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THE SERVICES DELIVERY ECOSYSTEM FOR USERS OF PUBLIC TRANSPORTATION

ABSTRACT

Current possibilities of wireless technologies for informing users (visually impaired) should be explored and defined according to the models of assistive technologies and e-business systems. The goal of this research is to choose a wireless technology whose characteristics can raise the level of the life quality for target user group, and propose guidelines for the development of informing services. Characteristics of wireless technologies will be explored according to user requirements, with the purpose of providing accurate and real-time information to the end user. User requirements are defined on the basis of the research results conducted among the target group of users moving through traffic network on a daily basis. Based on the results the architecture of the system for informing users and service delivery model whose main task is the fulfillment of customers' requirements was presented. The proposed solution represents a concept with all elements of assistive technologies and possible can be applied in the Internet of Things environment.

KEYWORDS

Assistive technology, Internet of Things, Ambient Intelligence, Visual impaired person, e-bussines

INTRODUCTION

With the development of information and communication technologies and services, there are quality potentials for informing users in public transport. Automatic Identification and Data Capture (AIDC) and Bluetooth low energy (BLE) connection technology can be used for this purpose. Service for informing users in public transport network can be implemented in the existing system by using Bluetooth technology and beacon devices. A survey was conducted in the city of Zagreb where targeted group of users (TGU) were persons with disabilities (visually impaired) and elderly. According to the defined user requirements, the implementation of new services into the existing system is proposed specifically because of the need for adaptive information for TGU. BLE and Beacon technologies were implemented in Smart Public Transport system in Bucharest in 2015, where they were used for informing users of public transport [1], [2]. The concept, according to which the users of the system are involved in the creating content of environment information and guidance (map making), is based on Braille and defines standard signs for individual elements of the system [3]. Elementi sustava javnog gradskog prijevoza kao što je stajalište, najava dolaska vozila te informativne mape također je moguće opremiti AIDC tehnologijom i integrirati aplikativno rješenje za mobilne uređaje [4]. BLE and beacon technologies that are used with application solution for informing TGU can help with errors in locating users that provide GPS application [5], [6]. Wireless System for obtaining information of public transport for visually impaired and identifying vehicles can also be based on BLE technology. Users can obtain all relevant information about possible movements in traffic network [7].

The disadvantage of the mentioned research is reflected through information that are not adapted to user's demands and universal design methods. The purpose of this research is to propose a system based on assistive technology models and Ambient assisted living (AAL) concept [8], [9]. Collecting, processing and data distribution are based on Internet of Things (IoT) concept with the aim to increase the level of quality of life for TGU [10], [11].

1. DEFINING USER REQUIREMENTS FOR INFORMATION SERVICES

Usage of different services, each user has determined demands that should be met while using the service. The survey that included questionnaires and interviews was conducted with TGU to define their demands. The first survey included 208 respondents (elderly) in nursing homes. The second survey that obtained information about the needs of persons with disability was conducted in cooperation with Up2Date that included 109 respondents.

1.1. THE RESEARCH ABOUT THE NEEDS OF THE ELDERLY

Respondents were asked about their age and the majority of respondents, 53,37%, were older than 80 years. Visual impairment is presented in 50,48% of respondents, while 49,52% doesn't have problems with vision.

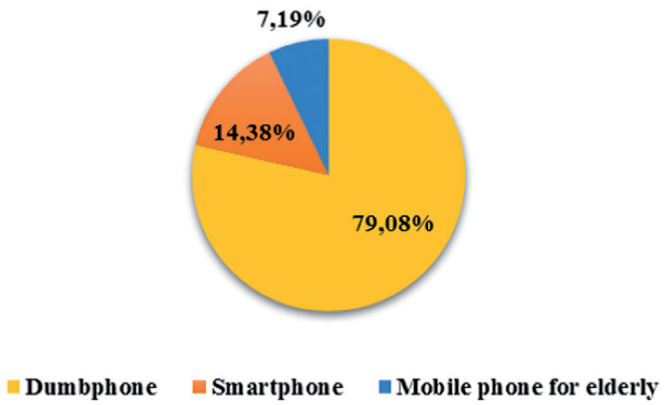

Fig. 1. Distribution of types of used mobile devices

On the daily use, 73,56% of respondents use mobile devices and the types of used mobile devices are shown in Figure 1. Dumbphone mobile devices use 79,08% of respondents, and 14,38% use smartphones where 76,19% of them use Android operating system. The service for informing persons in public transport was presented while interviewing users to collect information about the willingness to use such forms of information. Quer**y** about possible introduction of the new service was conducted on a sample of all users and sample of users who have smartphones. TGU that use smartphone have greater willingness to use new services, 77,27%, while 86,67% of them wants to have additional functionalities such as announcements of next bus/tram stations, etc.

1.2. THE RESEARCH ABOUT THE NEE DS OF PERSONS WITH DISABILITY

The age group of respondents who participated in the study is shown in Figure 2. It is shown that the most of the respondent belong to a younger age.

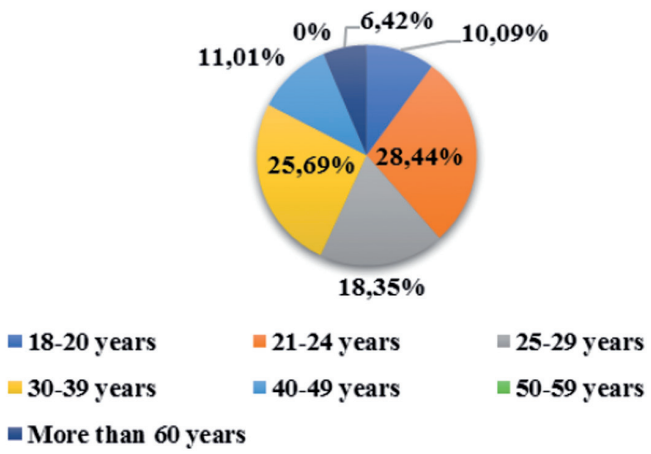

Fig. 2. Age group of respondents

Type of disability of respondents is shown in Figure 3. Gathered information is extremely important for defining guidelines for designing information that are accessible to the users.

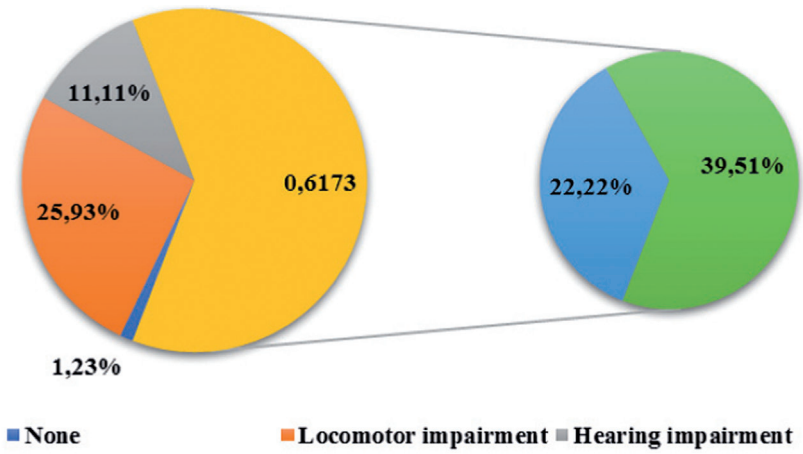

Fig. 3. Type of disability

The usage of smartphone devices is changing according to the type of the disability, which is shown in Figure 4.

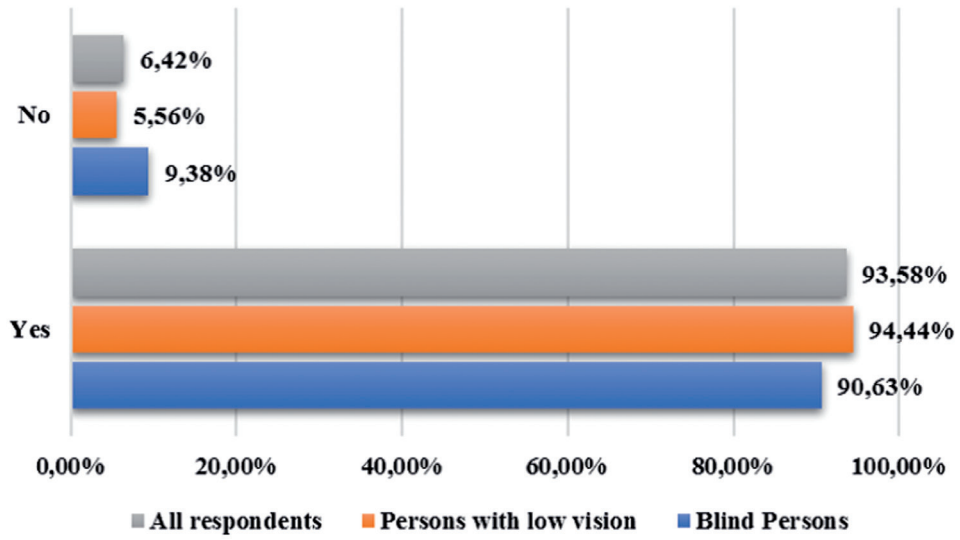

Fig. 4. Percent of the users that use smartphones

Figure 5 shows the satisfaction of users with the way of information being provided in public transport system. Almost every user, 99% of them, wants to have new services and customized information to their level of impairment.

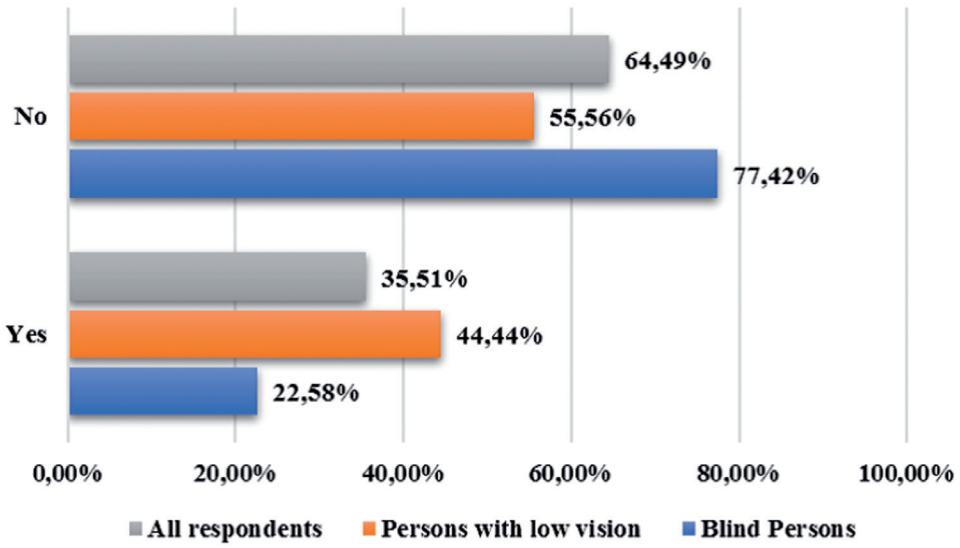

Fig. 5. User satisfaction with current manner of information

Figure 5 shows the satisfaction of users with the way of information being provided in public transport system. Almost every user, 99% of them, wants to have new services and customized information to their level of impairment.

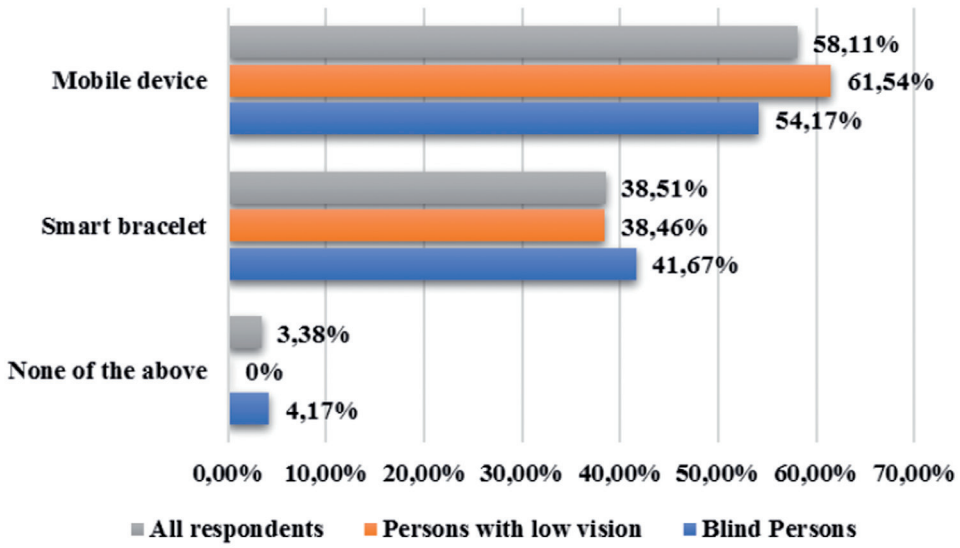

Fig. 6. Selected device to receive information from the traffic environment

The respondents expressed the desire for using new services via mobile devices, i. e. application solutions which is shown in Figure 6.

The importance of information about the movement in traffic network, 44,86% of respondents evaluated as very important, of which 75% of them are visually impaired

persons. According to the collected data about services for informing persons in public transport, user requirements, the type of mobile phone (smartphone) and operating system (Android) were defined. The most reliable way to receive information is through sound. The analysis also showed that users are not satisfied with the current way of informing them in public transport, and they also consider information related to public transport important or very important. Relevant information of system for informing users in public transport are related to the current bus/tram station, number of the bus/tram line and the direction of traveling. It is also recommended to develop information according to the degree and type of user's disability.

2. ANALYSIS OF WIRELESS TECHNOLOGIES FOR INFORMING END USERS

Wireless technologies for informing TGU can be divided into: technologies for collecting data (sensor and AIDC technologies), technologies for distribution information to TGU and communication technologies (BLE and Wi-Fi). For this purpose, AIDC technologies that can be used as the optimal technologies are: Radio Frequency Identification (RFID), Near Field Communication (NFC), QR code, GPS/telemetry and connection technologies such as BLE and Wi-Fi. Cloud Computing (CC) can be used for data processing and data storage.

2.1. AIDC TECHNOLOGIES

AIDC technologies are a set of methods that are used for automatic identification and data collection from objects and people, without the human influence on the process of identification and data collection [12].
Methodology on how AIDC technology works consist of three modes: data encoding, machine scanning and data decoding. Data encoding is the process where alphanumeric characters are converted into a form that is comprehensible to a machine (computer). Machine scanning is an activity in which the coded data are read and converted into electrical signals. The last mode is data decoding, a process in which electrical signals are converted into digital data and then in alphanumeric characters [13], [14].
RFID is a technology that is used for contactless identification in the electromagnetic field or radio waves. RFID system consists of two components: tags or transponders and readers. *Tag* is a device or an electronic circuit that is put on an object that needs to be identified [13]. A great potential to use RFID technology is in public transport, especially for smart cards that are used for contactless payment of transportation. Above mentioned method of payment is called Automatic Fare Collection (AFC). Smart contactless cards are designed for a period of ten years and they are durable to all weather conditions. Hybrid cards represent a combination of contactless smart cards and additional contact integrated circuit that is built-in a card. Dual interface card is a combination of contact and contactless interface on a single integrated circuit card.
NFC is a technology that enables contactless communication between devices such as: smartphones and tablets. Contactless communication allows the user to put the NFC device near another compatible NFC device to send information or pair devices without the need for a physical connection. NFC technology maintains interoperability between various technologies such as Bluetooth and other NFC standards (FeliCa standard – NFC Forum). NFC Forum is an organization that enact standards that manufacturers must meet when developing devices that have the possibility to use NFC technology[15].

2.2. BLE COMMUNICATION TECHNOLOGY

Bluetooth technology is used for wireless connectivity of equipment inside the network and data transmission using radio transmission. Bluetooth advantages over other technologies are: low energy consumption, ease of use and low cost. Because of mentioned advantages, Bluetooth is becoming more used in a wide range of information and communication services. Bluetooth technology provides three network topologies: point-to-point, piconet and scatternet network.
Today, terminal devices have integrated circuit with Bluetooth 4.0 version. This version of Bluetooth was developed because of the need to connect devices in the IoT environment. The effectiveness of Bluetooth and its low energy consumption makes it a quality option for devices within IoT environment that should work for a long period of time. BLE version has a possibility to work on different operating systems whose applications have various possibilities to connect into the CC concept. The most famous BLE version is Bluetooth beacon, a small transmitter that transmits data through Bluetooth technology [5]. Bluetooth beacon devices transmit Bluetooth signal to nearby devices. By pairing with different and adequate application solutions (specialized applications or classic web browser), they can be used for the delivery of interesting information to end users. Because of the range of Bluetooth signal, it represents one of service that is location-based service (LBS) [16].

3. PROPOSAL FOR IMPROVEMENT OF THE SYSTEM FOR INFORMING USERS OF PUBLIC TRANSPORT

In the city of Zagreb, the public transport is under the organization named *Hrvatske željeznice putnički prijevoz* (HŽPP) and *Zagrebački električni tramvaj* (ZET). Service of public transport is also used by persons with disability and elderly. For this purpose, it is necessary to design a system according to their needs.

3.1. CURRENT STATE OF INFORMING USERS IN PUBLIC TRANSPORT OF ZAGREB CITY

Informing users in public transport in Zagreb city is carried out by using the system for control and traffic management (ATRON). Also, it has a possibility to dynamically inform passengers about the time-table on displays that are visible on specific stations (DPI devices). The main method for informing passenger of public transport is by visual information (Figure 7).

Fig. 7. Types of visual information available in public transport

The architecture of ZET system for communication between vehicles and systems for data processing is wirelessly connected. Displays for informing users are connected with tetra radio link while wireless stations and the main center for data processing are connected through wire. Passengers can get visual and sound information. Visual informing represents textual information through display and sound informing is an audible information through speakers that are built inside and outside of the vehicle

of a public transport. Passenger informing is activated on the basis of knowing the distance between two stations and the distance of a vehicle from a station which is shown by odometer. After passing 10% of path from one station to another, passengers get visual and sound information about the next station. When the doors of the vehicle open, audio information about the current station is activated.
The disadvantages of the current ways of informing users of public transport are delay in the information delivery and non-adaptive information to a specific group of passengers.

3.2. PROPOSAL OF SERVICE FOR INFORMING USERS

Architecture of the proposed system for informing TGU is shown in Figure 8 and it consists three logically connected units: user segment (mobile device and application solution), vehicle segment and station segment. In addition to above mentioned segments, proposed architecture has CC that is based on Cloud Computing for the Blind concept. It is used for data processing and providing relevant information to users in real time [17].

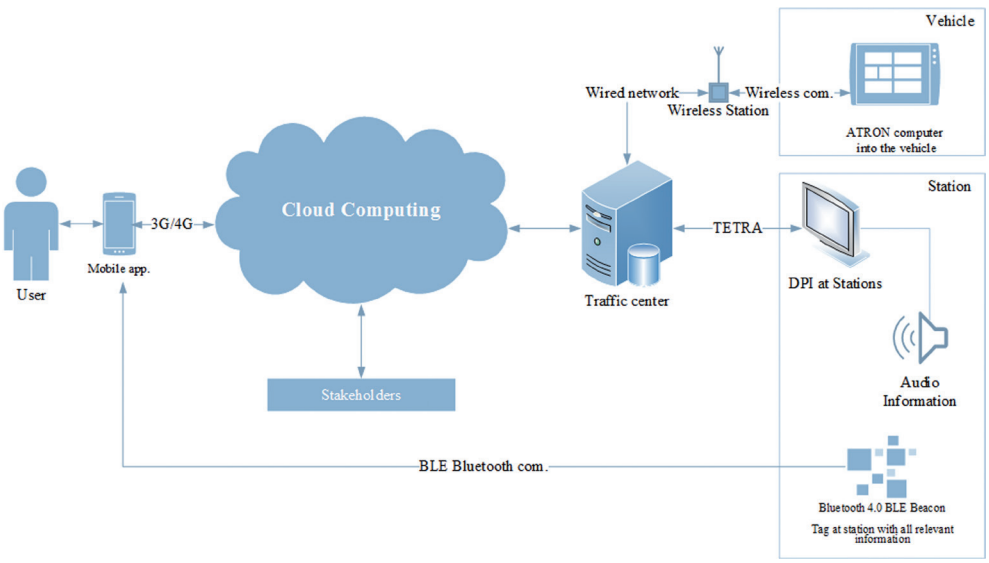

Fig. 8. Architecture for providing service to inform users

Connection technologies of the proposed architecture are: BLE Bluetooth, Wi-Fi and 3G/4G, depending on the type of the user's mobile device. BLE technology is used for obtaining information from Beacon devices that have all relevant information about stations (configuration about station, incoming vehicles, the point of entry into the vehicle and the level of accessibility) and real time information about the traffic. Vehicles and DPI devices that are placed on the specific stations obtain information from adequate traffic center, which makes a closed component of ZET communication system. CC has the purpose to store, process and deliver information to TGU and it is possible to adjust information to their demands. Information inside of vehicles or on stations can be provided to TGU in the form of audio or visual information, depending on their special needs or level of disability.

Application solutions need to be designed according to Web Content Accessibility Guidelines 2.0, assistive technology models (HAAT and CAT) and universal design principles [18]. Figure 9 shows proposal for the design of application solution with all accessible elements. Accessibility is manifested through equitable use, during which is expected for a user not to have a great physical effort to get to the required information. All relevant functionalities are shown in the proposed interface.

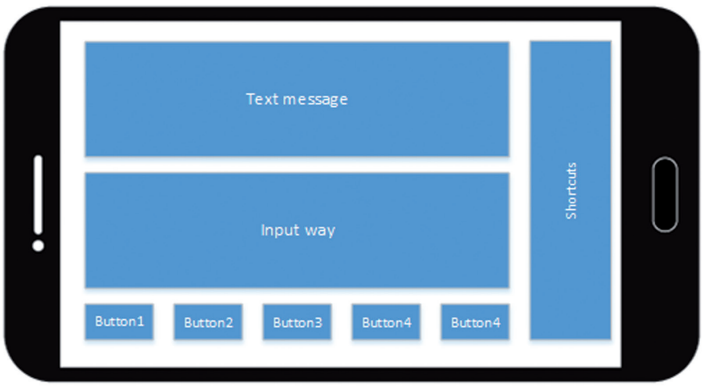

Fig. 9. Proposed design of application solution

Application solution should be based on Android operating system and devices that have a viable Bluetooth connection. When the user approaches to the public transport station, application solution should provide information such as where is the entrance to a vehicle, expected time of arrival and the line of vehicles. Beside the service providers, interest groups can also create real time information that are available to end users with the aim to enable safe movement and informing users. Figure 10 shows the interface of application solution of proposed information system (arrival of the vehicle).

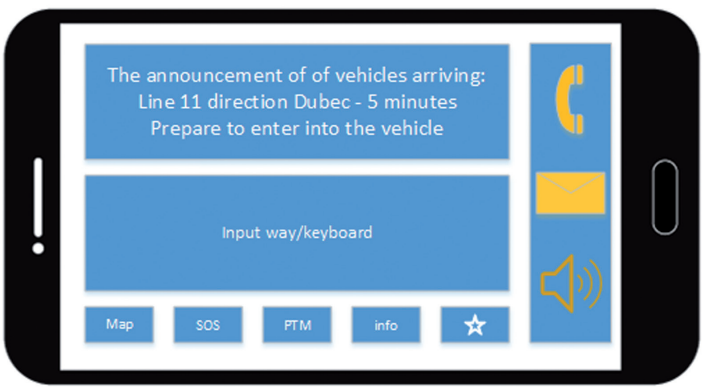

Fig. 10. Proposal for informing users through application solution

The possibility of informing users about the arrival of the vehicle and set of key to transform text to speech option and quick call is also shown in Figure 10. Additional functionalities are: SOS call, city map, PTM (predefined text messages), information

about public transport station (Info) and favorites (users can write important messages about station). Information about public transport stations can be obtained through Beacon devices that are set on the stations, as well as the information about the entrance of the vehicle. The announcement of the arrival of the vehicle is provided by DPI device and it is necessary to enable audio information to end users. Users can get above mentioned information through mobile application. In the public transport vehicle, users get audio information about the next station which they can also get through mobile application (with addition of textual information).

4. THE CLASSIFICATION OF THE PROPOSED SOLUTIONS ACCORDING TO E-BUSINESS MODELS

The business models of companies that can affect on the efficiency of traffic system with their business operations, is important to prepare for business operations of the e e-business market [19]. The proposition shows ZET company as a business entity and as service provider. Another business entities can also be included in creating and distribution of all relevant information (organizations, Red Cross, etc.). Possible models of e-business are shown in Figure 11 in which all stakeholders are involved in creating and providing information to end user.

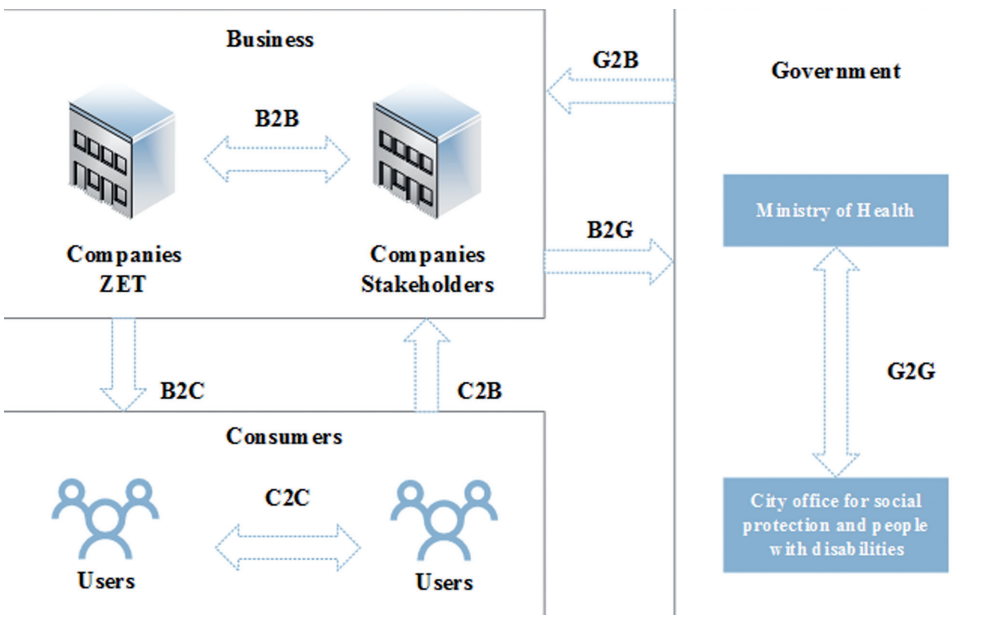

Fig. 11. Business models of delivery information service

E-business models are defined by three different parties that are involved in the business process (B-Business, C-Consumer, G-Government). B2B model represents ZET organization as well as all other organizations or influential groups aimed at providing information to the end user. G2G business model allows online interaction between Government entities and in this case, it is a communication between the ministry of health and City office for social protection and people with disabilities. Ministry of health contains in their databases information about people with disabilities and provides additional transport services of public transport. City office for social protection and people with disabilities provides information about elderly which have a possibility to

use public transport for free. This information is important for providing additional functionalities of application solutions (mobile payments). G2B and B2G models ensure interaction between government entities that provide informing service. Other information for TGU provide B2C and C2B models where the interaction between users, C2C, is also important because it allows them to participate in creation of information. Above mentioned service is possible to describe with business model with channel provider as shown in Figure 12.

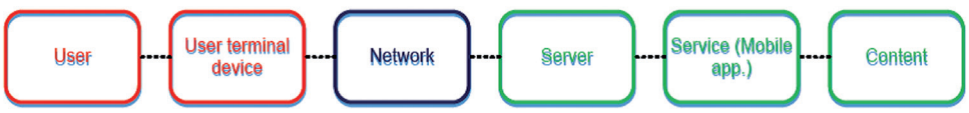

Fig. 12. Business model of proposed system

The business model consists of three stakeholders: user (red), network provider (blue) and service provider (green). User represents TGU that uses smartphones. Network provider is the mobile operator through which the user has the option for mobile access. Service provider (green) in the public transport is ZET.

CONCLUSION

Everyday activities such as moving through traffic network and using public transport represents a growing challenge for TGU. The challenge is to inform users in public transport about the vehicles which come to the station. In the city of Zagreb, public transport vehicles inform passengers via sound system about the route and direction of the vehicle which comes to the station, in specific periods of time during the day. The proposed system in this study is based on the BLE Bluetooth information and communication technology and mobile application solution, developed for the Android operating system in order to improve the existing system for informing users. By adding certain elements of the proposed system, the existing system can be significantly improved. For example, the user gets the information at the moment of vehicle's arrival at the station, meaning the information is given in time. This leads to increased mobility of users, which results in raising the level of quality of life. The proposed solution is also shown through the business models and possible application in the IoT environment.

REFERENCES

[1] Andreini, D.: Proximity marketing and its technologies : over 100 beacon use cases analysis, 2016.
[2] Blog, O. B.: iBeacon guides Visually Impaired in Public Transportation. [Online]. Available: http://www.onyxbeaconcom/world-premiere-large-scale-ibeacons-network-guides-visually-impaired-people-to-use-the-public-transportation-service/. [Accessed: 08-Feb-2017].
[3] Devlieger, P., Strickfaden, M.: Reversing the {Im}material Sense of a Nonplace: The Impact of Blindness on the Brussels Metro. Sp. Cult., vol. 15, no. 3, pp. 224–238.
[4] Campbell, M., Bennett, C., Bonnar, C., Borning, A.: Where's My Bus Stop? Supporting Independence of Blind Transit Riders with StopInfo. In: ACM ASSETS Conference, 2014.
[5] Cheng, R. S., Hong, W. J., Wang, J. S., Lin, K. W.: Seamless Guidance System Combining GPS, BLE Beacon, and NFC Technologies. Mob. Inf. Syst., vol. 2016, 2016.
[6] Korbel,P., Skulimowski, P., Wasilewski, P.: A radio network for guidance and public transport assistance of the visually impaired. In: 2013 6th International Conference on Human System Interactions (HSI), 2013, pp. 485–488.

[7] Santos, E. A. B.: Design of an interactive system for city bus transport and visually impaired people using wireless communication, smartphone and embedded system. In: 2015 SBMO/ IEEE MTT-S International Microwave and Optoelectronics Conference (IMOC), 2015, pp. 1–5.
[8] Hersh, M. A., Johnson, M. A.: Assistive Technology for Visually Impareired and Blind People. 2008.
[9] Nuno, J. J. P. C., Garcia, R. M.: Ambient Assisted Living Book. 2015.
[10] Silva E. M., Maló,P.: IoT Testbed Business Model. Adv. Internet Things, vol. 4, no. 4, pp. 37–45, 2014.
[11] Choi, H. S., Rhee,W. S.: Iot-based user-driven service modeling environment for a smart space management system. Sensors (Switzerland), vol. 14, no. 11, pp. 22039–22064, 2014.
[12] eriša, M., Peraković, D., Vaculík, J.: Adaptive technologies for the blind and visual impaired persons in the traffic network. Transport, vol. 30, no. 3, pp. 247–252, Jul. 2015.
[13] Klaus Finkenzeller, RFID Handbook: Fundamentals and Applications in Contactless Smart Cards, Radio Frequency Identification and Near-Field Communication. West Sussex: John Wiley & Sons, 2008.
[14] Carcieri, S., Morris,S., Perry, B. D.: RFID Technology to Aid in Navigation and Organization for the Blind and Partially Sighted, 2009.
[15] Spinsante, S. Gambi, E.: NFC-based user interface for smart environments. Adv. Human-Computer Interact., vol. 2015, 2015.
[16] Aguilar, S., Vidal, R., Gomez, C.: Opportunistic Sensor Data Collection with Bluetooth Low Energy. Sensors, vol. 17, no. 1, p. 159, 2017.
[17] Periša, M., Peraković, D., Šarić, S.: Conceptual Model of Providing Traffic Navigation Services to Visually Impaired Persons. PROMET - Traffic&Transportation, vol. 26, no. 3, pp. 209-218, May 2014.
[18] Kravets, A., Shcherbakov, M., Kultsova, M. Shabalina, O.: Creativity in intelligent technologies and data science: First conference, CIT&DS 2015 Volgograd, Russia, september 15-17, 2015 proceedings. Commun. Comput. Inf. Sci., vol. 535, 2015.
[19] Periša, M., Cvitić, I. Kolarovszki, P.: Challenges of Information and Communication Technologies Usage in E-Business Systems. In: E-Business - State of the Art of ICT Based Challenges and Solutions, InTech, 2017.

EKOSYSTEM ŚWIADCZENIA USŁUG DLA UŻYTKOWNIKÓW TRANSPORTU PUBLICZNEGO

STRESZCZENIE

Aktualne możliwości technologii bezprzewodowych dla informowania użytkowników (niedowidzących) należy zbadać i zdefiniować zgodnie z modelami technologii wspomagających i systemami e-biznesu. Celem tych badań jest wybór technologii bezprzewodowej, której cechy mogą poprawić poziom jakości życia dla docelowej grupy użytkowników oraz zaproponowanie wskazówek do opracowania usług informacyjnych.
Cechy technologii bezprzewodowych zostaną zbadane wg wymagań użytkowników, w celu dostarczania użytkownikowi końcowemu dokładnych informacji w czasie rzeczywistym. Wymagania użytkownika są definiowane na podstawie wyników badań prowadzonych wśród docelowej grupy użytkowników poruszających się codziennie w sieci ruchu. Na podstawie tych wyników przedstawiono architekturę systemu informowania użytkowników oraz model świadczenia usługi, których głównym celem jest spełnianie wymagań użytkowników. Proponowane rozwiązanie prezentuje koncepcję ze wszystkimi elementami technologii wspomagających i przypuszczalnie może być zastosowane w środowisku Internetu Rzeczy.

SŁOWA KLUCZOWE

technika wspomagająca, inteligencja otoczenia, osoba niedowidząca, e-biznes