralized system, the necessary inquiries and reports can be made.

The described such system is very close to the SMART CITY concept and for this reason such a system could be built as part of the overall solution, as a single software system, and it would be relatively easy to integrate an existing such stand-alone rental system. of bicycles for rent, after making the necessary hardware and software changes.

At present, in the existing urban eco-mobility systems, there are the following methods for paying for the service that customers use:

- Payment by SMS - in this method the user sends an SMS to a specific number and in response the system returns a 6-digit code (again via SMS), which the user must enter on the screen of the information KIOSK from which he wants to rent a bike or electric scooter. Upon successful validation of this code by the system, the user is given a screen with a choice of options for taking a bike / scooter from the currently available and he must make his choice, then unlock the selected one and it must be taken from the docking station for a certain time, which is in the range of 30 - 40 seconds. By sending an SMS and returning one from the system with a 6-digit validation code, an amount of BGN 1.00 is added to the user's monthly account through the mobile operator and thus the payment is actually made, and at the end of the reporting periods the respective accumulated amounts mobile operators and respectively through the operator of the SMS Gateway system reach the beneficiary supporting the service for urban eco-mobility, ie. the municipality built a similar system. By paying the amount of BGN 1.00, the user of the service has the right to use the rented bicycle within 1 hour, after which it is necessary to either return it to one of the bike stations of the system or to extend by another 1 hour the use of the service by sending new sms this number. The system takes care to automatically remind the user again by sending automatic SMS minutes before the end of his time for use.

- Payment via Virtual POS - in this payment method the user from the KIOSK screen is directed to a virtual POS terminal from the BORIKA system and there it is necessary to enter their credit / debit card data. After the user follows the necessary steps from the KIOSK screen , enter your data and make a payment through the BORIKA system, it is again forwarded to a screen with a choice of options for taking a bike / scooter from the currently available ones and he must make his choice, then unlock the selected one and it must be taken. from the docking station for a certain time, which is in the range of 30 - 40 seconds.

The system with a virtual POS terminal blocks the amount of BGN 15.00 from the user's card and starts counting the time of using the service for this user. Here again we have a tariff of BGN 1.00 for each starting hour and respectively if the user uses the service for example 3 hours and 47 minutes, it should be charged BGN 4.00. These BGN 4.00 will be deducted from the so-called virtual deposit of BGN 15.00 which is pre-blocked on the user's card and after the user has already returned the bike to the docking station, then the payment will actually be made in the system and the amount for the consumption of the service will be deducted, and the rest of BGN 11.00 will be returned on the card to consumer.

- Another method of taking a bike or scooter is a prepaid subscription with an RFID card. In this method, the user pays outside the system, a subscription with prepaid credits and is issued an RFID card, through which contactless readers of a docking station can unlock and pick up the bike / scooter. Here again, the information KIOSK decides to unlock or not, by communicating with the respective controller of the docking station whose reader the card has been validated and communicating with the central server of the SMART CITY system.

The KIOSK information refers to the central server, where the actual check in the database is performed whether a card is valid and whether it has the right to use the service or not. The central server returns a corresponding confirmation or rejection of a card to the information KIOSK and it in turn unlocks the respective bicycle / scooter.

The innovation that the SMART CITY system can contribute to an existing such system or to the construction of new ones is in addition a method for taking a bicycle / scooter, respectively a method of payment using our personal smartphone and the method of scanning static validating QR codes. from the screen of the information KIOSK, by analogy with the already discussed parking methods in the Blue and Green Zone, as well as the use of the SMART CITY system in public transport as a virtual ticket or a virtual subscription card.

Here again, when renting a bicycle / scooter from a public station for renting ecological personal vehicles, the SMART CITY system finds application precisely as a virtual ticket or a virtual subscription card for using this service.

On the screen of the information KIOSK, in addition to the methods of payment via SMS or through a virtual POS terminal from the BORIKA system, the user must have the option "Get a bike with a QR code". Selecting this option displays a static QR code on the KIOSK information screen, which is unique to each KIOSK in the SMART CITY system. In this QR code we have again coded 3 identifiers that make the QR code unique, namely again we have Account ID - this is the unique identifier of the municipality where the service is performed, Department ID - this is the unique identifier of the department (division) in this case this is ECO transport or in other words the type of service, the third unique identifier is the Station ID or the number of the bicycle station (information KIOSK) from which the service is requested.

The user scans this static QR code through the SMART CITY application, sends a request to the central server that he wants to rent a bike from a specific station in the ECO transport system. The user can associate with MyPOS, his credit / debit card through the SMART CITY application and thus pay directly for prepaid subscription plans or pay for one-time use of the service. Prepaid plans can also be paid at designated locations directly to SMART CITY cashier employees, in which case employees use centralized web-based software to register a subscription payment for a user in the system registered with their smart device. In this case, the user does not need to associate their credit / debit card through the SMART CITY application.

The scenarios for the use of the service by a client / user of the SMART CITY application in the ecological transport system are the following:

1. The client / user of the service has a valid prepaid monthly subscription, for unlimited time and number of uses of the service. He needs to scan the QR code from the screen of the information KIOSK of the station from which he wants to rent a bicycle / scooter, through his smartphone with the pre-installed application SMART CITY. The system compares the parameters obtained during the scanning of the static QR - code with the information in the centralized system for this specific Client / user. Finding that he has a valid prepaid subscription for unlimited time and number of use of the service, he returns a reply to his smartphone with the validity parameters of his current subscription and allows a choice to unlock a bike / scooter of the user's choice. A QR code for verification is generated, which is displayed on the screen of the user's smartphone. This verification QR code can be scanned by control officers with another mobile application in the SMART CITY system, and information on the validity of the current use of the service is returned accordingly.

2. The client / user of the service has a valid prepaid monthly subscription for a limited number / time of use of the service, for example 40 credits (40 hours), and for each started hour when using the service 1 credit is deducted from the prepaid ones. He needs to scan the QR code from the screen of the information KIOSK of the station from which he wants to rent a bicycle / scooter, through his smartphone with the pre-installed application SMART CITY. The system compares the parameters obtained during the scanning of the static QR - code with the information in the centralized system for this specific Client / user. Finding that there is a valid prepaid subscription for limited number / time use of the service, reduces the number of credits by 1, returns a response to his smartphone with the validity parameters of his current subscription and allows the choice to unlock a bike / scooter of your choice. consumer. A QR code for verification is generated, which is displayed on the screen of the user's smartphone. This verification QR code can be scanned by control officers with another mobile application in the SMART CITY system, and information on the validity of the current use of the service is returned accordingly.

3. The client / user of the service does not have a prepaid monthly subscription but has indicated through the application that he wishes to be on a tariff plan with deferred payment. He needs to scan the QR code from the screen of the information KIOSK of the station from which he wants to rent a bicycle / scooter, through his smartphone with the pre-installed application SMART CITY. The system compares the parameters obtained during the scanning of the static QR - code

with the information in the centralized system for this specific Client / user. Finding that for this client in the database is a tariff plan with deferred payment, the system starts a new parking session for him with hourly charge and returns a response to his smartphone with the validity parameters of his current subscription and allows the choice to unlock a bike / scooter of the user's choice. Of course, the system will notify him at each starting hour, via Push Notifications, that the amount for hourly parking according to the tariff plan is added to it. A QR code for verification is generated, which is displayed on the screen of the user's smartphone. This verification QR code can be scanned by control officers with another mobile application in the SMART CITY system, and information on the validity of the current use of the service is returned accordingly.

4. The client / user of the service does not have a prepaid monthly subscription. In this case, you must have a valid credit / debit card associated with the pre-installed SMART CITY application, then scan the QR code from the KIOSK information screen of the station from which you want to rent a bike / scooter via your smartphone. The system compares the parameters obtained during the scanning of the static QR - code with the information in the centralized system for this specific Client / user. Finding that for this client in the database there is a valid TOKEN for payment through the MyPOS system, a micro payment of BGN 1.00 is made, and a response is returned to his smartphone with the payment validity parameters and allows a choice to unlock a bike / scooter of the user's choice. Of course, the system will notify him at each starting hour, via Push Notifications, that the amount for hourly parking according to the tariff plan is added to it. A QR code for verification is generated, which is displayed on the screen of the user's smartphone. This verification QR code can be scanned by control officers with another mobile application in the SMART CITY system, and information on the validity of the current use of the service is returned accordingly.

The decision on which of these scenarios to validate the use of the service by the client / user of the service is made automatically by the system, according to the individual information in the database. The algorithm of action always starts in this order: First, a check is made for the availability of a subscription for unlimited time and number of use of the service. If there is no such, continue checking for prepaid subscription limited in number / time use of the service. If a subscription for prepaid number / time use of the service is not available, but the user has chosen to be on a tariff plan with deferred payment, then the system adds to the total virtual account an amount according to the tariff plan. If there is no subscription for prepaid number / time or option for tariff plan with deferred payment, then the system decides that the user will be charged according to the tariff for hourly use of the service. If a valid Token is available, then the system performs a payment transaction via MyPOS. Upon successful payment, the use of the service is validated and the unlocking of the bicycle / scooter is allowed on the KIOSK screen. In case of unsuccessful payment, a response for unsuccessful validation is returned to the smartphone and unlocking of the bicycle / scooter is not allowed.

So far, we have considered the algorithm of response of the SMART CITY system to the user in terms of payment methods for the service. The user may have chosen to be on a prepaid subscription plan, and in the subscription plans the variations can be very different, for example unlimited in number / time use of the service, as well as a combination of restrictions on these same parameters. Accordingly, the price of the different subscription plans would be different according to the restrictions on the use of the service. The user can pay for a subscription plan at the designated places, in which case the employee of the respective cash register uses the centralized software of the SMART CITY system to reflect the payment of a selected subscription plan for the specific customer already in the system with his smartphone. If the customer has an associated credit / debit card through the SMART CITY application or could from the application itself make a choice of a subscription plan and pay it directly online through the MyPOS system, without the need to visit the cash register. While for subscriptions the customer does not have to associate his credit / debit card with the SMART CITY application, as he can also prepay at the checkout, in case the customer has chosen to use the service without a prepaid subscription, but on a one-time basis,

then the customer or must be on a tariff plan with deferred payment, which again allows him to pay to the cashier the amount charged at the end of the reporting period or must have an associated credit / debit card to make an instant payment at the time of completion of the service. When choosing a tariff with deferred payment, the customer can pay the invoice issued to him at the end of the reporting period and through the SMART CITY application, where a complete history of invoices and payments will be displayed.

CONCLUSION

In the conditions of globalization and more and more intensive migration to the megacities, modern cities face a number of challenges, including: the unbearable energy consumption and the ecological footprint of their inhabitants, the deteriorating quality of atmospheric air and drinking water, and most of all - increasing -the unbearable combination of transport services and urban infrastructure to the growing needs of citizens and businesses. Therefore, the integration of information and communication technologies in the urban environment and public life, better known as "smart cities", is not just another technological trend, but a necessary way to find a sustainable, safe and integrated way to live together in modern conditions. civilization. The efficiency of transport systems and traffic management have always been the most pronounced problems of any modern city. The integration of information and communication technologies in the urban infrastructure (parking lots, roads, traffic lights, public transport, eco transport, etc.) achieves more efficient management of transport systems and infrastructure and better awareness of citizens about what is happening. in their city. The "opening up" of this data to citizens through the creation of publicly available applications with a user-oriented design and the provision of related electronic administrative services are issues on which the legal, standardization or ethical requirements in force in the field of e-government and public sector data.

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