

Czech University of Life Sciences Prague

Faculty of Economics and Management

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Diploma Thesis

Use of information management in Smart Cities

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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Xhesilda Vogli

Informatics

Thesis title

Use of information management in Smart Cities

Objectives of thesis

The main objective of the thesis is to analyze and propose implementation of smart city concept for countries in development focusing on Tirana.

Partial goals of thesis are such as:

- to make an overview of current smart cities implementation around Europe
- to analyze why development countries should implement smart city concept.
- to propose a management model for Tirana, the capital city of Albania.

Methodology

Methodology of the thesis is based on reviewing and analyzing the latest literature which includes books, reports and research papers related to the topic. In the practical part, a proposal of smart city concept implementation for Tirana will be analyzed by using business impact analysis. Based on the evaluations of theoretical and practical part, conclusions are presented. For further work in the future, discussions will be provided.

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Recommended information sources

An analysis of key factors in developing a smart city, Aidana ŠIURYTĖ, Vida DAVIDAVIČIENĖ, [online], 2016 [cit. 2016-12-20]

<http://www.mla.vgtu.lt/index.php/mla/article/viewFile/900/pdf>

Orchestrating Infrastructure for Sustainable Smart Cities. International Electrotechnical Commission [online], 2014 [cit. 2016-12-20]. ISBN 9782832218334, pages 62.

<http://www.iec.ch/whitepaper/smartcities/>

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Smart City Framework – Guide to Establishing Strategies for Smart Cities and Communities, BSI (British Standards Institution), [Online], 2014 [cit. 2016-12-20]

<http://www.bsigroup.com/en-GB/smartcities/Smart-CitiesStandards-and-Publication/PAS-181-smart-cities-framework/>

The Smart City Market: Opportunities for the UK. Department for Business, Innovation and Skills [online],

2013 [cit. 2016-12-20]

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249423/bis-13-1217-smart-city-market-opportunities-uk.pdf

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Declaration

I declare that I have worked on my diploma thesis titled "Use of information management in Smart Cities" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on 29.03.2018

XHESILDA VOGLI

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I would like to thank my thesis supervisor, **Miloš Ulman** for guiding and supporting me over this paper.

I dedicate this thesis to **Adam** for his constant support and unconditional love.

Využití správy informací v inteligentních městech

Souhrn

Implementace inteligentních technologií správy města není jen procesem, při kterém technologie nabízí řešení pro různé problémy. Inteligentní město ovlivňuje celou řadu oblastí, jako je ekologie, vzdělávání, infrastruktura, recyklace odpadů, veřejné zdraví, doprava a mnoho dalších. Zavádění technologií inteligentního města je proto nevyhnutelností. Tato práce popisuje příležitosti a výzvy, jimž čelí rozvojové země při implementaci technologií inteligentních měst. V rámci teoretické části nabízím přehled literatury popisující problematiku internetu věcí a inteligentních měst. Záměrem této diplomové práce je navrhnout využití osvědčených postupů, které již byly realizovány v Amsterdamu, Vídni a Praze. Tato tři města jsou v práci použita jako vzor při realizaci projektu inteligentní veřejné dopravy v albánském hlavním městě Tiraně. Navrhované řešení zohledňuje technologické a sociální dopady systému, analyzuje a poskytuje hlubší pochopení využití správy informací v inteligentních městech. Konečně se vyvozují závěry, které se týkají důsledků veřejné dopravy v Tiraně, aby byla v budoucnu rozšířena integrace s ostatními odvětvími.

Klíčová slova: inteligentní město, městská mobilita, rozvojové země, e-ticketing, čipová karta, inteligentní veřejná doprava, interoperabilita, integrace.

Use of information management in Smart Cities

Summary

Implementing smart city management technologies is not just a process where technology offers solutions for different problems. Smart city influences a wide range of sectors such as ecology, education, infrastructure, recycling, health, transportation and many more. Therefore, nowadays implementation of smart city is a must.

This paper describes the opportunities and challenges that countries in development are facing while implementing smart cities. During the theoretical part, a literature review is provided describing Internet of Things and Smart cities. The motivation behind this thesis is to make use of best practices already implemented in Amsterdam, Vienna and Prague. Those three cities are used as an etalon while proposing a smart public transportation for Tirana. The proposed solution takes into consideration technological and social impacts of the system, analyzing and providing a deeper understanding of the use of information management in smart cities. Finally, conclusions are made by setting out implications of Tirana's public transportation for a broader integration with other sectors as a future work.

Keywords: Smart city, urban mobility, developing countries, e-ticketing, chip-card, smart public transportation, interoperability, integration.

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Introduction

The urban areas around the world are increasing exponentially. Today 54% of the population lives in cities and is predicted that by 2030, 6 out of 10 people will live in urban areas. While in developed countries, urbanization has reached its peak and is now growing at constant rates, the situation is totally different in developing countries. Almost all urban population growth in the next 30 years will occur in cities of developing countries. This rapid urbanisation has caused many issues among which environment, traffic, healthcare and resources. Implementing smart city management technologies is not just a process where technology offers solutions for different problems. Smart city influences a wide range of sectors such as ecology, education, infrastructure, recycling, health, transportation and many more. Therefore, nowadays implementation of smart city is a must.

The concept of smart city has been changing and developing for many years. Until these days this concept is still evolving and the definition is not clear.

The implementation of smart cities has also stimulated competition between cities to get the most profitable human resources, businesses and entrepreneurs. For this reason, citizens today are not simply seen as a city user but also as a source of further development and solution providers.

This paper describes the opportunities and challenges that countries in development are facing while implementing smart cities and proposes a solution for the public transportation in Tirana, taking into consideration technological and social impacts of the system, analyzing and providing a deeper understanding of the use of information management in smart cities.

Chapter 2 reviews and analyses the latest literature which includes books, reports and research papers related to internet of things and smart cities concept. Currently in 2017, 250 smart cities projects are completed or ongoing all over the world with Europe leading in terms of the numbers of projects. Amsterdam, Vienna and Prague, being demographically similar to Tirana, are used as an etalon while proposing a smart public transportation system for Tirana.

Chapter 3 includes the practical part where a general review of the main sectors in Albania is made. To have a better understanding of what citizens think and know about the smart city concept a survey is conducted. The survey tries to not impose a single definition of smart city, but mostly it focuses in gathering opinions of citizens on what they perceive as smart initiatives. This chapter concludes with the proposal of a smart public transportation system.

In **Chapter 4**, after proposing a smart system for public transport in Tirana and analysing its impact, the performance of the system is tested, how it can be integrated into the future with other smart modules and how much the expectations are met.

The proposed system is analysed using business impact analysis (BIA). It is important to make sure that users understand how the system works, how do they perceive the improvements, are they happy with the security or if they feel they are getting a better service or not. In a more structured way, to answer all these questions, a conceptual model on the acceptance level is provided and a survey is suggested.

Chapter 5 concludes by setting out implications of Tirana's public transportation for a broader integration with other sectors as a future work.

1 Objectives and Methodology

1.1 Objectives

The main objective of the thesis is to analyse and propose implementation of smart city concept for countries in development, focusing in Tirana.

Partial goals of thesis are such as:

- to make an overview of current smart cities implementation around Europe focusing in Vienna, Amsterdam and Prague.
- to analyse why countries in development should implement smart city concept.
- to propose a management model for Tirana, the capital city of Albania focusing in public transportation.

1.2 Methodology

Methodology of the thesis is based on reviewing and analysing the latest literature which includes books, reports and research papers related to the topic. In the practical part, a proposal of smart city concept implementation for Tirana will be analysed by using business impact analysis. Based on the evaluations of theoretical and practical part, conclusions are presented. For further work in the future, discussions will be provided.

2 Literature Review

Technology has become a vital part of everyday life and the idea that every problem may have a technological solution is growing more and more.

Google's chairman Eric Schmidt was asked about the future of the web during a panel at the World Economic Forum and he said: "The Internet will disappear. There will be so many IP addresses, so many devices, sensors, things that you are wearing, things that you are interacting with, that you won't even sense it. It will be part of your presence all the time." (Smith, 2016)

So called Internet of things no matter that is a wide research area in now days, still what it represents it is not very clear. Many think IOT as a big sensor networks, machine-to-machine communication or just wireless communication between different devices. As a result, in this chapter will define Internet of Things, analyse the relationship between IoT and smart city concept and identify real life examples of this implementation.

2.1 Internet of Things

2.1.1 Definition of IoT

Definition of IoT it's not an easy task because Internet of Things is not a single technology, but it's a concept that changes the way we perceive the world around us. The near future affected by IoT will define internet not only as network of computers, but it will evolve into a network of devices of all types and sizes.

So, a "thing" in IoT can be an automated coffee machine that will prepare the coffee every morning before you wake up, a heating system that uses energy efficiently, or even a human with a heart monitor implant. Generally speaking every device natural or not, that can be assigned an IP address with the ability to transfer data over a network is "a thing".

This makes Internet of Things a global concept. (Rouse, 2016)

A simple definition could be: "Devices of several types and sizes, uniquely identified with an IP address, produce, transmit and analyse data without human interaction".

This definition is easy to understand but is not enough because it doesn't explain the global role of IoT and raises some questions. What about virtual devices? Are existing devices suitable for this new concept? Do we have security issues?

The most complete definition of IoT is formulated by International Telecommunications Union which defines IoT as stated below:

“The Internet of Things (IoT) has been defined in Recommendation ITU-T Y.2060 (06/2012) as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

NOTE 1 – Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

NOTE 2 – From a broader perspective, the IoT can be perceived as a vision with technological and societal implications.” (ICT, 2015)

2.1.2 Brief history of IoT

While the IoT may seem like science fiction, it is becoming reality faster than most of us can comprehend. Visionary people like Nicholas Tesla defined how our future will look like since the 19th century:

“When wireless is perfectly applied the whole earth will be converted into a huge brain, which in fact it is, [...] and the instruments through which we shall be able to do this will be amazingly simple compared with our present telephone.” (Luigi Atzoria, Antonio Ierab, Giacomo Morabito, 2016)

Since IoT is not a single technology it’s hard to determine his roots. We mentioned earlier while defining Internet of Things that in order to be classified as a “thing” in IoT an object should be uniquely identified, be able for machine to machine (M-2-M) communication and should be accessible from internet.

The first device that meets the requirements is a Coca Cola machine. In the early 80’s, at the Carnegie Mellon University in Pennsylvania, US they modified a Coke machine in order to keep track of how many bottles are inside and for how long they have been there. So, each student could know if there are any bottles and if they are cold or not.

But what made this machine even more remarkable is that it was able to connect to the internet. Each student that had a computer connected to internet was able to have the information he needed from the beverage machine. (Carnegie Mellon University, 2017)

Just a few years later, in 1989 John Romkey created a toaster that could be turned on and off over the Internet and therefore was connected to a computer with TCP/IP networking. (Facility, 2015)

In 1995 Siemens set up a dedicated department inside its mobile phone business unit to develop and launch M2M communication. This was the first step forward GSM data module and since the idea was successful, it soon became a separate company. (Facility, 2015)

But the term Internet of Things was never used prior 1999. It was Kevin Ashton, executive director of the Auto-ID Center that used the phrase in a title of a presentation at Proctor & Gamble.

In 2005 International Telecommunications Union published the first worldwide report for IoT. They stated in the report: *"A new dimension has been added to the world of information and communication technologies (ICTs): from anytime, any place connectivity for anyone, we will now have connectivity for anything. Connections will multiply and create an entirely new dynamic network of networks – an Internet of Things"* (ICT, 2015)

In 2008 is held the first European Iot Conference in Zurich and now is a annual event. (IoT European Conference, 2008)

2008 is also known as the year where IoT was born because the number of connected devices exceeded the number of people according to GSMA analytics. (GSMA Intelligence)

GLOBAL DATA

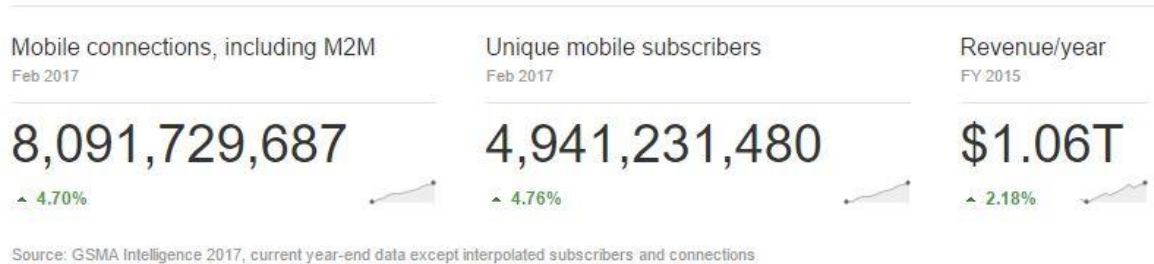
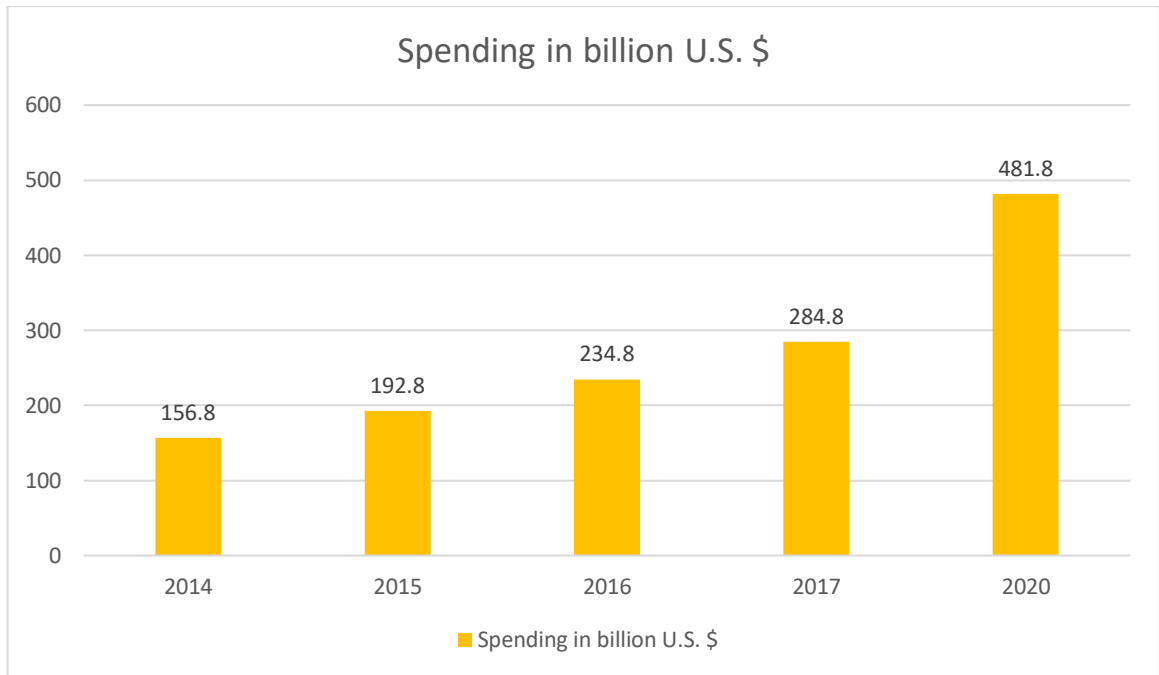


Figure 1-Real time data for connected devices

2.1.3 Technology hierarchy in IoT

To provide a dynamic network infrastructure and full services as described above, Internet of Things should have a hierarchy technology. This would help the global market create efficient services and products, deal with heterogeneity and manage the autonomous services and products as a whole.

1. Hardware Platforms are the lowest level of Internet of Things hierarchy. It consists of sensors and actuators, power and connectivity. The critical role of sensors and actuators includes gathering and monitoring information directly from the environment. Companies like Cisco, IBM, HP and many others are now manufactures of sensors and actuators for developing smart products.



Graph 1-Internet of Things products spending worldwide from 2014 to 2017 and in 2020 (in billion U.S. dollars)¹

Forecast for 2020 shows an increasing trend. Companies will spend three times more if we compare 2014 and 2020 prediction.

Power in IoT technology is a concept mostly related with efficiency. The devices should always be powered up and since they can be everywhere, this makes it a challenging task. Solution is offered through wireless power transfer, solar energy or low power consumption design. Each possibility has different difficulties. Using wireless power transfer is not a great solution in wearable devices because it has side effects. Wireless power transfer is done through magnetic inductive coupling or electromagnetic radiation which can be harmful for living beings wearing those devices. While designing system that power up with solar

¹ **Source** Gartner **Survey** by Gartner (January 2017) <https://www.gartner.com/newsroom/id/3598917>

energy, companies must consider power source and storage capabilities of devices. (Texas Instrument, 2016)

2. Midpoints are the devices that connect small hardware platforms to broader networks. One midpoint controls one function. For example, the water midpoint of a building monitors usage and costs of water. It may suggest better ways to use water and communicate with other midpoints to provide more information. One single building might have more than one midpoint. Each midpoint has some main functions that include:

- monitoring physical platforms
- encrypt/ decrypt information (internal security)
- storage for data- analyses data for increasing efficiency (McLaren, et al., 2015)

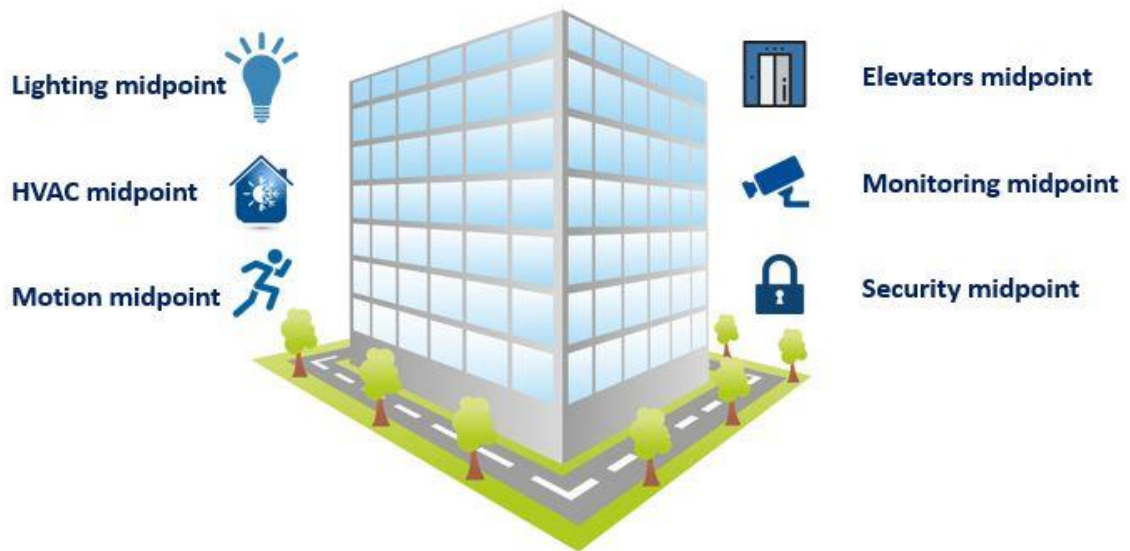


Figure 2-Midpoints of a single building²

3. Integrated Points connect together midpoints and support heterogeneity. The first company to implement an integrated point is Apple with their product called HomeKit. It connects together different devices from different vendors and make them controllable from a simple user interface in your phone. Other big companies like Google and Oracle are also developing integrated points. In this level, the companies don't care about the underlying functions, they just provide the software for midpoints company. Those companies use the software to connect their services. To conclude, an integrated point should:

- handle compatibility

² This schematic design was created by the author of this thesis

-analyze data

-M2M communication (no human interaction)

An example of an integrated point is a family member might press the “bedtime” button on his or her iPhone, and the service would then dim or turn off certain lights, lock the doors, set the security system, close the garage door, and lower the thermostat, all at the same time. (Jennifer Bélissent, 2010)

4. Cloud Integration is a upper level whose main goal is to provide the infrastructure for IoT in general. Midpoints and Integrated Points of lower levels need to store, analyse and collect big amounts of data. It’s impossible to manage all of this individually. For this reason, cloud integration level offers the cloud infrastructure that can be used from down levels to communicate without user interaction and use internet services they need. So this level offers connectivity through different transmission channels (WI-FI, Bluetooth, mobile data, etc.) Also, by implementing cloud integration a new concept comes alive: social IoT. It is possible to provide the infrastructure needed to build or connect to social networks, so that users of the IoT can compare experiences and share data. (Frank C. D. Tsai, 2012)

5. Smart Coordination At this level we deal with big data. Beside analyzing actual data, this level takes care for historical data too and provides an overall result. Since at this level everything is connected, devices can exchange information in real time without human interaction and provide a better coordination.

Level 1,2 and 3 are already reality. While level 4 and 5 need development. At the moment we can provide just vague examples of technology in cloud integration or smart coordination. Developing a clear hierarchy of IoT will make companies focus in certain products/services. With all these possibilities, companies run the risk of moving in too many directions at once and thus being overwhelmed by more focused competitors with more distinctive IoT-related capabilities. (Ovidiu Vermesan, 2014)

2.1.4 Application areas of IoT

From smart machines to wearable technology, IoT touches different areas of our life. Vermesan and Friess have identified six big domains where IoT has a big potential to grow: smart cities, smart transport and mobility, smart energy, smart homes and buildings, smart manufacturing and smart health. (Ovidiu Vermesan, 2014)

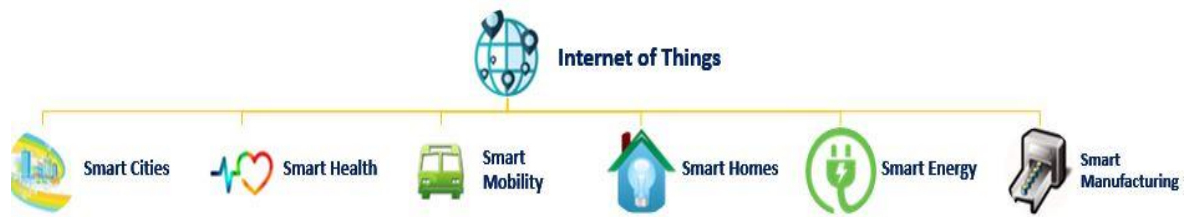


Figure 3-Application areas of IoT³

1. **Smart cities** are cities that incorporate different systems in order to solve main urbanization problems. Urbanization is not anymore, the only solution for development. Nowadays the goal of each city is to ensure sustainable growth by making citizens happy and fulfilled. According to IHS Markit, there will be at least 88 smart cities all over the world by 2025, up from 21 in 2013. Smart cities can offer different smart features but the crucial ones will be water management, energy management, urban mobility and waste management. To conclude we can define a smart city as a city that monitors all his infrastructures, optimize his resources and focus in security aspects.

2. **Smart transport and mobility** means connecting to the internet every vehicle used for transport. This provides security, safety and more functions of our vehicles. Implementation of smart transportation provides users with real time information about traffic management, weather conditions and road situations. To gather all this information is necessary to have vehicles with lots of sensors. Greater the number of sensors the more sophisticated data mining strategies we need. User interaction should be replaced with M2M communication to arise efficiency. A research topic is security because it's important to provide anonymity regarding destinations, habits and schedules of users. This area will evolve more in the future but however some of IoV (Internet of Vehicle) features already exists. Most of the vehicles produced nowadays have GPS devices that help on selecting routes and making better decisions. In IoV new ways of communication will be used:

V2V-vehicle to vehicle communication. Two cars can exchange data with each other and alerting you in case of a possible collision for example. With data we mean speed, moving direction and position.

V2R-vehicle to road. A vehicle can communicate with a road and gather data for infrastructure conditions and provide re-routing options in case there are problems.

³ This schematic design was created by the author of this thesis

V2H-vehicle to human. After analyzing data from the previous forms of communications, a vehicle will provide information for the user. Warnings, suggestions or decisions are some of the forms a vehicle can communicate with the user. All the forms of communication described above are cloud based systems. (Frank C. D. Tsai, 2012)

3.Smart energy is a must for every city in the world nowadays. With a consumption that grows every day and resources that are running out, it's obligatory using in a smart way resources like wind, water and sun energy. Implementation of smart energy enables companies or individuals to monitor and analyze the energy flow, which means better performance of resources, costs reductions and personalized energy usage. The entire concept of smart energy is related with the term smart grid. Years ago, the electricity network was built around communities and it kept growing while communities were growing. But this was a one-way communication. Smart grid offers the possibility to exchange information between the utility and the consumer. This interaction between humans, computers, companies and IoT technologies makes the smart grid more reliable, secure and greener. Since different types of energy will be interconnected, smart grid will offer a better integration and more efficient transmission of electricity. U.S Department of Energy believes that the Smart Grid will likely bring the same kind of transformation that the Internet has already brought to the way we live, work, play, and learn.

4.Smart homes and buildings is a home or building that allows his habitants to remotely control different functionalities through a smart device. The main functionalities include monitoring house, energy management and security. But a smart home is designed to provide comfort and personalized services for his occupants. The example of a person who wants to check if there is milk in the fridge is a cliché example that doesn't represent the main goal of a smart house. If you are on vacation and you want to ensure the security of your house, change the temperature using the HVAC system or just monitor main areas of the house, it's enough to use your smartphone. This gives a better picture of what a smart home can do. It can also record and analyze some of your habits to save you time in repetitive tasks.

5.Smart manufacturing will change the concept how a product is manufactured. This implementation of IoT technology will bring together technology, information and human skills. Work safety will be improved and waste will be reduced, which leads to a friendly environment process. A normal smart manufacturing process includes sensors, intelligent motors, less human interaction and advanced software. All those components will be

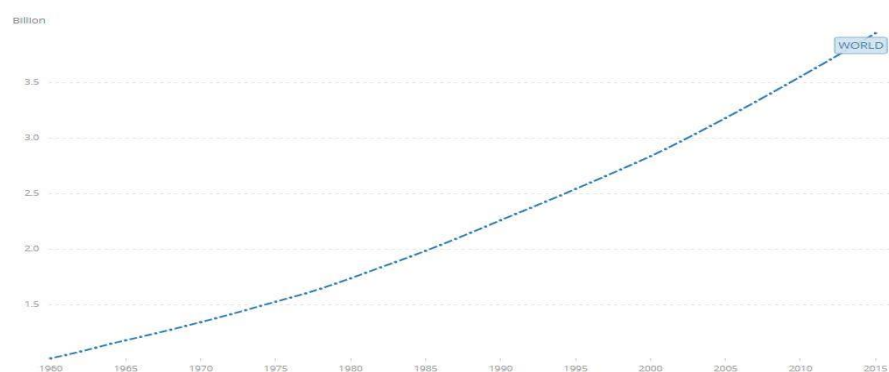
integrated and will communicate with each other. More integration means more intelligent data interpretation. Every business will use process simulation and have precise results which will further improve the existing processes, use energy efficiently and optimize outputs.

6. Smart health is a high level of the health sector nowadays. We already use e-health that allows us to keep track of our medical treatments and we also use m-health that allows to do the same in our mobile, but smart health will bring a new dimension to the health sector. Health systems will be interconnected and behave like they “think”. Like every other IoT implementation even this sector will include sensors, devices, information technology, software and humans. Main role of smart health is to connect together as much components as possible and provide autonomous actions. (University of Malmö, 2016) A good example that represents smart health is Google Contact Lens. This wearable technology is a normal contact lens that measures the level of glucose on your blood and sends real time results in your smartphone. Interconnectivity between devices will allow our doctors to remotely control our condition and create a friendly communication between patient and doctors.

2.2 Smart City Concept

2.2.1 Introduction

Smart city is one of the most important IoT implementations. According to World Bank, 100 years ago 2 out of 10 people lived in urban areas. Today 54% of the population lives in cities and is predicted that by 2030, 6 out of 10 people will live in urban areas. Almost all urban population growth in the next 30 years will occur in cities of developing countries. (World Bank, 2016)



Graph 2-World urban population⁴

With this trend going on, cities are facing new challenges. As the graph above shows, urbanisation is growing almost exponentially. This rapid urbanisation has caused many issues among which environment, traffic, healthcare and resources. Implementing smart city management technologies is not just a process where technology offers solutions for different problems. Smart city influences a wide range of sectors such as ecology, education, infrastructure, recycling, health, transportation and many more. Therefore, nowadays implementation of smart city is a must.

The concept of smart city has been changing and developing for many years. Until these days this concept is still evolving and the definition is not clear.

*A **smart city** is an urban development vision to integrate information and communication technology (ICT) and Internet of things (IoT) technology in a secure fashion to manage a city's assets. These assets include local departments' information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services. (McLaren, et al., 2015)*

A smart city can develop urban area that creates sustainable economic development and high quality of life by excelling in multiple key areas like economy, transport, environment, people, living, and government. Excelling in these key areas can be done so through strong human capital and social capital.

2.2.2 Advantage and disadvantages of smart city implementation

As defined in the above definition, a smart city is basically a city where various components are in sync with each other to optimize standards of living. To achieve this synchronisation usage of technology is needed.

The advantages of this concept are:

- **Operational efficiency**: Being able to track all the assets is one of the advantages of a smart city implementation. For example, buses used for public transportation, containers, taxis or vehicles can be tracked and monitored. In case of an unexpected event they can raise alerts. This will create a better operational efficiency. (Trinh, 2014)

⁴ World Bank <http://data.worldbank.org/indicator/SP.URB.TOTL>

- **Environmental advantages:** By implementing the technology of a smart city energy consumption decreases, waste management is more efficient and gas emissions are decreased. For example, Boston University implemented in its campus Big Belly containers which are equipped with sensor that notify collection vehicles when they are full. All the energy they need to function properly is produced using solar energy. The result is that they reduced trash collection from 14 times a week to 1.6 times a week. (Boston University , 2016)
- **Health improvements:** Technologies of sensor networks, data collection and storage have made it possible to have real time observations of complex engineered systems. Sensor networks have the power to employ large number of small, cheap, and energy efficient sensors that would collaboratively collect and process data and measure wide range of parameters including temperature, sound, pressure, water quality, pollutants, and many more in different industries. This would allow citizens to have real time data and interpret them to protect and improve their health. (Forbes, 2016)
- **Safety:** The use smart video surveillance, panic buttons, identification systems, ability to react efficiently and quickly to alarms raised in various parts of the city and much more, will increase the safety of a city and his habitants.
- **Mobility:** By synchronizing all the resources together, a smart city can create the idea of smart parking that will allow users to know the precise free place for parking, to pay through mobile payments and to detect their vehicle in a big parking place.

Energy	Utility	Mobility	Safety
Smart buildings	Water management	Smart parking	Remote security
Remote notifications	Water treatment	Vehicle detection	Video surveillance
Waste management	Emergency response	EV charging	Emergency response
Smart maintenance	Equipment monitoring	Mobile payments	Mass notification

Table 1-Advantages of smart city implementation⁵

⁵ Verizon. Smart Cities Solutions, 2014

- **Economic sustainability**: Cities need to provide citizens with the capacity to develop their economic potential, and attract business and capital. Their financial sustainability now depends also on new financial models, as well as more efficient and better-integrated services and infrastructures.
- **Social sustainability**: In order to be attractive for people, business and capital a city should create a good quality of life (QoL), business opportunities and improve security which are guaranteed by social inclusiveness. (Orchestrating infrastructure for sustainable Smart Cities , 2014)

All those advantages have one common denominator, the need to achieve more and better with less, efficiency. Efficiency must also be achieved in a manner that brings benefits and opportunities to citizens, making the city more dynamic and participatory. But focusing in efficiency can create some disadvantages that will be discussed below.

- **Present infrastructure not suitable**: Most of the present infrastructure is not suitable and adequate to support smart city concept. Thus, is required to make new installations that will increase the cost of a smart city implementation.
- **Heterogeneity**: The components that will create synchronization include various technology requirements. Horizontal integration of infrastructures through technology is essential to get the benefits of innovation and the potential and necessary efficiency.
- **Security leak**: In case of a security leak, data may be misused. For example, habitants of a smart city will have real time data for their health conditions. Imagine the scenario under a hack attack where the hacker is able to modify those data and favor the selling of a certain medicine.
- **Lack of scale**: Higher costs because of modules and infrastructure due to lack of scale as a result of low adoption by end users. Since most of the infrastructure will be built by governmental instances, end-users will be excluded by most of the costs. This will create a lack of scale and the cost of modules and infrastructure will be higher.
- **Lack of experience**: Smart cities are nowadays implemented in developed areas around the world. However, the concept is still new and under continues change. For this reason, many governments may postpone this implementation until they have more examples, more experience that can be shared and more ‘sources’ to be inspired. (Smart cities: Utopia or neoliberal ideology?, 2017)

2.2.3 Requirements for Smart City

Smart development requires solutions to be adapted to the specific needs of the city and its citizens, and standards have to be developed with this purpose in mind, removing technology barriers that prevent technology integration.

- **New solutions**: Every day big cities are faced with complex problems just because the process of planning, designing, financing and implementing is not the right one for them. Smart city implementation requires to be open to new approaches and it can only exist if fundamental reforms are undertaken.
- **Stakeholders**: A good plan requires the participation, input and ideas from a wide range of stakeholders within the city. The stakeholders are:
 - State representatives*: This includes political leaders, mayors from local government and any other state representatives.
 - Service operators*: Services can be from private or public sector. Every operator that provides utilities like water, gas, electricity, transport, education etc. is included in stakeholders.
 - End users*: In this category inhabitants and businesses of a city are included.
 - Investors*: Big companies, corporates, local and international banks, capitalists and sponsors.
 - Masterminds*: this category includes people that will provide the solutions like engineers and technology providers. Their concerns need to be carefully considered and acknowledged and next steps have to be collectively approved. In the absence of proper consultation, the authorities will sooner or later face considerable additional obstacles to make their vision a reality. Urban decision making should be based on big data mining and accurate analysis.

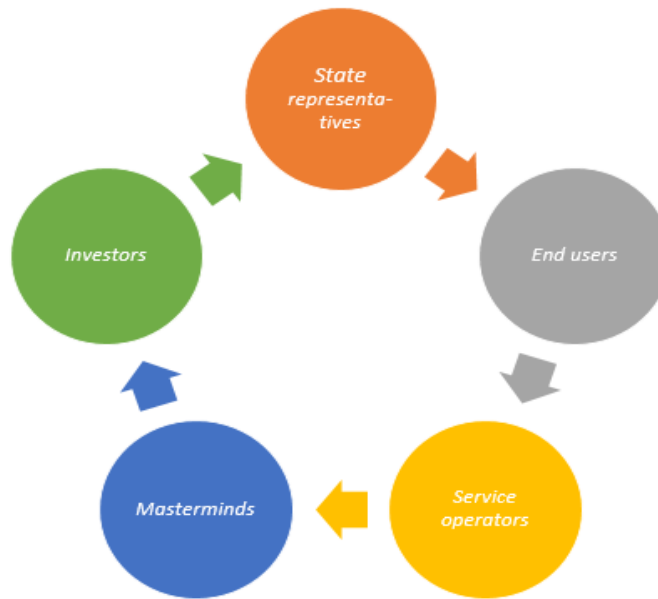


Figure 4-Schematic view of stakeholders⁶

- **Integration**: In order to create a smart city implementation integration is required. System of a system creates a hierarchic concept that is required for this type of implementation, otherwise we cannot speak for smart city concept. Electric grids, gas, water distribution systems, transportation systems, and buildings, hospitals, homes play a key role in shaping a city's liveability and sustainability. For this reason, those components should be integrated vertically and horizontally. Technology integration includes vertical integration from sensors, to low cost communication, real time analysis and control, and horizontal integration of historically isolated systems up to citizen based services. Combined, this creates a system of systems. Today's smart city projects are mainly focusing on improving the integration of vertical components like parts of existing utilities, improving for example energy efficiency, or reducing water leakage. The next step is horizontal integration. Data from the different sectors can be combined to better manage the city and reduce risks.
- **Homogeneity**: Future collaboration can only be guaranteed through the existence of international standards ensuring that components from different suppliers and technologies can interact. To create homogeneity, sharing and development of common standards to ensure that data can flow freely between systems, is essential.

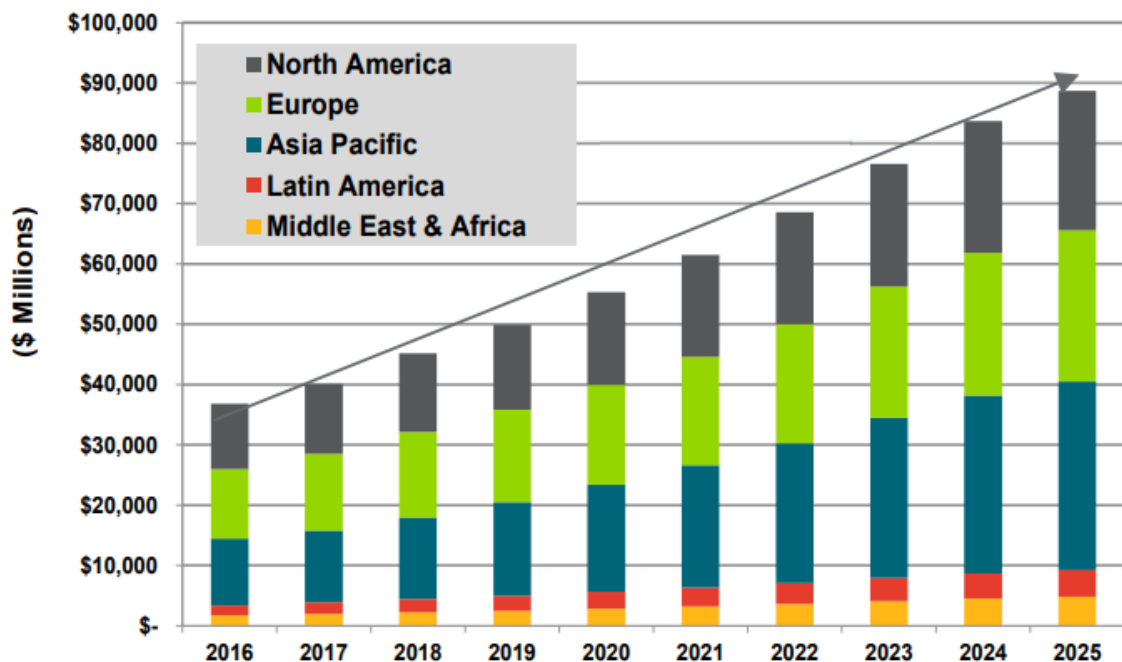
⁶ This schematic design was created by the author of this thesis

- **Security and reliability**: Connectivity and data factors also bring risks, including exposure of personal information, lack of service to critical infrastructure and damaged public trust. While a failure of internal systems is a relatively private and isolated, a failure between interconnected sectors presents risks of a much larger magnitude. For this reason, smart city implementation requires a comprehensive security architecture to ensure safety of data.

2.2.4 Actual smart cities review

Currently in 2017, 250 smart cities projects are completed or ongoing all over the world with Europe leading in terms of the numbers of projects. While South America is the region with the lowest number of smart city projects. 178 cities worldwide started the process of smart city implementation focusing in energy efficiency, transport and water management.

In addition, as sensor technology improves and costs decrease, smart city technologies are becoming more efficient, higher performing, and cheaper. The global market for smart city solutions and services is expected to grow from US\$40.1 billion in 2017 to US\$97.9 billion in 2026. (Research, 2017)



Graph 3-Annual Smart City Revenue by world regions: 2016-2025⁷

2.2.4.1 Amsterdam Case Study

Amsterdam Smart City ‘s main tool is an information platform, where entrepreneurs can initiate innovative solutions and test them on a larger scale. The main focus of the project is making better use of the existing technology, not necessarily creating new. (Baron, 2014)

Urban Population	1,108,000 ⁸
Global Urban Competitiveness	24th in the world ⁹
Global Cities Index	22th in the world ¹⁰
Innovation Cities Index	12th in the world ¹¹
Fixed broadband Penetration	41.9%(Netherlands) ¹²
Households with broadband access	82.9%(Netherlands) ⁸

Table 2-Amsterdam's Indexes for GUC,GCI,ICI and broadband-2016

The first step for the city was to create an inventory of data they already possess. In this way the city made available electronically data that can be used from programmers to create all kind of applications. This inventory created 12,000 datasets from 32 city departments. By managing only data you already have and making them public, all forms of applications can be created. For example, the private sector created an application to help manage traffic flow by using input data from 2011. By analyzing open data, the software makes it possible to check traffic flow in real time. However, this model needs to be updated, because in 2016-2017 the city has 100% more scooters and 25% fewer cars than it did in 2011.

Amsterdam focused the smart city implementation in 6 main themes that include:

- **Infrastructure and Technology**

⁷ Navigant Research, Smart Cities Research Report, 2Q 2016

⁸ <http://worldpopulationreview.com/world-cities/amsterdam-population/>

⁹ http://www.gucp.org/cities/CountryCities/CityList_English?orderYear=2012&orderType=2

¹⁰ 2016 CGI <https://www.atkearney.com/documents/10192/8178456/Global+Cities+2016.pdf/8139cd44-c760-4a93-ad7d-11c5d347451a>

¹¹ Innovation Cities Index <http://www.innovation-cities.com/innovation-cities-index-2016-2017-global/9774>

¹² OECD Broadband <http://www.oecd.org/sti/broadband/oecdbroadbandportal.htm>



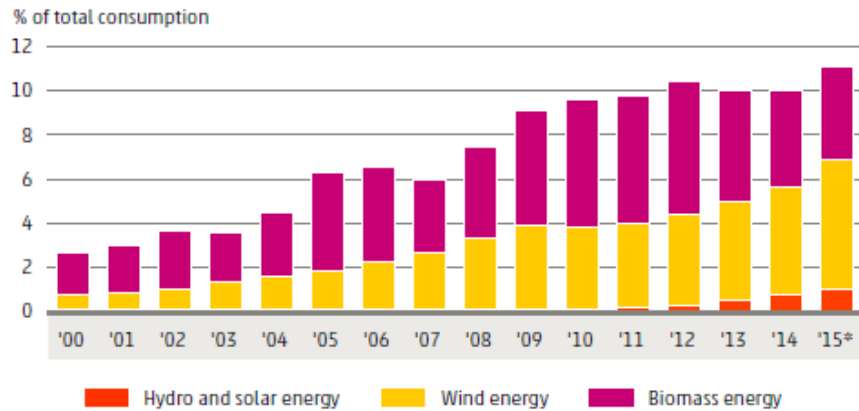
Graph 4-Internet traffic between 2014-2017¹³

According to Ams-IX statistics, between 2014-2015, the internet traffic increased with 23% and between 2015-2016 the growth was 25%. Eleven out of fifteen Trans-Atlantic data cables are connected with or go through Amsterdam, making the city the second largest internet exchange point in the world. (Amsterdam Smart City, 2017)

- **Energy, water and waste**

Netherland Statistics states that in 2015-2016, 11% of total energy consumption in the Netherlands was produced by renewable energy. By transforming waste into electricity, Amsterdam Electricity Company produces for every 1000 kg of waste, 900kWh. (Amsterdam Smart City, 2017) (Statistics Netherlands, 2016)

¹³ <https://ams-ix.net/technical/statistics/historical-traffic-data?year=2017>



Graph 5-Renewable energy production

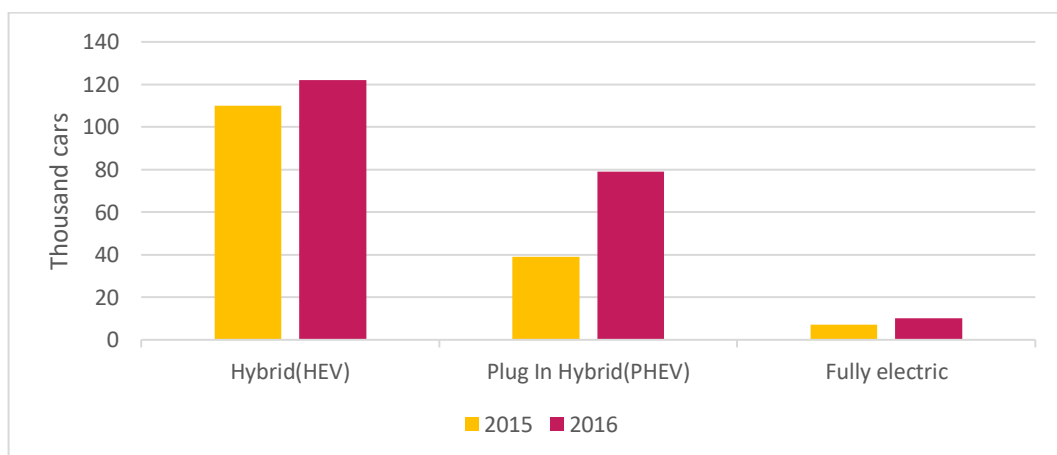
- **Mobility**

Amsterdam city has simulated the purchase of electric and hybrid cars through tax liabilities. In 2015, the additional tax liability is as shown in the table below:

Table 3-Tax liabilities according to the type of car

Type of Car	Additional Tax Liability
Fully electric car (0 gram CO ₂)	4 %
Plug-in hybrid	7%
Polluting cars	25%

This was followed up by a 53% increase of the number of electrical and hybrid cars in 2016. (Amsterdam Smart City, 2017)



Graph 6- Comparison of electric cars number between 2015 and 2016 (Statistics Netherlands, 2016)

Amsterdam is also working in changing the mentality of his citizens by financing projects that consider mobility as a service. Nowadays using services is more important than owning

them. Since every person uses his car by average only 7 hours a day and not 24 hours, internet platforms are trying to find a smart way how to make new business out of unused capacity. Besides being the country of bicycles and electric cars, Amsterdam has a public transportation adopted to a new system related with chipcards.

- **Circular City**

Amsterdam is moving to a circular economy where products are reused, recycled and reduce pollution. For example, the project called ‘Hemelswater’ aims to reduce the rain proofing problem by reusing the rain water and produce beer out of it. It’s goal is to make 100 building catch the water from the rain and turn this into products. The project, estimates that 200 rain tanks could catch 200,000 liters of rainwater before it ends up the Amsterdam sewer. In 2016, Amsterdam had a 30% separation rate and aims to go up to 65% in 2020. ¹⁴

- **Citizens and Living**

According to Netherland statistics (Statistics Netherlands, 2016), in 2015 the population of Amsterdam grew with 34,000 habitants from over 180 nationalities (3.2% growth rate). The trend is positive for the upcoming years also as shown in the table below:

Table 4-Population growth in Amsterdam

Year	Growth rate	Growth
2010	3.2%	33,000
2015	3.2%	34,000
2020	2.9%	32,000

Also, the number of tourists increased by 7% in 2016. ¹⁵ In order to provide qualitative, efficient and smart services, the city needs to collaborate with its citizens. One of the projects that brings together ideas from Amsterdam habitants is ZO!City. Its main goal is to create a dashboard dedicated to urban transformation. Now, habitants, government, organizations and business can exchange information in real time using the platform that integrated data-sharing, participatory democracy, collectivity plan and innovative ideas.

A similar platform is civocracy, that allows her users to get inform for every change in the city and express their views, by using this platform every citizen of Amsterdam has the possibility to read about everything happening in the city and also get an overview of the

¹⁴ <https://www.municipalwasteeurope.eu>

¹⁵ <https://amsterdamsmartcity.com/themes/citizens-living>

best arguments. Civocracy will also provide diverse ways how to actively participate and be involved in issues the citizen is interested.

2.2.4.2 Vienna study case

Vienna Smart City is an online platform, where government, entrepreneurs and citizens can bring together innovative ideas that will make the city more liveable and smart. Like every other city, even Vienna is facing big challenges that include: climate change and urban heat, rapid population growth, slow economic growth and limited resources.

Urban Population	1,767,000 ¹⁶
Global Urban Competitiveness	27th in the world ¹⁷
Global Cities Index	19th in the world ¹⁸
Innovation Cities Index	10th in the world ¹⁹
Fixed broadband Penetration	28.8% (Austria) ²⁰
Households with broadband access	72% (Austria) ¹⁷

Table 5-Vienna's Indexes for GUC,GCI,ICI and broadband-2016

The Framework strategy of Smart City Vienna is focused in providing the best quality of life for all citizens of Vienna, while minimizing the consumption of resources, realized through comprehensive innovation. (Vienna Smart City, 2017)

In order to compare previous case study (Amsterdam) with Vienna, we will analyze their smart city implementation describing 6 main themes:

- **Infrastructure and Technology**

By providing the right infrastructure combined with smart technology, Vienna is the choice of numerous international organizations and global companies as a city for their headquarters. 133 international companies set up business operations in Vienna in 2013, more than ever before. Total investment volume was around EUR 38 million. In the past ten years more than 1,000 international firms have established branch offices in Vienna, creating

¹⁶ <http://worldpopulationreview.com/world-cities/vienna-population/>

¹⁷ http://www.gucp.org/cities/CountryCities/CityList_English?orderYear=2012&orderType=2

¹⁸ <https://www.atkearney.com/documents/10192/8178456/Global+Cities+2016.pdf/8139cd44-c760-4a93-ad7d-11c5d347451a>

¹⁹ <http://www.innovation-cities.com/innovation-cities-index-2016-2017-global/9774>

²⁰ <http://www.oecd.org/sti/broadband/oecdbroadbandportal.htm>

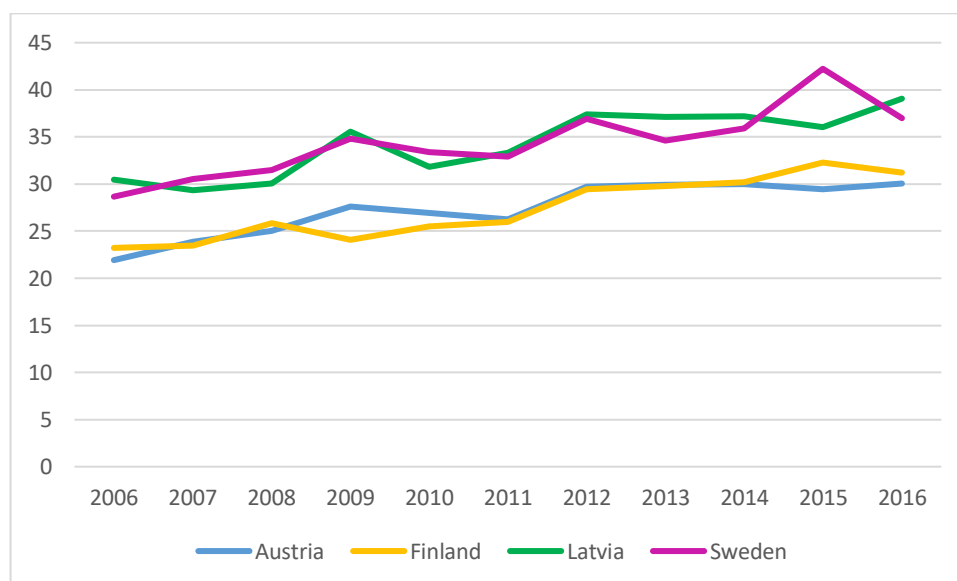
9,100 jobs and stimulating investments of EUR 800 million. In this case Vienna scores points with investors thanks to the high quality and reliability of its smart infrastructure, as well as its globally unique quality of life.

Over 195,000 students at 9 universities make Vienna a city with a great education infrastructure. The new campus of the Vienna University of Economics and Business Administration is built according to “green building” concept, offering students and teaching staff optimal surroundings for education and research. (Vienna Smart City, 2017)

Internet infrastructure is an important component that determines what capacities has a city to be smart. According to Eurostat, the number of households with internet increased from 72% in 2010 to 85% in 2016. There are two internet Exchange points in Austria, the biggest one being in Vienna (VIX).¹⁷

- **Energy, water and waste**

Austria is the fourth country in Europe with the highest rapport between renewable energy and primary energy supply. Renewable energy is defined as energy of hydro, geothermal, solar, wind, tide, wave sources, biofuels and biomass. While primary energy supply is estimated as energy production plus energy imports, minus energy exports. (OECD, 2016)



Graph 7-Renewable energy-Total, % of primary energy supply, 2006 – 2016²¹

Vienna has approached the smart metering technology that has a great potential to achieve cost-efficient energy savings. Also, smart meters play an important role in smart grids.

²¹ Data for this graph is attached in appendix 7.2.

In April 2012, Ministry of Economy has issued a decree which determines the mandatory time schedule for implementing smart metering services in Austria. The electricity network operators have to equip at least 95% of all metering points by the end of 2019. According to estimations of the regulatory authority, about 300,000 electricity customers have already been equipped with smart meters. (SmartRegions, 2013)

- **Mobility**

Vienna currently has five subway lines, 29 tram routes and 127 bus routes. The total public transportation network amounts to over 850 km in length.

Wiener Linien, that is the largest company running public transportation, is choosing to modernize its fleet of buses by increasing numbers of electric buses. Also, Wiener Linien was awarded the Austrian State Prize for Mobility in 2013 for the project involving "zero emissions buses"

As we discussed before for Amsterdam, service sharing is a concept implemented even in Vienna. Different types of bicycles are offered for rental by private individuals and bicycle shops on the bike sharing platform www.listnride.com. Same applies if you need a car. Vienna currently has two free-floating systems with www.car2go.com and www.drive-now.com that offer you the possibility that without owning a car you can have personal mobility. Another alternative is SCO2T, a platform where by using a smartphone app you can reserve a SCO2T nearby you and start the rental when you are there. At the end of the ride, simply park the bike in a legal parking place and end the rental again via the app. (Vienna Smart City, 2017)

- **Circular City**

Vienna was one of the first cities in the world to realize that waste separation contributes significantly to environmental protection. Thus waste is separated, collected, recycled and disposed of in Vienna already since the 1970s. The waste management system contributes not only making Vienna a very clean city but it is also strongly oriented towards the Smart City Wien objectives and due to smart technology saves 550,000 tons of CO₂ annually, which is more than it actually causes through the process of waste management (420,000 tons of CO₂ equivalents). This is achieved by producing centralized heat from residual waste combustion, the fermentation of kitchen waste in Vienna's biogas plant, waste separation and waste recycling as well as the use of compost for organic farming. (Vienna Smart City, 2017)

- **Citizens and Living**

Mercer carries out a study in order to assess the quality of life in 231 cities around the world. The results of the study in 2017 also gave Vienna top marks and made it the most livable city in the world for the eighth time in a row.

Smart technologies improve and simplify the life of not only Vienna's citizens but also to its visitors. Different smartphone apps, free Wi-Fi, interactive tourist websites and interconnected technology make Vienna one of the top cities in the world to live in.

Free WI-FI is accessible at different public places in Vienna. Most of the tourist information offices located in key points like Albertinaplatz, Stephansplatz, Danube Island, etc. offer this service.

Adding numerous hotels, cafés and bars offering the same service, the number of free Wi-Fi access points it is raised to around 400.

The website dedicated to tourists www.vienna.info has a responsive design since January 2015 that allows the website to adapt to any screen size or device. No matter you are using a desktop, tablet or smartphone, the content, function and design will automatically adapt to your screen size. The city map with the "What's around me" function and mobile travel plan allows you to see what is happening around you in real time.

Vienna is the best example that culture and smart technologies get along together. Since October 2013, Vienna State Opera has made possible to follow selected performances via livestream on your Smart-TV in UHD (ultra-high definition). By downloading the application, subtitles in different languages are available. Also, to make the experience enjoyable like if you were there, you can choose between footage and a complete view of the stage. In this way, Vienna State Opera is making accessible its cultural events to a larger audience.

2.2.4.3 **Prague study case**

Smart Prague is the online platform where a summary of the smart city projects can be found. (SmartPrague, 2018) Prague, the capital of the Czech Republic, as many European cities are facing today's challenges: public spaces, population growth, green spaces, transport, etc.

Urban Population	1,346,000 ²²
Global Urban Competitiveness	31th in the world ²³
Global Cities Index	46th in the world ²⁴
Innovation Cities Index	53th in the world ²⁵
Fixed broadband Penetration	29.88%(Czech Republic) ²⁶
Households with broadband access	72%(Czech Republic) ¹⁷

Table 6- Prague's Indexes for GUC,GCI,ICI and broadband-2016

- **Infrastructure and Technology**

Nowadays, where most of the information is exchanged via smartphones, it is very important that the city focuses on building a Wi-Fi free broadband network.

Currently Prague offers free WI-FI access to the main tram stations, major public attractions such as the Old Town, the Rudolphium Opera and all shopping malls. A good example of this is the Zoo and Botanical garden, where visitors connected to park WI-FI get real time notifications about events happening around, such as feeding animals. The network has 5 GHz navigation speed and its build according to legislative standards. The city is also working in expanding the free network towards Petřín Park (planned to be finished by 2018) To improve public transportation, Prague is working in offering internet connection in metro station. The biggest benefit of this project, that started to be implemented in October 2017, is that DPP will be able to send push messages in case of emergencies. This will increase the security of commuters. (SmartPrague, 2018)

- **Energy, water and waste**

In the period of January 2019 - January 2020 the city of Prague intends to implement a Smart building and energy project with the aim of creating an assessment system of buildings owned by the city. Under this project Prague expects to adopt more qualified decisions relating to energy investments and building innovations resulting in energy savings and lowering of operational costs. As a part of the smart waste management project Prague

²² <http://worldpopulationreview.com/world-cities/prague-population/>

²³ http://www.gucp.org/cities/CountryCities/CityList_English?orderYear=2012&orderType=2

²⁴ <https://www.atkearney.com/documents/10192/8178456/Global+Cities+2016.pdf/8139cd44-c760-4a93-ad7d-11c5d347451a>

²⁵ <http://www.innovation-cities.com/innovation-cities-index-2016-2017-global/9774>

²⁶ <http://www.oecd.org/sti/broadband/oecdbroadbandportal.htm>

intends to optimize the waste collection process through implementation of system of sensors located in the waste containers. Information therefrom will help the municipality to organize the waste collection routes in a rational way thus reducing the costs and freeing the roads for other traffic. (SmartPrague, 2018)

- **Mobility**

Mobility will be explained in detail in this thesis when a comparison between Vienna, Amsterdam and Tirana will be provided. Prague has one of the best public transportations in Europe, cheap, fully integrated and very efficient. It's easy to buy tickets from touch screen machines located in the main metro stations, where cash or card payments are possible. If you are a regular traveller, *Lítačka* is the right choice. This card contains your personal information and is easily identifiable, refilled online and since 2020 there will be no need for physical validation. The card can also be used to borrow books from the national library, to benefit from discounts on some museums or for boats on the Vltava river. (SmartPrague, 2018)

- **Circular City**

Wasteless city is the motto of Prague as a circular city. The smart project being implemented for waste management is called compression baskets. 30 baskets are installed currently in the city centre of Prague and the results of this pilot project will decide if this method will be implemented all over the city. The baskets are interconnected via Internet and they can compress mixed waste by saving space for the city. Once the basket is full, an automatic notification is sent to the collection company. The entire process operates by using batteries recharged by solar energy. (SmartPrague, 2018)

- **Citizens and Living**

Prague is working continuously to provide services that are more advanced, attractive and efficient for its citizens. One of the projects that is worth mentioning is the return of *Naplavka* boulevard to a tourist attraction through the latest technology.

It is planned that the whole boulevard will be equipped with sensors that control the environmental and social phenomena. In this way it is possible to collect the data that show real-time traffic monitoring and monitoring of energy consumption. Another positive aspect of implementing such a smart system is to increase the security of the area. (SmartPrague, 2018)

3 Practical Part

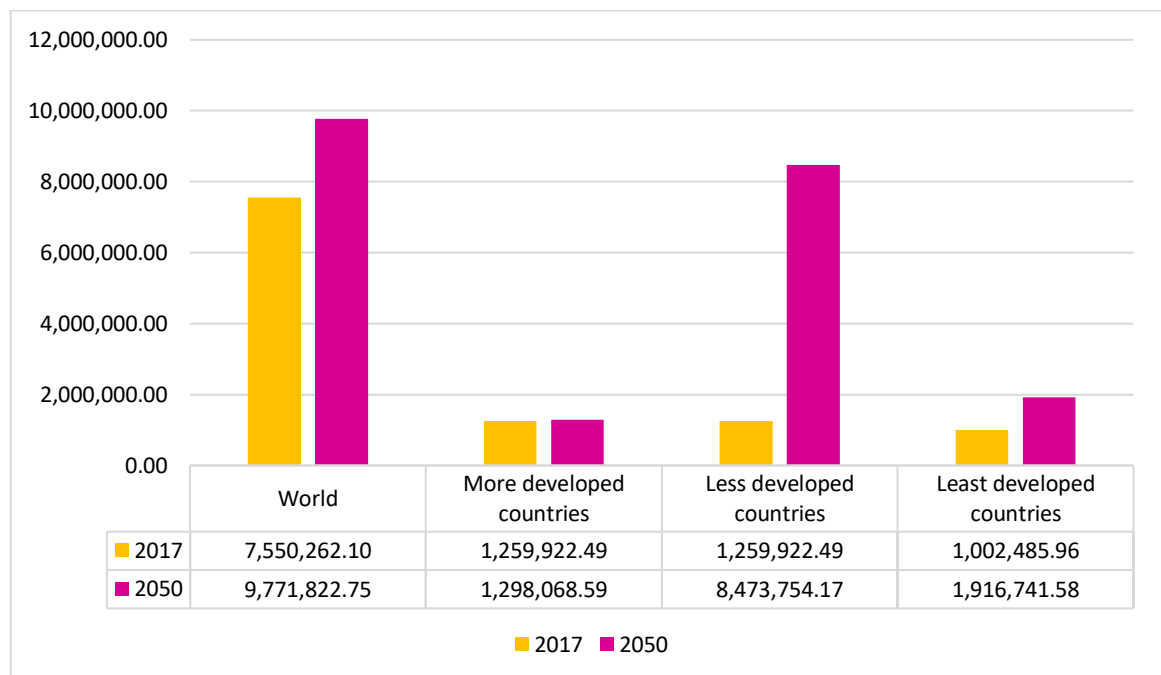
3.1 Why developing countries should implement smart cities

Countries in development will experience different urbanization patterns. Thus, the implementation of smart cities requires an approach that is personalized for each of them.

Fast urbanization

Developed regions like North America, Japan or European Union have already obtained high levels of urbanization and for this reason is not expected further increase in their urbanization. In contrast, developing regions like Africa, Asia and South Europe are projected to experience a large growth in urban population in the upcoming years. (United Nations, 2014)

The trend of population statistics shows that while population growth is increasing slowly, urbanisation will increase more rapidly.



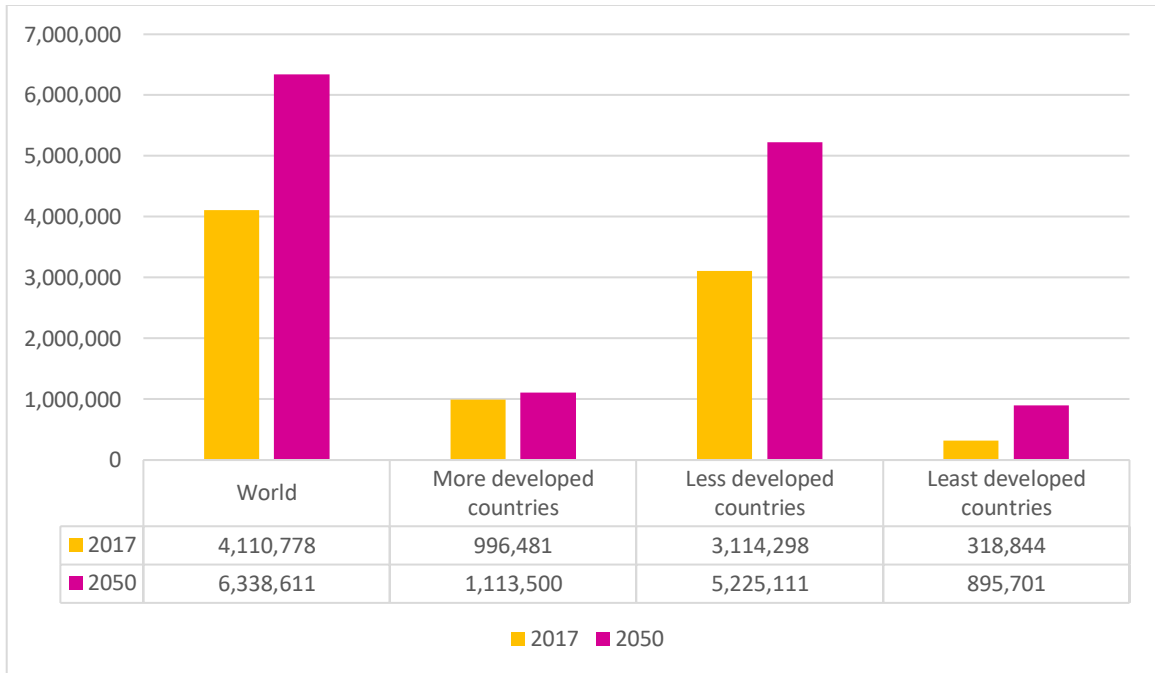
Graph 8- Annual Population Statistics²⁷

²⁷ United Nations: World Population Prospects 2017 <https://esa.un.org/unpd/wpp>

* More developed regions comprise Europe, Northern America, Australia/New Zealand and Japan.

** Less developed regions comprise all regions of Africa, Asia (except Japan), Latin America and the Caribbean plus Melanesia, Micronesia and Polynesia and small region in Europe.

According to United Nations, the world population will growth with 23% from 2017 to 2050. If we divide it in 3 groups, respectively in more, less and least developed countries, the difference is significantly big. More developed countries will face a population growth of just 3%, while in less developed countries the increase is going to be 85%. While urbanization trends are quite different from total population growth.



Graph 9- Annual Urban Population Statistics ²⁸

Worldwide, 54% more people will live in cities if we compare 2017 and 2050. In more developed countries, the growth is 12% while in less developed countries urban population will grow with 67%.

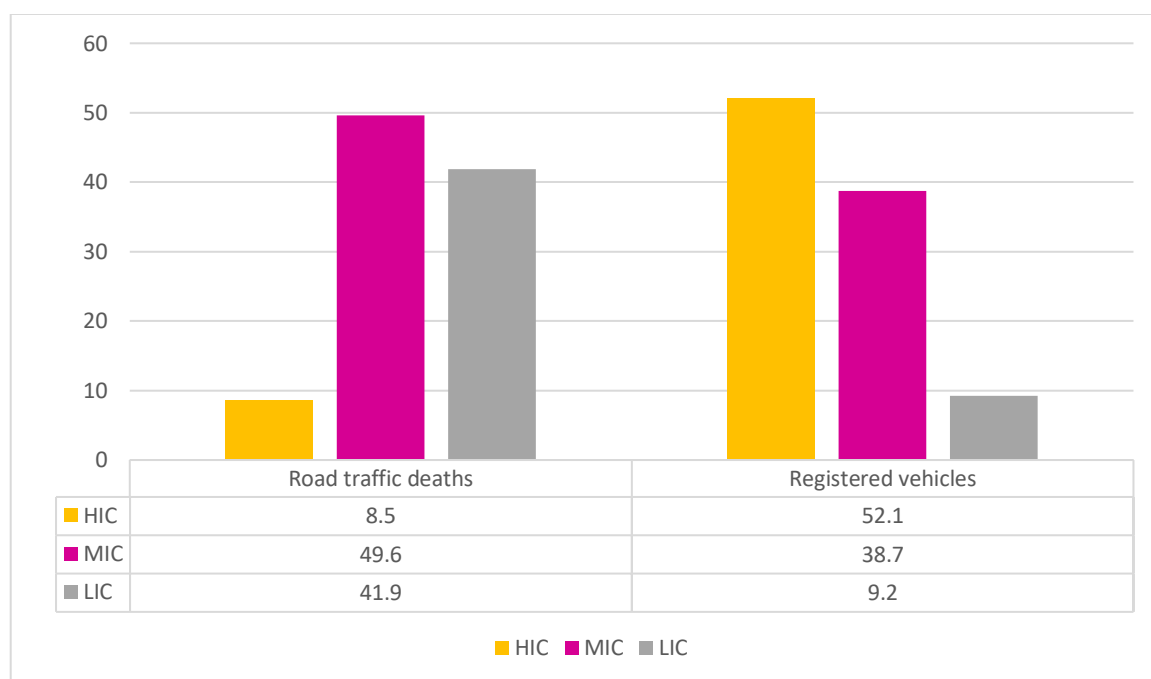
Lack of critical infrastructure

Another main reason for developing countries to keep an eye in smart cities implementation is the lack of critical infrastructure and services. While developed countries are struggling on finding efficient ways on how to upgrade existing systems, developing countries have the possibility to analyse their decisions carefully. By building everything from scratch, they have a better flexibility towards new implementations. Since nowadays, smart cities

*** The group of least developed countries, as defined by the United Nations General Assembly in its resolutions included 48 countries in January 2014: 34 in Africa, 9 in Asia, 4 in Oceania and one in Latin America and the Caribbean.

²⁸ United Nations: World Urban Prospects 2017 <https://esa.un.org/unpd/wup>

structure is more and more solid, for those countries, it will be easy to adapt in future changes. Transport is one of the infrastructures that needs immediate attention since over 49.6 per cent of the deaths on the roads occur in middle income countries and around 41.9 per cent in low-income countries, which have only 48 per cent of the world’s registered vehicles. (Global Status Report on Road Safety, 2015)



Graph 10- The state of road safety around the world (Global Status Report on Road Safety, 2015)

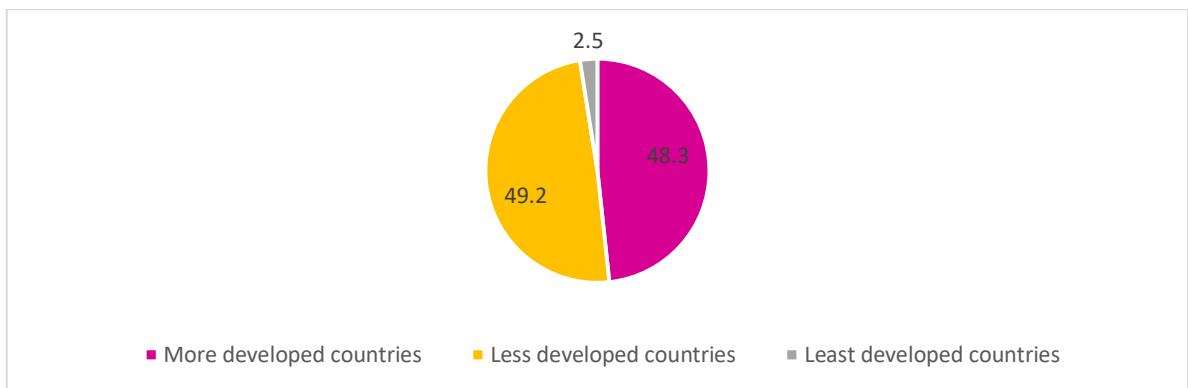
By incorporating the smart city vision right from the inception, countries in development can improve their services like education or health sector. Interconnection of systems that smart city offers will exponentially increase the efficiency of data processing and as a result end users (citizens) will profit directly in having better services. The main focus of those countries will include water, energy, transportation, health and education since in those sectors the future demand will be higher. (Jennifer Bélissent, 2010)

Unsustainable growth

This is another factor directly related to fast urbanization. The rapid and unplanned displacements resulted in a lack of major resources, amongst the most important housing. Built urban area in developing countries in the last 16 years equals the amount of built urban area around the world since 2001. ²⁴

Environmental sustainability growth

Nowadays, when climate change is more apparent than ever, environmental degradation has increased and the need for resources is at highest levels, environmental sustainability is in the foreground. Rapid urbanization did not take into account environmental costs, as it increased in developing countries. These negative consequences on our environment have drawn a lot of attention, being one of the main reasons why developing countries are seeing smart cities technologies as an immediate solution.



Graph 11- Global share of emissions ²⁹

The graph above clearly shows the role played by developing countries in the production of global share emissions. Developed countries and developing countries, almost symmetrically emit the same amount, thus increasing the responsibility of developing countries.

3.2 Overview of Albania with a focus in Tirana.

Tirana is the capital city of Albania with a population of 2,876,591 in 2017 according to Instat³⁰. Being the biggest city in Albania, Tirana keeps around 20% of national population after 2005, is facing many challenges, one of them being urbanization.

In 2017, the population of Tirana reached 862,361, from 374,483 in 1997²⁴, or an increase of almost 230% in just 20 years. A rapid urbanization resulted in serious urban problems such as lack of infrastructure, especially in housing. Many rural migrants illegally settled in protected green areas with no sufficient water, power supply systems and where solid waste is managed poorly, resulting in significant degradation of the urban environment.

²⁹ http://expo.nikkeibp.co.jp/scw/2012/conference/pdf/k2_suzuki.pdf

³⁰ <http://www.instat.gov.al/al/temat/treguesit-demografik%C3%AB-dhe-social%C3%AB/popullsia/#tab2>

Albania also falls under the less developed countries trend where population increase rate is less than urbanization rate.

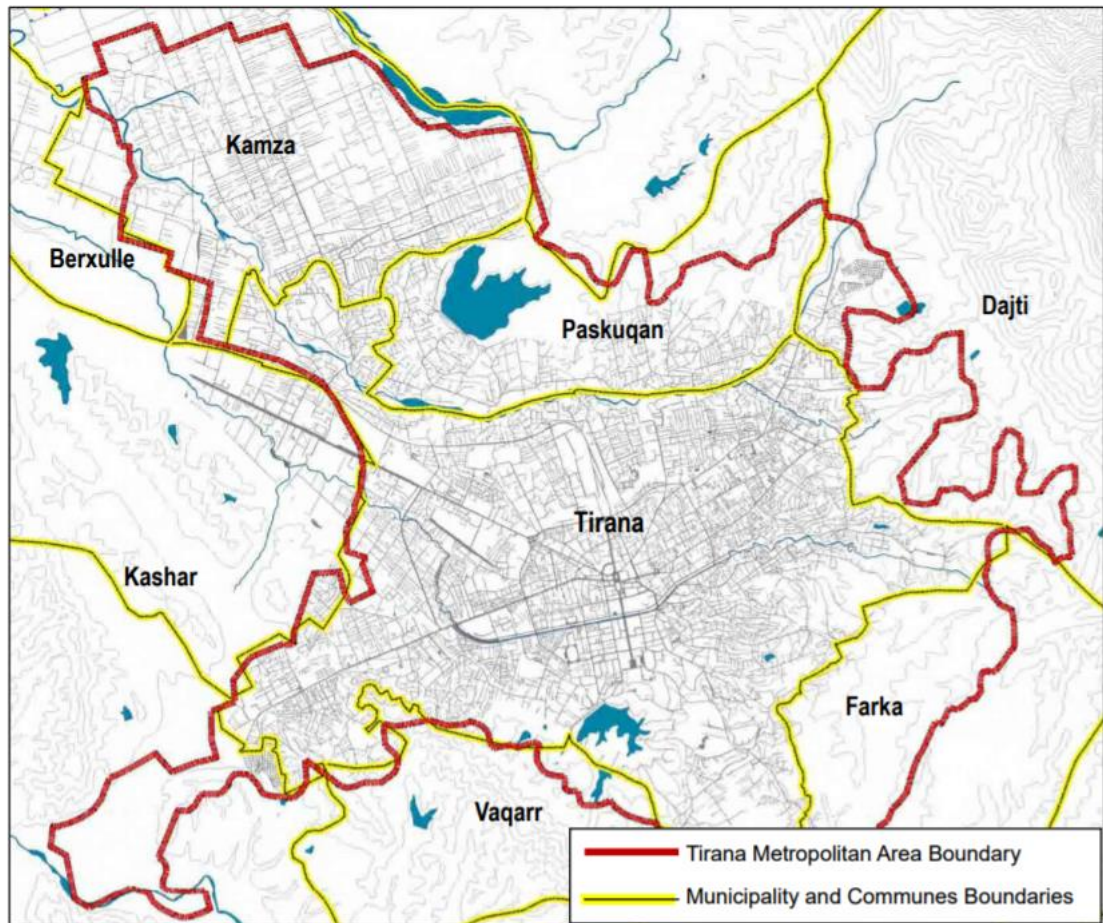
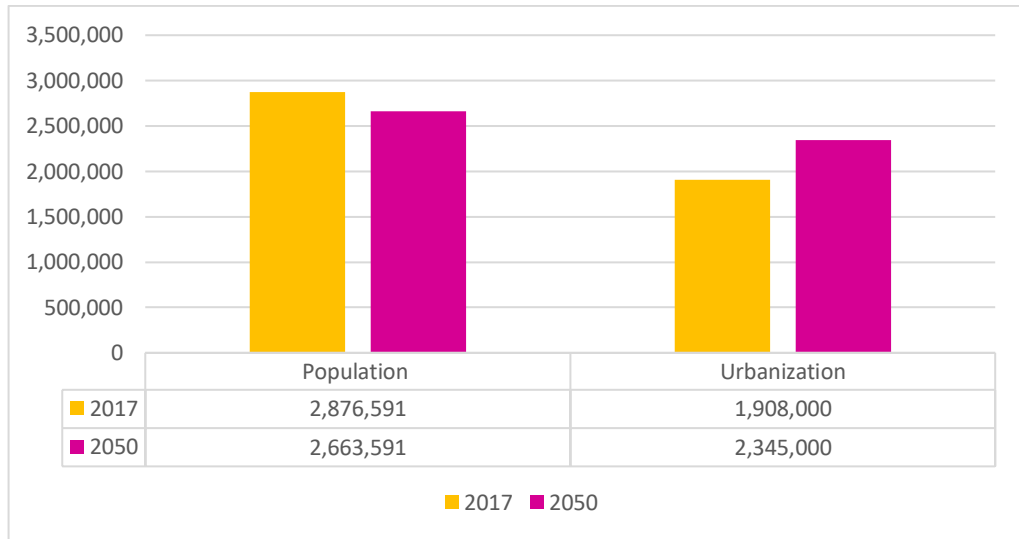


Figure 5- Map of Tirana metropolitan area boundary (JICA, 2012)

The graph below shows the population and urbanization in 2017 and predictions of 2050. Total population will undergo a decrease of 7.5% still the urbanization is predicted to have an increase of 22%. It is thus urgent for urban developments in main sectors to keep up with the progress of urban population.



Graph 12- Population and urbanization of Albania ³¹

Public transportation

Currently, public transport in Tirana is largely met by buses and partly by taxi or bicycles. It has 15 bus lines that cover the main areas and 4 bus lines connecting the city center with suburbs. No tram or metro is available. Since the service of electronic tickets is not available, there are not accurate statistics on the total number of passengers using urban transport. The implementation of this phase does not only serve to provide a quality service but builds infrastructure for a further improvement of the city transport service.

According to the Municipality of Tirana, the Municipality defines its policies, and these policies are given to consultants to invest in the material. Such was also the tram project that has been introduced to the JICA project. The Municipality of Tirana confirms that it has seen the economic analysis of the necessary investments and the possible costs of operating a tram system. According to the Municipality of Tirana, the Municipality does not have the financial resources that even if it builds it with a concession, to issue millions of euros each year to repay the investment, the following, the Municipality has decided not to support this project for financial impossibility, but to support a high-capacity transport system with buses.

³¹ World Urbanization Prospects <https://esa.un.org/unpd/wup/DataQuery/>

Energy

Albania is among the countries with the highest potential for renewable energy production in Europe. Through a strong political commitment and an ambitious national strategy, the Albanian Government has positioned the renewable energy sector as one of the priority sectors. The Government's long-term vision is the positioning of Albania as one of the major renewable energy-oriented economies.

For the moment, the main source that covers energy requirements is water power. Water resources are among the most important natural resources in Albania. Eight major rivers, fed by hundreds of rivers and streams flow through the country from the mountains to the East to the Adriatic Sea and the Ionian Sea in the West. The average altitude of the hydrographic territory of Albania is about 700 m above sea level. However, it should be noted that the country has an enormous potential for exploiting wind, sun and biomass energy also. The wind speed in Albania is 6-8 m / s, but this speed is achieved only in the coastal areas and in the mountainous part of the east and south. For this reason, Tirana has a limited potential to exploit wind energy. Domestic and foreign investors are licensed to study wind power production in Albania. By 2020, the government aims to generate 5% of total electricity from wind sources. Having a Mediterranean climate, Albania has very favorable conditions for the development of solar energy, including an average solar radiation 4.1 kWh / m² and average of 2400 sunny hours per year. Currently, solar energy is mainly used for heating purposes. Photovoltaic energy still has opportunities for exploration. (AIDA, 2017)

Education

Being the country with the highest percentage of youth people (15-24 years old) education has a significant role in government and private sector investment.³² Education is one of the few sectors where Albania is implementing smart concepts based on international experience.

One example is the project "Modernization of the Education System in Albania through e-Education", implemented by the Austrian company BIT Media e-Learning Solution GmbH & Co. KG will offer 3 modules:

- Central Education Portal

³² <https://www.theguardian.com/world/datablog/2016/aug/12/the-countries-with-the-youngest-populations-from-albania-to-antarctica>

- E-Learning Platform for ICT Skills and English Language
- E-Learning Platform for Materials with Authoring.

Project implementation has started since August and is foreseen to be implemented for a period of 18 months and in several phases, including installation of infrastructure of operation, its adaptation in Albanian, installation of various system components as well as phase of testing. Finalization of the project will enable each student access to a set of courses / lectures and experiments created by an Albanian teacher's panel and will serve as a platform for exchange of knowledge and learning experiences. Also, the platform will enable the development of knowledge through new information and communication technologies. With a budget of 600 million ALL that will focus on the digital education infrastructure project. Added to the agreement with the Austrian government for about 500 million ALL for the "digital e-learning" learning system, the electronic system management system and the electronic registry, this year the government is investing about ALL 1.2 billion for digitalization of the education system in place. The new digital system is being implemented as a pilot project in a few high schools around all the country.

Statistically:

- 60 general high schools in 38 zones around Albania
- 120 labs, each having 40 tablets, a lap-top, smart-projector
- 5850 tablets, not only for laboratories but also for teachers (to work individually, as well as special classes where students can take them with you). (Ministry of Education, 2017)

Health Care

The health care service is currently the worst public service for Albanian citizens. Albanian healthcare fails to realize any of its functions: it does not prevent, diagnose, cure, and rehabilitate.

The contributory health insurance system provides coverage for less than half of the working age population. For this reason, around 1 million working-age Albanians have to pay out for health care, thus increasing inequality and social injustice. In 100 ALL spent on health, only 40 ALL are funded by public money.

Information on health care indicators and their linkage with basic social indicators at the individual and national level is deficient, inaccurate, fragmented and incoherent. Consequently, decision-making is also carried out unprofessionally. The government aims to set up a unique digital healthcare system that will link all actors in the health, public and

private healthcare system. At the centre of the system will be the individual and his electronic health file. Digitalisation of information on health and health care will also be used to significantly increase transparency in public communication on the state of health of the population, the use of available resources, to begin implementation of open accountability standards of public officials and service providers and confidence-building between the population, service providers and senior officials.³³

Environment

From air quality monitoring, it is concluded that air quality in monitored cities is not a very good level. The main pollutants of urban air quality are PM 10 and PM 2.5 at the stations of Tirana, Elbasan and at Korça station in the winter period. The main source of PM10 contamination at Elbasan and Tirana stations is the discharge of vehicles since the stations are installed along the heavy traffic routes while at Korça station the main source of PM10 / 2.5 pollution is the use of combustible materials for heating the dwellings.

The problem is the overtime of days (35 is the number of days allowed in a year) of the EU daily rate of 50 µg / m³ for PM10 respectively at the Tirana KTA station and Korca station where the number of days exceeded respectively are 73 and 65.

From urban noise monitoring for 2016 it turns out that in all cities there are high levels of noises for the period during the day. While only in some of the monitored spots of the cities of Korca, Berat and Saranda there is a noise level within the standard. (Ministry of Environment, 2017)

Water resource management

There has been some improvement in water supply and sewerage in Albania over the last few years. Currently, coverage with the water supply service is approximately 80% in urban areas and 50% in rural areas. Coverage with sewerage services is approximately 80% in urban areas and 10% in rural areas. Numerous investments have been made for the sector, which have not been efficient due to several factors, such as: (1) the way in which investments have been distributed over the years; (2) high costs of sewage treatment due to poor intervention and maintenance; and (3) the quality of non-optimal management of service delivery.

Indicators	Value
Total annual water flows	39.22 billion m ³ /year

³³ <https://kryeministria.al/al/programi/sherbimet-publike/kujdesi-shendetesor>

Renewable water resources	13,300 m3 per capita
Water loss	>60%
Water supply from the public system	covers 85% of the population
Electricity production	90%
Use in agriculture	43% of the surface is covered by the irrigation system
Production of electricity	90%
The annual average rainfall	1485
Coastal area	7000 km2 (25% of the national territory)
Coastline length	476 km

Table 7- Data for water resources management in Albania. (Ministry of Environment, 2017)

From the hydrological point of view, the site is divided into six river basins that are: Drin-Buna, Mat, Ishëm-Erzen, Shkumbin, Seman and Vjosa. For their management, there are authorities at central and local level, however, it often seems that these responsibilities have overlapping and lack of proper management. With the rapid and uncontrolled economic development over the last two decades and based on annual data of environmental status reports, the quality of water resources has undergone significant deterioration.

The extraction of river gravel and the construction of hydropower has created great pressures on the waters and river beds. (Ministry of Environment, 2017)

Digital Infrastructure and Online Services

Albania in the framework of its path to membership in the European Union has undertaken several reforms needed to get closer to international and European standards. The use of information technology in recent years shows the high public utility of these tools and the support they give to the enhancement of quality and effectiveness in performing public functions.

Electronic registration and administrative processing systems in registration and licensing of businesses, conducting public procurements, payment of taxes, civil registry or receipt of a penalty certificate have significantly increased access, ease, transparency and decreased the costs of receiving these services from citizens and businesses.

In the context of these developments are approved Law "On Electronic Communications"; Law "On Electronic Signature", Law "On Electronic Data Protection", Law "On Electronic Commerce"; the law on electronic document, cybercrime legislation, and the fundraising for state databases. Since three years it was established the National Agency for Information Society (NAIS) , and recently the Agency for Research, Technology and Innovation (ARTI),

The National Register is digitized; e-procurement system has been implemented since the end of 2007 and currently all public procurements services are carried out electronically; Electronic Tax Service has been offered in place since 2008; Customs declaration is made electronically and First Biometric Passports are released on beginning of 2009. The registration of businesses is realized from 2007 through one-stop shop process at the National Registration Center (NRC) and recently since 2009, is possible to obtain licenses at the National Center of Licensing (NLC). Also, a project is being implemented to have access points to the public at all Albanian Post Offices. (Public administration department, 2010)

City Governance

Being the first level with which citizens' face, local government has a high responsibility for ensuring transparency and guaranteeing local government. Some of the key services that city governance covers are public procurement, building permits, licenses and the provision of important services such as housing and education.

Currently the main project of the municipality is the construction of the Electronic Registry of Civil Status. This register is integrated with the government platform e-albania, where citizens can log in and receive within a short interval of time various services such as birth certificates for example.³⁴

Economy

With the rapid introduction of technology into the economy, Albania has facilitated the creation of new jobs, industrial sectors are built to maintain the respective pillars for long-term economic development. But it also helps the country's governance through the harmonization of technology with the objectives of a clean environment preservation and expanding the interest of foreign citizens. Once the industries that will be promoted for long-term economic development will be set, the skills and quality of workforce will increase through the education system in the country, as well as competing with regional markets.

³⁴ <http://www.tirana.al/>

As mentioned in IMF reports, regarding budget policy and the recommendations of the World Bank office coincide with the idea of coordination of a policy of economic development, structured according to the factors mentioned above. The Albanian economy at 70% is today dominated by the trade and services sector. On the other hand, it should be noted that capital accumulation from economic development was concentrated due to low-level corruption. Accumulation of capital in few individuals and companies is a major reason for the significant slowdown in economic growth in recent years. (Gjokutaj, 2017)

Finance

The finance sector is one of the sectors where the concept of open data is applied in Albania. Specifically, through the online platform called "local finances", citizens can read periodic reports on major financial developments; control the income of 61 municipalities by main sources (own or government); as well as on local expenditures by economic nature.

The main financial services where a trend of implementation of smart techniques is observed are electronic payments, the banking system and insurance.

Nowadays, the main mission of financial institutions in Albania is to meet customer requirements at an even higher level. Most of the second level banks in Albania now offer internet banking. The positive aspect of internet banking is not simply to allow consumers to carry out financial action quickly and simply, but to allow them to receive financial advice from more than one source. (Local Financial, 2016)

Citizens participation

Citizen Participation is a two-way communication process between government and citizens or the private sector. The main goal is to make decisions that are approved by the public and aim at achieving the objectives.

Concerning citizen participation in Tirana, some of the problems identified are: the citizens are little or no informed about initiatives taken by the government or the private sector; citizens are not aware of their rights and responsibilities; often incorrect implementation of the legal framework by officials creates disappointment. (Partners Albania, 2013)

Recycling

Albania recycles over 17% of locally generated recycled materials (over 221,000 tons of recycled waste) recycled is exported to other countries. It is estimated that the potential for

investment in the recycling sector amounts to about 50 million Euros. It should be noted that this sector is still in its development phase and that every day there are noticeable changes, despite the various problems encountered starting with the way waste is disposed in Albania. About 60 private companies are in the market, which are dealing with waste recycling. Companies recycle these waste streams:

- Recycling of paper: 3 companies
- Plastics: 10 companies
- Textiles: 1 company
- Aluminum: 4 companies
- Steel: 15 companies
- Scrap metal: 21 companies
- Inert waste (bricks from destruction): 1 company
- Wood: 1 company
- Remaining oils: 1 company
- Used tires: 1 company

There are about 12,000 individuals involved in metal collection. They are not well equipped and untrained and above all have no official contract with their buyers. Barriers to recycling have been identified: high energy prices, transport pricing, poor economic power of aggregators, individuals and companies together; lack of separation from the beginning; lack of public, administrative and commercial information; lack of stimulation and promotion of reuse, recycling and processing; lack of experience from the businesses themselves; difficulties in accessing financial resources to develop such businesses. (Land, 2015)

Fire and emergency response

Each year, in Albania, hundreds of hectares of forest and pasture are burned, causing great damage to the country's economy and the environment. However, Albania continues to have limited capacities both in means and in human resources, to cope with the recurring emergency situations that are caused annually by fires in the forest areas of the country.

Emergency response is low and since the hydraulic equilibria of the burned soils break down and Albania has losses from the water reserves but also other losses in the forest resources, without forgetting the degradation of wildlife habitats and undoubtedly the degrading effect of the natural landscape.

3.3 Survey analysis

The survey is based on gathering and analysing information provided from different age groups of Tirana's citizens. The survey tries to not impose a single definition of smart city, but mostly it focuses in gathering opinions of citizens on what they perceive as smart initiatives.

As a methodology, in order to analyze the citizen's knowledge, we included 14 general sectors where each participant had to indicate with a scale from 1 to 5, how much they think the city is working towards smartness in this sector.

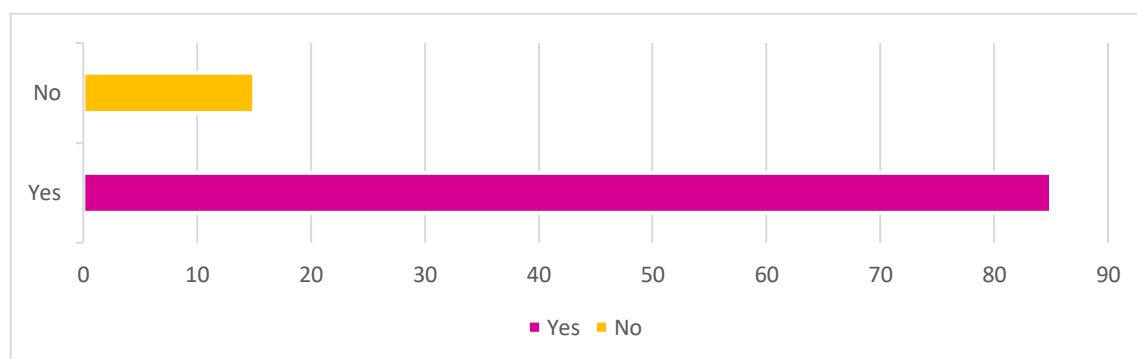
The second part of the survey included a free space where participants had the possibility to express their opinion by choosing 3 sectors out of 14, according to what they consider more important and where the government/private sector focus should be.

The survey was developed based on Eurocities project: survey for citizens& stakeholders (CityKeys & Eurocities, 2015) where required changes to be adapted to Tirana were made.

3.3.1 Exploratory data analysis

The survey was distributed by using a web link to 149 participants. The replies obtained scored a 67% participation.

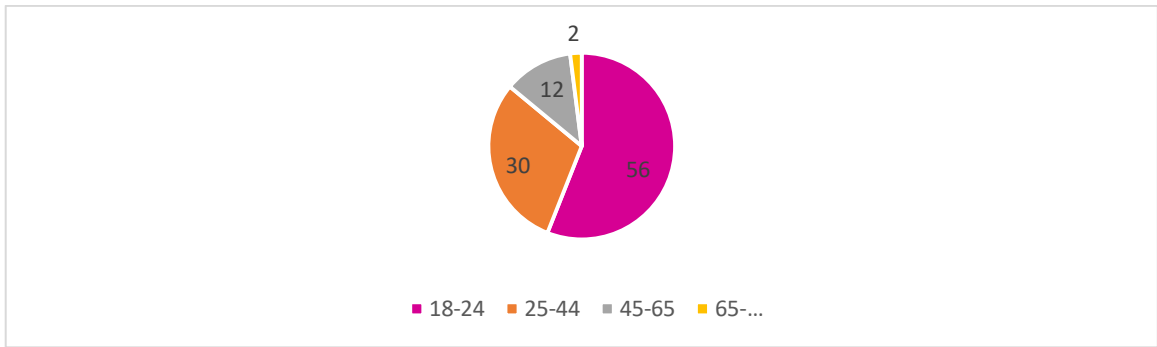
On a time interval from 5th of December to 12th of January ,100 answers were collected. 85 of 100 participants live currently in Tirana, having a closer view to the city projects and investments focus.



Graph 13-Currently living in Tirana³⁵

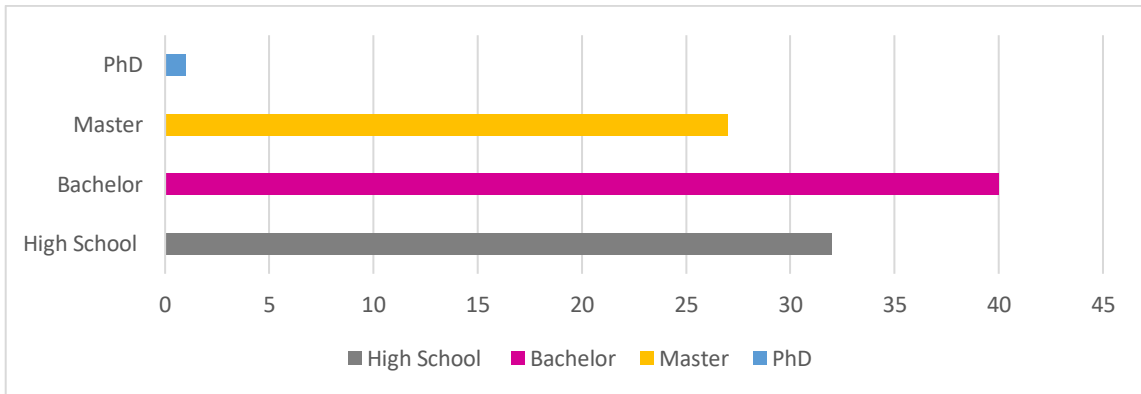
The main age group that participated in the survey is 18-24, followed by the age group of 25-44.

³⁵ Source: Based on data gathered during the survey



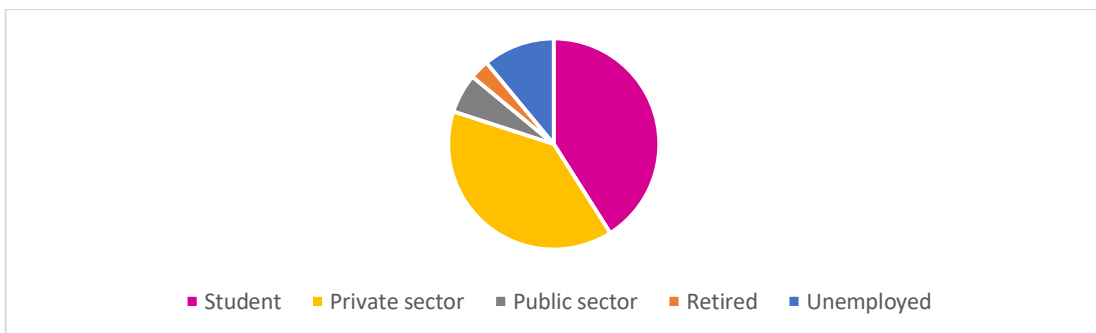
Graph 14- What group age do you belong to?³⁶

68% of the participants have a higher education than high school, where 40 participants have at least a bachelor degree.



Graph 15- Choose the level of your education³⁷

Currently 39 out of 100 participants are employed in the private sector and only 6 out of 100 are working in the public sector. The majority of the participants are students, an expected result based on the age group that participated in the survey.



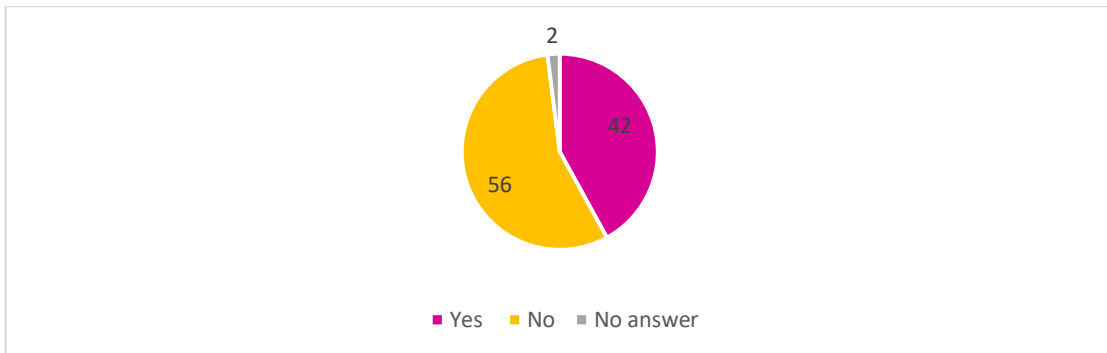
Graph 16- Status of employment³⁸

³⁶ Source: Based on data gathered during the survey

³⁷ Source: Based on data gathered during the survey

³⁸ Source: Based on data gathered during the survey

During the survey, participants were asked if they had any information regarding smart city projects that Tirana is implementing. A simple definition of what a smart city project includes, was also provided before the answers to create a defined framework. 56% of the participants had no information regarding smart city projects being implemented in Tirana.

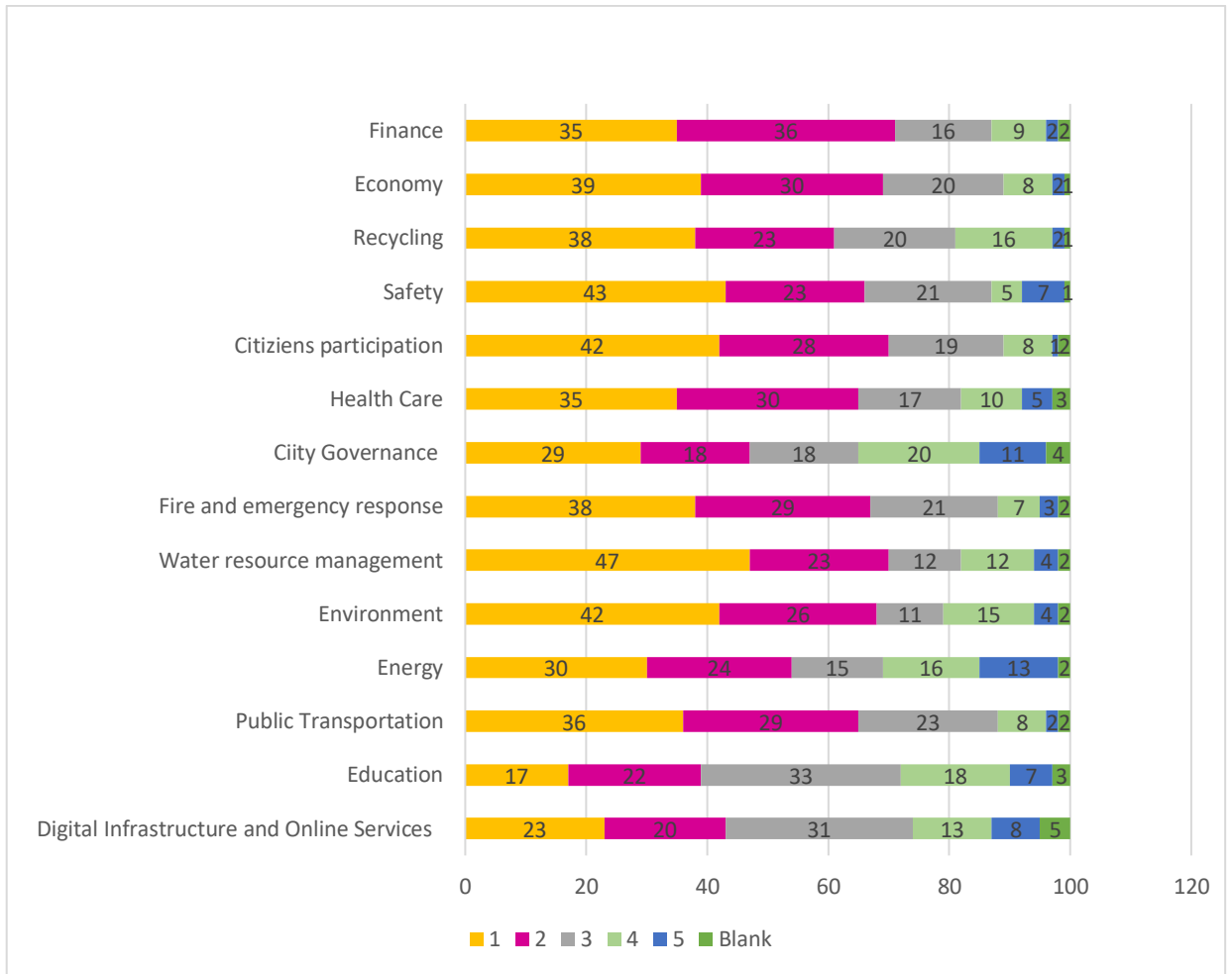


Graph 17- Are you aware of the implementation of Smart City projects in Tirana?³⁹

The graph below represents a summary of question six in the survey. Participants were asked to rate using a scale from 1 to 5, how much they think Tirana is investing in each of the 14 sectors suggested, where one represents few investments and five represents multiple investments in the sector.

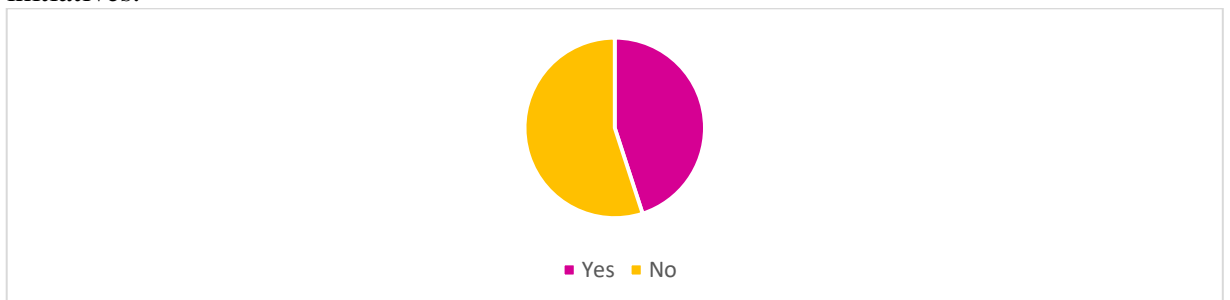
47% of the participants rated with only one the investments in water resource management, making this sector the least rated one. To differentiate the sectors where according to the participants less investments are made, a weighted average value was calculated. Citizens participation, water management and public transportation are the sectors with the lowest rating.

³⁹ Source: Based on data gathered during the survey



Graph 18- Can you tell which of these general sectors includes the projects you know? Tirana is working ...⁴⁰

55% answered with no to the question if they think the city is publishing enough smart initiatives.

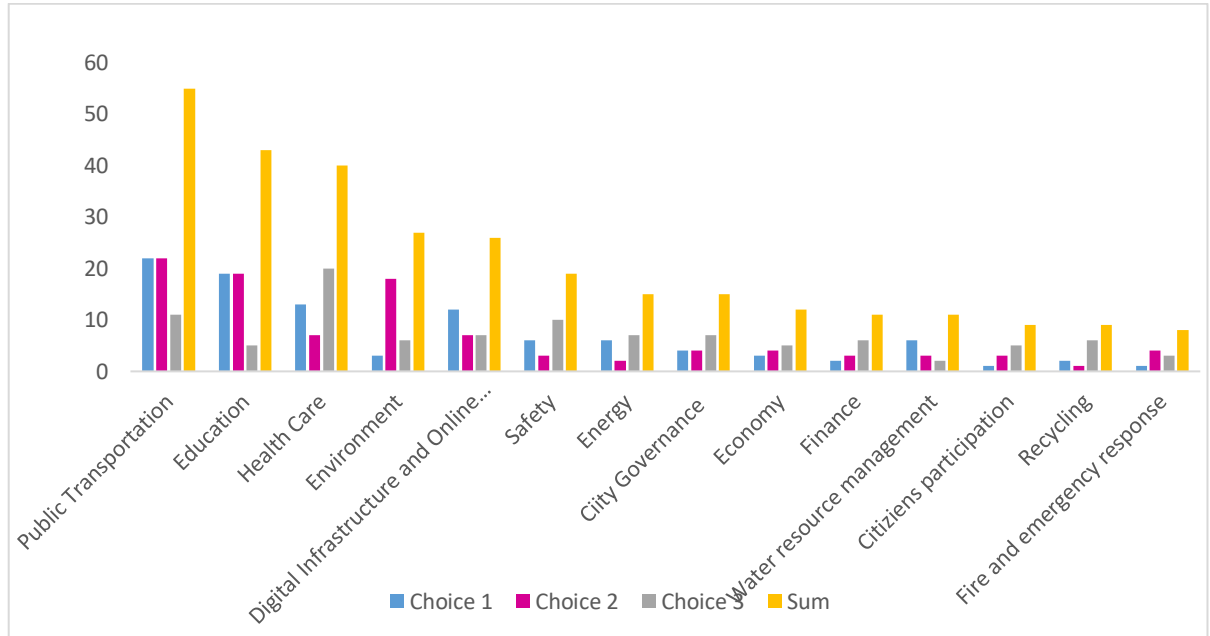


Graph 19 - Do you think your city is doing enough to publish its activities?⁴¹

⁴⁰ Source: Based on data gathered during the survey

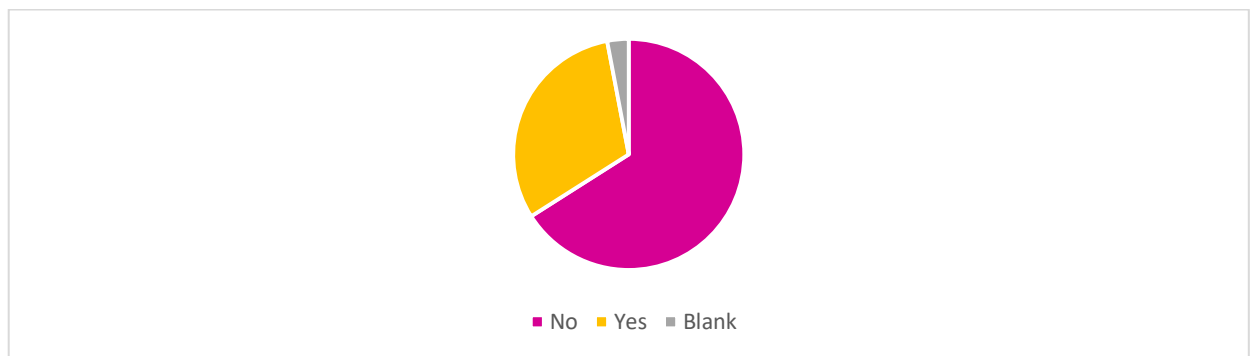
⁴¹ Source: Based on data gathered during the survey

After evaluating the investments in each of the fourteen sectors, participants were asked to choose 3 main sectors in which according to them, smart city projects should focus. Public transportation, education and health care are three top choices, shown in the graphic below:



Graph 20- Importance of these sectors while evaluating the importance and impact of a smart city project⁴²

While proposing a management system about Tirana, public transportation is the main sector we will focus on. The last part of the survey focused in open data concept. As a first step, a definition of open data was provided to the participants and later they were asked if they are aware of any open data initiatives from Tirana. 66% of the participants answered no to this question.

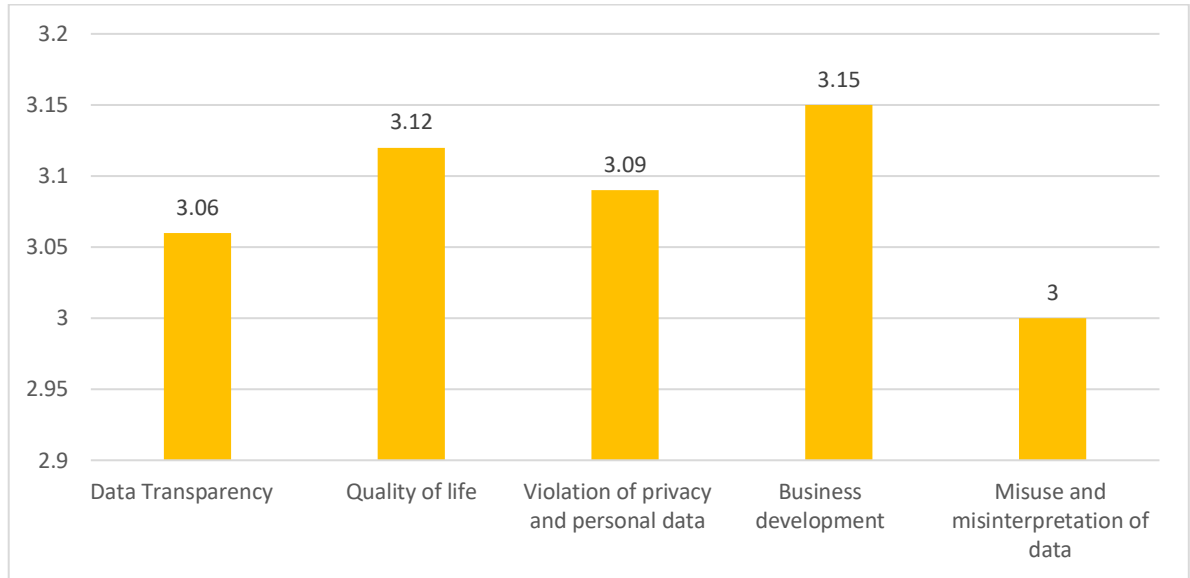


Graph 21- Do you know about the "open data" initiatives that Tirana is implementing?⁴³

⁴² Source: Based on data gathered during the survey

⁴³ Source: Based on data gathered during the survey

Participants had to rate using a scale from 1 to 5 where one represents less important impact and five represents more important impact. A weighted average was calculated for each of the impacts. Results are shown in the graph below:



Graph 22- How important do you think are the following influences of "open data"?⁴⁴

For the participants, how open data will impact business development is more important compared to the other influences. However, the differences between the rating are almost insignificant and the participants rated with a range of 3-3.15 all the impacts suggested to them.

3.3.2 Cross Data Analysis

A crucial component in smart cities implementation is the participation of citizens. For this reason, it is important to understand why 56% of respondents answered with no to the question if they are aware of projects the city is implementing. First assumption is that age could be related to the ability to get information.

Below the contingency table summarizes the results from the survey:

H₀: There is a relationship between age and awareness of city projects being implemented.

H₁: There is no relationship between age and awareness of city projects being implemented

During this test, the category of people over 65 years old was excluded since 2 responses are considered insignificant to determine the test results.

⁴⁴ Source: Based on data gathered during the survey

	18-24	25-44	45-55	Row Totals
Yes	23 (23.87) [0.03]	10 (12.82) [0.62]	9 (5.31) [2.57]	42
No	31 (30.13) [0.03]	19 (16.18) [0.49]	3 (6.69) [2.04]	53
Column Totals	54	29	12	95 (Grand Total)

Table 8- Contingency table: Is there any relationship between age and awareness of city projects.

[source:own]

There is a relationship between age and awareness of city projects being implemented. The chi-square statistic is 5.7821. The p-value is .055517. The result is significant at $p < .10$.⁴⁵ Participants belonging to the age group 18-24, answered with no in 57%, the group age 25-44 answered with no in 65% of the cases and 45-55 group age answered with no in only 25%. This discordance between ages groups can be interpreted by the main media they use to get information. As a conclusion, the government and business private should pay more attention on using all the communication channels to provide information regarding smart city projects in order to include as many group ages possible.

Another indicator showing that government is not publishing enough their activities is shown by this cross table.

	Are you aware of smart city projects being implemented in Tirana?	
	Yes	No
	Currently you are:	
Working in public sector	6	2

Table 9-Overview of people working in public sector being aware of smart cities projects [source: own]

75% of people working in the public sector are aware of smart cities projects being implemented in Tirana. This is related directly with the communication channels, where people from public sector get the information more easily.

The second cross analysis includes finding a relationship between level of education and awareness of smart city implementation projects.

Level of Education	Are you aware of smart city projects being implemented in Tirana?	
	Yes	No
	High School	19
Bachelor	15	25
Master	10	17

⁴⁵ Calculations are made using SaS University Edition software.

Table 10- Cross table: Is there any relationship between education and awareness of city projects.

[source: own]

Among participants with a high school education, 65% answered yes to this question, while the trend changes for participants with a university degree. 62% of people with a Bachelor or Master answered no to the question. Being a new term, smart city concept is not introduced during a high school level education.

3.4 Public Transportation -Smart system implementation proposal

3.4.1 Current situation description

Currently, public transport in Tirana is largely met by buses and partly by taxi or bicycles. It has 15 bus lines that cover the main areas and 4 bus lines connecting the city center with suburbs.



Figure 6- Public transportation map of Tirana ⁴⁶

⁴⁶http://www.shktq.org/index.php?option=com_phocagallery&view=category&id=69%3AInjati-e-shktq&lang=en

During this proposal, the focus will be L1 line that will be used as a pilot project and later, the same practice can be used in all other lines.

There are two options to pay for your journey by public transport in Tirana: monthly tickets and single use ticket. Monthly ticket is offered for a single line or for multiple lines. Children under 6, war veterans and people with a status blind, disabled, paraplegic and tetraplegic are excluded from paying. Students are the only category that benefits from discounts. The travel fee is flat. This means that a person traveling only one station pays the same amount with someone traveling 10 stations. Since there is no electronic ticketing system, every bus has a representative of the company that checks the tickets and sells in case you are not equipped with one.

Currently, a driver communicates with the center through a two-way radio communication and the center cannot track the location of the bus in any other way. Since a bus doesn't have a specific lane and traffic is not managed with any smart tool, this way of communication is not efficient and creates further delays.

Bus stops are not equipped with timetables, decreasing the predictability and time management of travelers is almost impossible. No accessibility is provided for people with disabilities. Now, public transportation doesn't provide audio or visual instructions, making it impossible for visual impaired or deaf people to travel alone. All the instructions are in Albanian, so tourists have a tough time using public transportation.

Also, video surveillance is not available in any bus line, decreasing the security of travelers.

3.4.2 Fares

Tirana is using a flat fare to charge the travelers. The 15 main bus lines in Tirana are included within one administrative area therefore fares zones do not exist. The table below summarizes the ticket types available for travelers in Tirana.

Ticket type	Category	Entry	Purchase	Method of payment	Extra documents	Price
Single ticket	All	One way	Bus	Cash	No	0.30€
Monthly pass- General use	All	Multiple entries for one month ⁴⁷	Bus	Cash	No	12.21€
			Ticket offices			
			Tobacco shops			

⁴⁷ Month refers to calendar month. It starts from the 1st of each month and is valid until the end of the month.

Monthly pass-Route specific	All	Multiple entries for one month	Bus	Cash	Passport picture	9.15€
			Ticket offices			
			Tobacco shops			
Student pass	Student	Multiple entries for one month	Ticket offices	Cash	Passport picture	4.57€
					Student confirmation	
Free	Children under 6 years		-	-	-	0 €
	People with disabilities		-	-	Disability confirmation	

Table 11- Fares of public transportation in Tirana⁴⁸

Compared to Vienna, Prague or Amsterdam, Tirana applies a different fares system. Currently in Prague, the fare system is combined between time based and zone based system. Payment fees are divided into two main areas: Zone P and Zone 0. The P Zone includes practically all public transport modes in Prague, such as subway, tram and buses. Zone 0 includes the suburbs and includes buses and railways that travel towards Prague.

Ticket type	Category	Entry	Purchase	Method of payment	Extra documents	Price
Short-term	All	30 minutes	Ticket machines	Cash/Card	-	1€
Basic	All	90 minutes	Ticket machines	Cash/Card	-	1.25€
			Bus	Cash		
1 day	All	24 hours	Ticket machines	Cash/Card	-	4.32€
			Tobacco shops			
3 days	All	72 hours	Ticket machines	Cash/Card	-	12.21€
			Tobacco shops			
Monthly	All	30 days	DDP	Cash/Card	ID/ISIC	21.63€
Quarterly	All	90 days	DDP	Cash/Card	ID/ISIC	58.22€
5-monthly	All	150 days	DDP	Cash/Card	ID/ISIC	94.41€
10-monthly	Student	300 days	DDP	Cash/Card	ID/ISIC	94.41€
1 year	All					

Table 12-Fares of public transportation in Prague⁴⁹

Differently from Tirana, where the monthly ticket is not transferable, Prague offers two possibilities: transferable and not transferable tickets. The transferable ticket is more expensive and can be bought without providing any personal data. It can be used by more

⁴⁸ <http://www.shktq.org>

⁴⁹ <http://www.dpp.cz/en/fares-in-prague/>

than one person. The not transferable ticket can be used only by the person who provided the personal data during the purchasing process.

Regarding Vienna, the fare system is zone based. You can travel by a bus, tram, and metro with a ticket if you are inside of a zone travel. Since the zone consists of Vienna's boundaries there are discussion where the fares in Vienna is considered flat. But since most of the railways, suburbs buses and airport shuttles are outside of zones, you need to pay differently.

Ticket type	Category	Entry	Purchase	Method of payment	Extra documents	Price
Single ticket	All	One zone ⁵⁰	Ticket machines Bus, Tram	Cash/Card Cash	-	2.4€ 2.6€
Half Price	Children Dogs	One zone	Ticket machines	Cash/Card Cash	-	1.50€
Senior ticket	Age >62	One zone	Ticket machines	Cash/Card	ID	4.32€
1 day	All	24 hours	Ticket machines WL ticket	Cash/Card	-	8 €
2 days	All	48 hours	Ticket machines WL ticket	Cash/Card	-	14.10€
3 days	All	72 hours	Ticket machines WL ticket	Cash/Card	-	17.10€
8-day ticket	All	Limited ⁵¹	Ticket machines WL ticket	Cash/Card	-	40.80€
Weekly ticket	All	Calendar week	Ticket machines WL ticket	Cash/Card	-	17.10€
Monthly ticket	All	Calendar month	Ticket machines WL ticket	Cash/Card	-	51€
1 year	All	365 days	Vienna Transport head office	Cash/Card	Passport picture	365€

Table 13-Fares of public transportation in Vienna⁵²

The biggest difference of fares system is found in Amsterdam. Completely different from Prague and Vienna, Amsterdam has a check in check out process. Also, the tickets are not paper based but chipcards. The chipcards offers a small memory that can be used to travel on a balance. So, Amsterdam public transportation offers fares even for distance based travelers. There are many discussions if public transport in Amsterdam is efficient or not. Travelers and specially visitors get confused with this mixed version between distance based,

⁵⁰ You can change as often as is necessary, but you may not travel on a circular route or go back to your starting point.

⁵¹ ticket is valid for unlimited travel in Vienna for one person on the day of validation until 1:00am of the following day.

⁵² <http://homepage.univie.ac.at/horst.prillinger/ubahn/english/fares.html>

zone based and time-based fares. Also, GVB, Connexion, EBS and NS have different types of tickets creating more confusion among travelers.

Ticket type	Category	Entry	Purchase	Method of payment	Extra documents	Price
1-hour ticket	All	60 minutes	Ticket machines Bus/Tram GVB Service Points	Cash/Card Card Cash/Card	-	2.6€
1-day ticket	All Children Bicycle	24 hours	Ticket machines GVB Service Points	Cash/Card Cash/Card	-	7.5€ 3.75€ 1.7€
2 days' ticket	All	48 hours	Ticket machines GVB Service Points	Cash/Card Cash/Card	-	12.50€
3 days	All	72 hours	Ticket machines GVB Service Points	Cash/Card Cash/Card	-	17.50€
4 days	All	96 hours	Ticket machines GVB Service Points	Cash/Card Cash/Card	-	22.50€
5 days	All	120 hours	Ticket machines GVB Service Points	Cash/Card Cash/Card	-	27.50€
6 days	All	144 hours	Ticket machines GVB Service Points	Cash/Card Cash/Card	-	31.50€
7 days	All	168 hours	Ticket machines GVB Service Points	Cash/Card Cash/Card	-	34.50€
1-night trip	All	1 trip	Ticket machines Bus	Cash/Card	-	4.5€
E-purse	All Children Senior	distance based	GVB Service Points	Card	ID	0.155€/km 0.102€/km 0.59€/km
Amsterdam & Region Travel Ticket	All (Visitors)	1 day 2 days 3 days 4 days	I amsterdam Store Ticket machines GVB Service	Card/Cash	-	18.50€ 26.00€ 33.50€ 41.00€

Table 14-Fares of public transportation in Amsterdam⁵³

After analyzing the fare system used by Amsterdam, Vienna and Prague, the fare system proposed for Tirana is described below.

Three are the main fares system in public transportation:

- distance based
- zone based

⁵³ <https://en.gvb.nl/reizen/producten-en-tarieven/ov-tarieven-2018>

- time based

A distance based system cannot be implemented in Tirana because distances are short and tariffing will be difficult. This type of fare system is used in metropolitan areas and big populated cities, where to cover big distances stations are away from one another.

For the same reason, a division by area would not be an efficient solution. In the size of Tirana, the zone-based system means that the boundaries of the municipality will be one area. In this case, it does not make sense to apply different charging rates. Consequently, charging would be flat. Citizens have always expressed a dissatisfaction with a flat charging system.

Bearing in mind, the simplicity of the system, how absorbable it can be for the users, the changes that are required in the current one, a time-based system is proposed. The suggestion of this thesis proposes a merged version between the system used in Vienna-Prague (time-based) and Amsterdam (chip-card). The implementation of chip-card will be explained further in the sub-charter ticketing system.

When proposing a charging system, these are the parameters that are kept in mind:

- simplicity
- providing many fare options for the citizens
- reduced fares for specific travelers
- reducing actual costs of travelling
- providing the possibility to change bus line with no extra cost (time-based system)
- reducing bureaucracy (requiring less documents)

Ticket type	Category	Entry	Purchase	Method of payment	Extra documents	Price
Paper chip ticket / Chip card reload						
Half hour ticket	All	Multiple for 30 minutes	Ticket Machines	Cash/Card	NA	0.3€
			Ticket offices	Cash/Card		0.3€
			Bus	Cash		0.4€
One hour ticket	All	Multiple entries for 1 hour	Ticket Machines Ticket offices	Cash/Card Cash/Card	NA	0.45€
1 day ticket	All	Multiple entries for 1 day	Ticket Machines Ticket offices	Cash/Card Cash/Card	NA	0.8€
5-day ticket	All	Multiple entries for 5 days	Ticket Machines Ticket offices	Cash/Card Cash/Card	NA	3.5€

⁵⁴ Monthly ticket	All Student Senior	Multiple entries for one month	Ticket Machines Ticket offices	Cash/Card Cash/Card	ID/ Chipcard Number	12.21€ ⁵⁵ 4.75€ 4.75€
Half Year ticket	All Student Senior	Multiple entries for 6 months	Ticket Machines Ticket offices	Cash/Card Cash/Card	ID/ Chipcard Number	61.2€ 24.80€ 24.80€
One-year ticket	All Student Senior	Multiple entries for one year	Ticket Machines Ticket offices	Cash/Card Cash/Card	ID/ Chipcard Number	122.1€ 47.5€ 47.5€
⁵⁶ Monthly ticket	All	Multiple entries for one month	Ticket Machines Ticket offices	Cash/Card	Chipcard Number	15.50€ ⁵⁷
Half Year ticket	All	Multiple entries for 6 months	Ticket Machines Ticket offices	Cash/Card	Chipcard Number	77.5€
One-year ticket	All	Multiple entries for one year	Ticket Machines Ticket offices	Cash/Card	Chipcard Number	155€
Chip OV Card	All	Onetime payment	Ticket offices	Cash/Card	ID/ NA	6€

Table 15- Proposed fares of public transportation for Tirana [source:own]

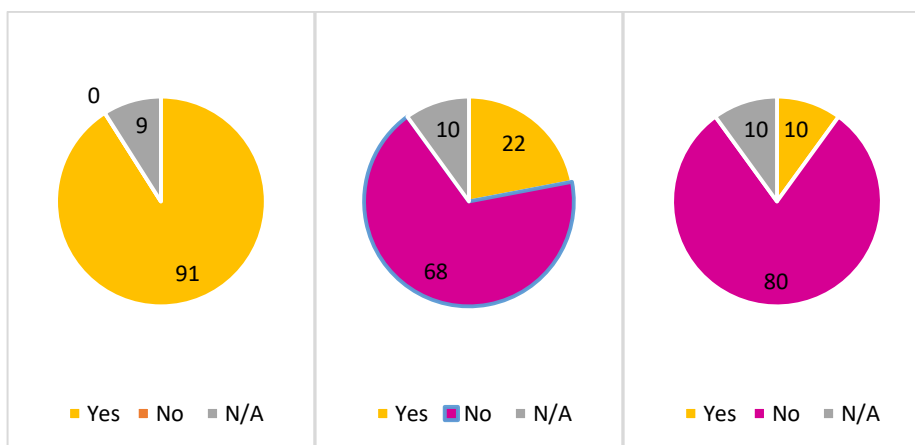
All the prices shown in the table above are suggestions and are not based on any market research. The practice followed is based on Amsterdam's experience. The price of a single and monthly ticket is maintained the same, while the 6-month ticket price is counted as the five time more than the monthly ticket price. The annual ticket costs ten times more than a monthly ticket. According to a JICA survey completed in 2011, 91% of the responds would pay 0.4€ for a single ticket for a new mass transit. While only 22% of them are willing to pay 0.56€ for a single ticket. While proposing the new fares system this data was used.

⁵⁴ Rows underlined in grey show ticket types available only for reload in a personal chip card.

⁵⁵ Prices are left unchanged until further evaluation of the service

⁵⁶ Rows below show ticket types available only for reload in anonymous chip card.

⁵⁷ Prices are left unchanged until further evaluation of the service



Graph 23- Transportation survey- How much are you willing to pay for a new mass transit?⁵⁸

The proposed chip card will be offered in two variants: anonymous and personal. Anonymous card can be withdrawn at any ticket offices without any additional document, it costs more and can be used by more than one person under the condition that during a trip only one person uses it. The personal card can also be retrieved at any ticket office, with a simple ID, used only by the person who represents the ID and costs less than the anonymous card. This practice is followed in Prague. One of the positive aspects of the personal card is that you can block it in case it gets stolen or lost.

Students must present in the ticket office a student confirmation or a student card in order to get the reduced fare. A difference of the proposed fares is the addition of a new category that benefits from reduced fare. People over 60 years old, by presenting a ID card to prove their age and with no extra document can receive a reduced fare. Children under 6 still travel for free. However, since the new system includes random controls on the bus by authorities, the parent is obliged to keep a document with them that proves the age of the child.

3.4.3 Ticketing System

According to a study report conducted by European Commission, 71% of public transportation will use smart cards in the future. (Gleave, 2016)

This is one of the main reasons why the base of the proposed ticketing system is the chip card offered in both anonymous and personal versions. 30 minutes' ticket, 1-hour ticket, 1 day and 5 days' tickets are magnetic paper based. This solution is provided to lower the cost of the traveler that may not have a chip card.

⁵⁸ 2011 Transportation Survey, JICA Study Team

The proposed ticketing system allows the traveler to use a memory chip card to check in by using the front door only. Close to the driver, there will be installed a reader (scanner) of the chip card. Once the user puts his card in front of the scanner it will show a signal that the driver can see. If the light is green, it means that the traveler is permitted to board, otherwise boarding will be denied.

The ticketing system proposed in this thesis, suggests implementing the chip card logically different from Amsterdam. Currently Amsterdam follows a policy that requires users to check in and check out. According to their barometer website where users give feedback about the public transportation, even after 5 years of being implemented, travelers still face problems rating public transportation 7.3/10.⁵⁹

The main difference between the proposed system and the Amsterdam system is that travelers in Tirana will just check in using the front door. An honesty system like in Prague and Vienna cannot work out in Tirana, because it will require training of end users and constant controls until the mentality is changed.

To further elaborate how the system works, let us consider an example. A traveler wants to go from station A to station B. He calculates that the distance between A and B does not last longer than 25 minutes, so he decides to buy a half hour ticket.

To buy such a ticket he has two possibilities:

- paper ticket one-time use
- upload the travel service in his chip card.

In case the traveler already owns a chip card, then he can enter from the first door of the bus and scan his card. The system will detect that the traveler has uploaded in his card a travel service (half hour ticket in this case). In the moment, the traveler scans the card, in memory of the chip, the field called “validity” will be updated. After travelling around 10 minutes with L1, the traveler decides to change to L9. Since he travelled just 10 minutes, the ticket is still valid. Entering in another bus, the traveler will need to scan his card again. The system will detect again a traveling service and check the field of validity.

The field of validity is needed in order to allow users to buy more than one travel service and use just one at a time.

⁵⁹ <http://www.ovklantenbarometer.nl/>

Another scenario is when the traveler buys a paper ticket. Positive side of paper tickets is that they are one time use and contactless. Negative side is that they need to be used after the moment of purchase. In the moment, you buy a ticket in the ticket machine (located just a few meters away from the station) the machine will stamp on the ticket the time of purchase and validity. When boarding, the traveler needs to show the ticket to the driver.

The system cannot be frauded in most cases since the passenger will need to board one by one. The only issue is created by the half hour/ one-hour tickets. There is a chance the traveler can board one minute before the ticket is expired and the system will still consider the ticket valid, but after boarding the traveler can stay on the bus for one hour. To avoid such scenarios, the companies responsible for public transportation in Tirana should create a team that will control randomly like in Prague or Vienna.

3.4.4 Interface

The proposed system attempts to create a simple interface where the end user should be able to buy a ticket with only 3 clicks. In the interface, the fares are divided in two main sectors. The short trip tickets are shown directly, while the monthly tickets are available under reload chip card sector. The prototyping below shows the behavior of the proposed system interface.

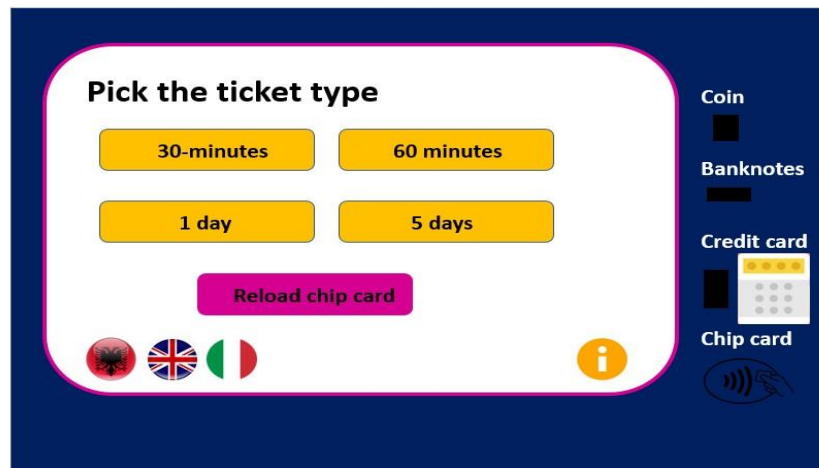


Figure 7- Home page of proposed system interface⁶⁰

⁶⁰ Source: The interface prototyping is created by the writer of this thesis.

A traveler who does not own a chip card and wants to buy a paper ticket for a short trip just clicks on the home page.

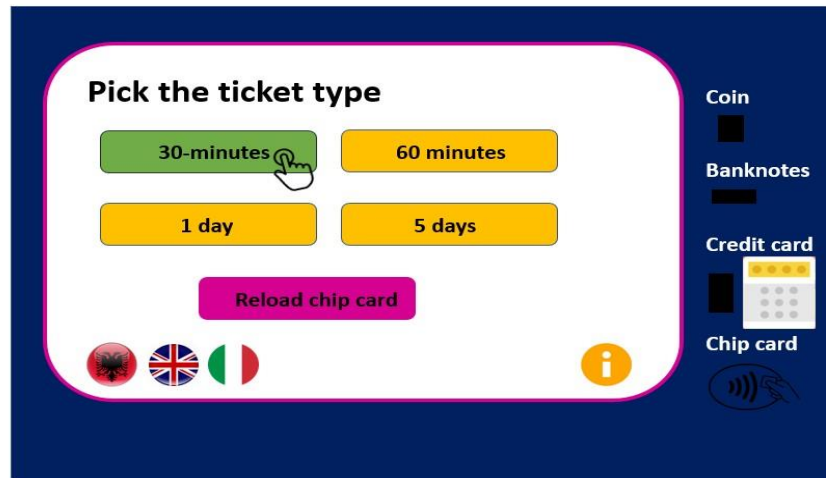


Figure 8- First click- Buying short trip ticket [source: own]

The end user will be redirected directly to the payment interface, where the system will show a summary of the purchase and the possibility to choose between paying by card or cash will be offered.

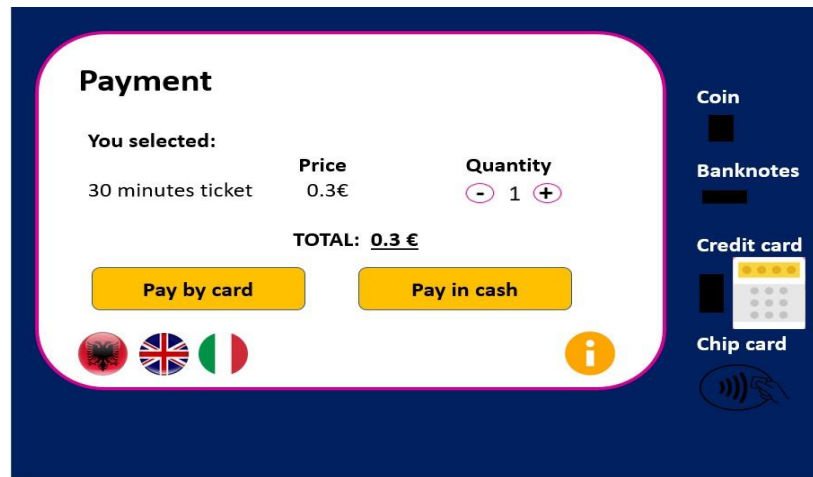


Figure 9- Summary of purchase-Buying short trip ticket [source: own]

In this interface, the traveler has also the possibility to change the quantity of the tickets purchased. The total is automatically updated.

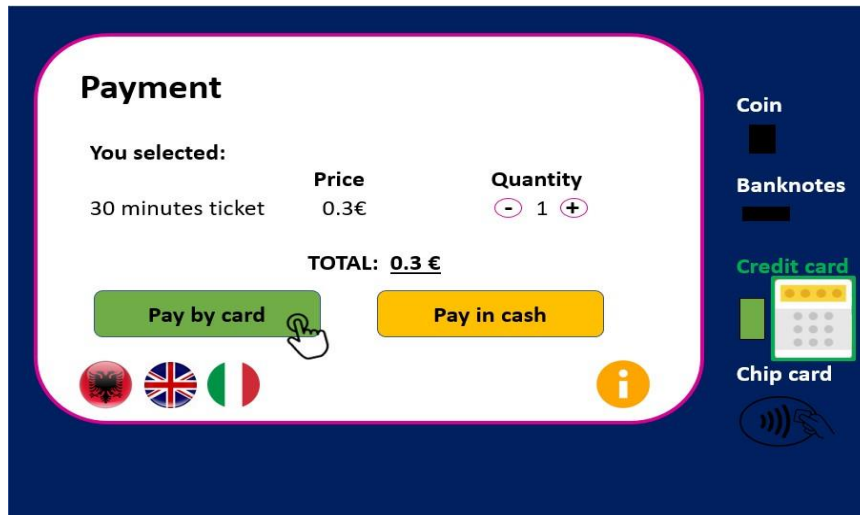


Figure 10-Second click- Buying short trip ticket [source: own]

When the traveler chooses the method of payment, the respective terminal will be lighted in green.

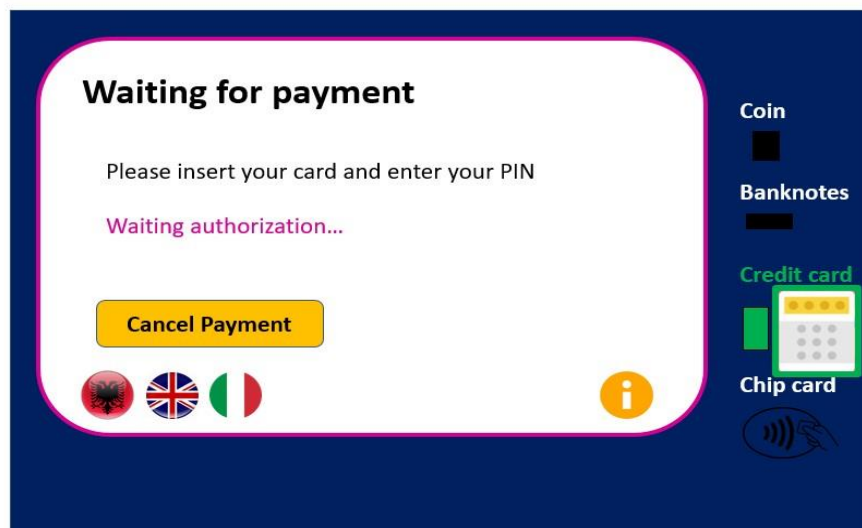


Figure 11- Third click- Buying short trip ticket [source: own]

The interface offers the possibility to choose between three languages: Albanian, English and Italian. The default language is Albanian, since it is the local language.

A traveler that owns a chip card, by using this interface, will be able to reload travel services in his card. Travel services includes every type of tickets available: short trip and monthly tickets.

In the home page of the interface shown in [Figure 7](#), the traveler needs to click on **Reload chip card** button where the system will require to scan the chip card. After the scan, the system will be able to identify if the chip card is anonymous or personal card. If it is an

anonymous card, short trip tickets and monthly tickets can be purchased with higher prices than personal card.

If the card is a personal card, the name of the user is displayed in the screen with a welcome note. Prices for short trips and monthly tickets are available with lower prices than anonymous card and discounted tickets are available for students and seniors.



Figure 12- Personal card- Reload chip card [source: own]

The components of the system that need an interface design are the dashboard in the bus showing the next stations and the dashboard in a bus station showing the waiting time.

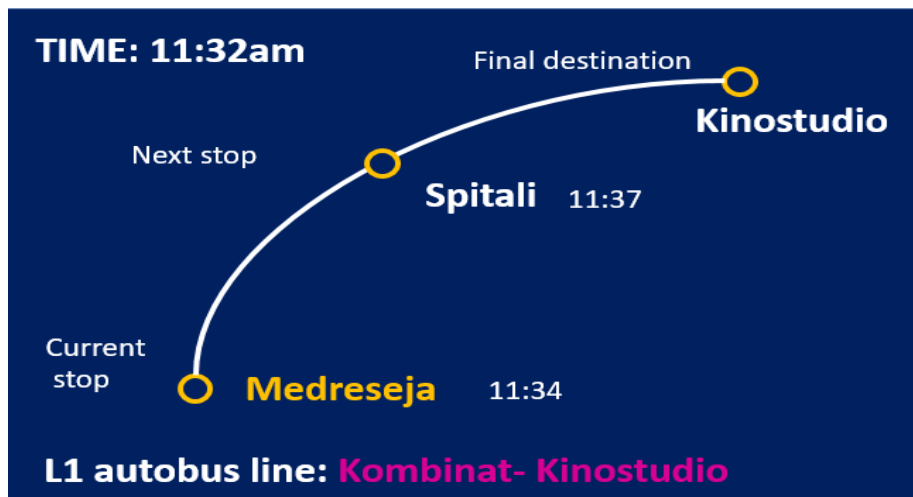


Figure 13- Informative dashboard in the bus [source: own]

This is a simple dashboard, based on the one currently used in Prague and Amsterdam. Vienna has a slightly different one, providing for the traveler just the next station.

Current stop, next stop and the direction of travelling are shown in this dashboard. The name of the bus line and time are also included.

Bus line	Direction	Arrives in
L1	Kinostudio	3 minutes
L9	Qender	7 minutes

TIME: 11:55

Figure 14- Bus station dashboard [source:own]

The proposed system includes in main bus stations an electronic dashboard where the bus line, direction of travelling and estimated arriving time is shown.

3.4.5 Security

It is a practice known by many public transport companies to ignore security in order to reduce costs. Usually providers will choose a cheap card and focus their security strategy in the back office. Since data protection policies is a hot topic in European Union, every new project and system should put data protection and security as a priority.

During this thesis, security will be discussed in three main points:

- Travelers security
- System security
- Data protection

Currently the public transportation in Tirana needs to improve the security perception for the travelers. No video surveillance is implemented creating the perception of a lack of safety in buses and stations.

In the barometer website of Amsterdam, travelers answered with yes in 75% to the question: Do you perceive an increase of security after applying the video surveillance in public transportation? ⁶¹

⁶¹ <http://www.ovklantenbarometer.nl/>

The main purpose of installing video surveillance in buses is to decrease anti-social issues and increase the security perception in public transportation.

The video surveillance is a module of the entire proposed system and will be integrated with the other modules, as explained in integration sub-chapter. All the data from video surveillance system will be collected, processed and create electronic reports. This will provide the citizens with a up to date solution.

System security relies on many aspects, of which detection of fraud is one of them. Many public transportation providers, choose to provide cheap cards and handle the encryption process in the back office, but this opens a gate for individuals that deal with cloning of cards, fake re-creation or stealing. The system should be able to detect this type of fraud and insert the card directly in black list. Since many systems related to e-ticketing, gather information offline, it may happen that from one transportation method to the other, the blacklist is not updated in real time, causing a risk increase. Cryptography is also required to lower the chances of fake cards.

Data protection is proposed based on previous experience from Amsterdam. When Amsterdam implemented the chip OV card technology for the first time they encountered a big issue with data protection. As explained before, chip cards can be contactless or not. In case the chip card is personalized containing personal data of the user, the database table storing personal data should be apart from the database table storing open data.

What happened in Amsterdam is that they stored together this type of data, increasing the risk of misuse of data. If someone would perform an attack, the personal data would be exposed. Since the chip card transmits information about when did the traveler got into the bus, frequent transits, etc. it is easy for the hacker to find a pattern of where the traveler goes continuously.

3.4.6 Interoperability and Integration

To determine the interoperability of the proposed system, IFM system architecture will be used. The IFM system is a basic standard for the functional interoperable fare management system architecture.

Level 0 includes all the elements of the system that produce input data. The main one is the passengers. Passengers themselves do not produce data, but through the travel services they

use, they return to one of the main components. In this level the travel services are described: personal chip card, anonymous chip card and short trip tickets (paper tickets).

Level 1 includes inter-usability. Since the proposed system is compound from three different types of travel services and 2 methods of payment, inter-usability should be considered.

The user experience should be consistent and smooth. The travel services should be recognized by every device used in level 1. In the public transportation of Tirana, various service providers exist, but travel services are produced by a central agency. The difference between the current system and the proposed system is that this agency will no longer produce travel services that only one service provider can recognize. The chip card contactless or personal one is valid in any of the 15 bus lines operating in Tirana. Ticket machines in every station, card readers of controllers' staff and the bus scanner are all able to recognize each of the travel services.

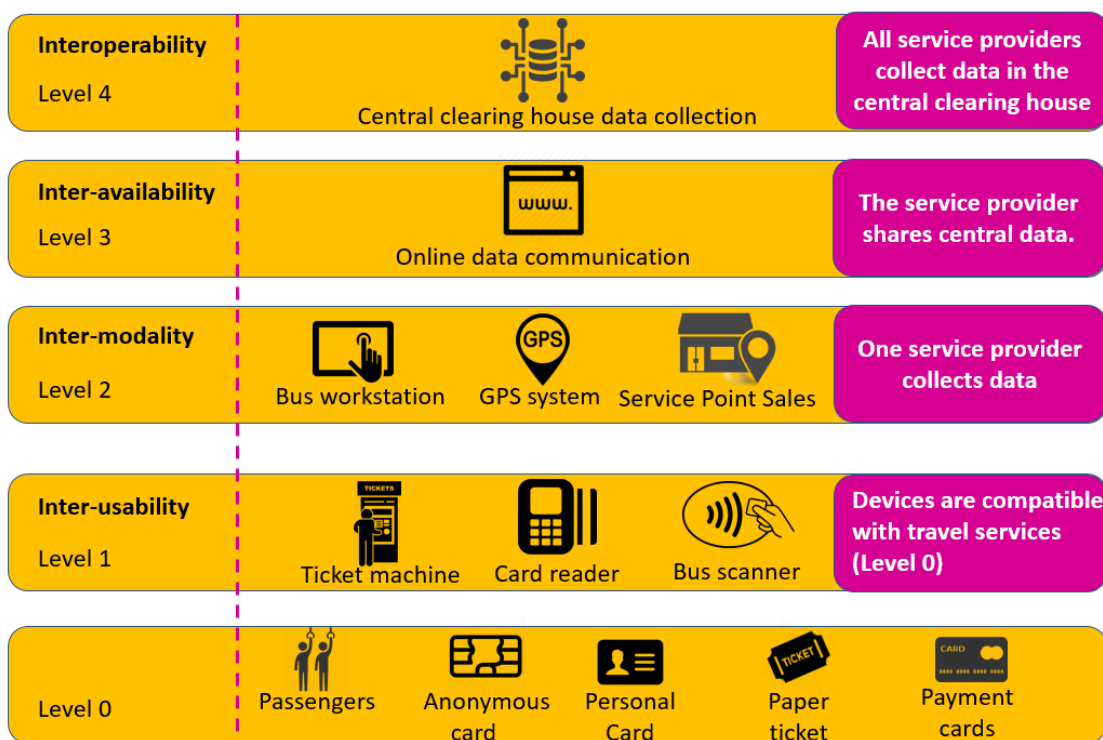


Figure 15- Level approach of the proposed system in Tirana. ⁶²

Level 2 deals with inter-modality. In Amsterdam, Vienna and Prague inter-modality has a broader meaning. Since metro, tram and buses are available there, inter-modality includes the use of travel services in all the transportation methods. While in Tirana, currently only

⁶² This level approach is created by the writer of this thesis.

buses operate. In such case, inter-modality refers to the ability of the service provider to collect data from parts of the system installed in their transportation vehicles and sales. The proposed system includes a bus workstation (mainly data produced by the scanner), GPS system and the service point sales.

On **Level 3**, inter-availability is included. In a smart system, travelers should be able to access data produced in Level 2.

Inter-availability implies reloading the chip card from different resources (ticket machines, website and mobile app), checking the availability of the bus, reporting a lost card, updating personal profile and uploading required documents for discounts. The central data house of a service provider makes available for the travelers' basic analysis of the data gathered on level 2. One crucial element to be mentioned is security. In this level, personal data of users is important.

Level 4 is the highest level in the proposed system. Currently achieved in Prague and Vienna and partially in Amsterdam. The situation in Tirana is more simply, since the service providers offers only bus transportation for the moment. Interoperability describes the ability of a system to allow the travelers use different travel services, equally recognized by any service provider, which provide and collect data in a central clearing house.

The advantage of this level is that service providers agree in business rules, have clear roles and responsibilities and cooperate in continuous solutions.

The data provided and collected in the central clearing house is used for statistical purposes, business analysis and marketing.

4 Results and Discussion

4.1 Business Impact Analysis

4.1.1 Purpose

Business Impact Analysis (BIA) main goal is to identify the key activities that deliver the service and develop a disaster recovery plan, based on impact analysis.

4.1.2 Identification of main challenges of Tirana

The main challenge of Tirana is related with the informality being the main methodology of urban planning; a lack in infrastructure and inefficient use of resources.

Tirana should use the best practices offered by European countries or any other developed country but keep in mind that to follow the same strategies is not recommended. Every city, specially cities from countries in development like Tirana have different challenges, conditions or citizens.

The term lack of infrastructure refers to the lack of special lanes for buses, bicycle lanes and routes that could improve the public transportation map. The proposed system includes dashboards that will provide information about arriving time of a bus. Since there are no specific lanes, a traffic jam could make the system look totally inefficient and impossible to predict. In this case, a good integration between the GPS system of the driver and the operational centre is required to provide the travellers with real time data.

Informality, another issue of smart implementation, creates a gap between government and governed. The instability and high levels of corruption have created a wall between the public sector and citizens. Improving those issues will create the foundations for smart initiatives.

In a social point a view, the new system will face challenges with “technophobic” citizens. No matter the progress, the number of people not familiar with technology or touch screen technologies is high. Hence, is important to make available as many learning resources as possible. For example, the ticket machines can cover the flux of ticket sales and therefore the need of ticket offices seems excessive, but citizens will have this service available to get used with the new initiative.

4.1.3 PEST analysis

PEST analysis takes into consideration macro-factors like political, economic, social and technology and how those factors impact the proposed system.

Political

The public sector has a positive approach to investment in public transport. According to the Municipality of Tirana, 39% of the investments in the 2018-2020 budget plan will be used for public transport. If we compare 2017's budget with 2018, 12% more investments will go for public transportation. The will of government to invest in infrastructure has a positive impact in public transportation. (Municipality of Tirana, 2018)

Currently, fares are regulated by the Municipality of Tirana with the main justification ensuring that fares will be affordable for the citizens and will not fall prey to the private sector that in this case is represented by service providers. This explains why service providers are offering a substandard quality, not frequent service and with old buses. Regulation of fares should be part of the free market, where a service provider under a specific price offers a certain service. If the price is too high, people will avoid using the public transportation and make the company reflect and analyse their decisions. Being part of a free market, a private company (offering public transportation in this case) would always think about how to generate more profit which translates in improving their service.

Another way the government has an impact on public transport is through taxes. For example, parking tax in public places, from 2016 to 2019, is expected to increase by 18%. (Municipality of Tirana, 2018)

Economic

One of the economic factors that has impact on using the public transportation is the price of fuel. Following the global trend, even in Albania the price of fuel increased by 29% compared to last year. With such a double-digit increase, people are increasingly diverting the idea of having a personal car. At the same time, since taxi service is not centralized, it is a more sensitive service to price fluctuations. Thus, the possibility of replacing public transport with another option is low. (INSTAT, 2017)

Given that the main public transport competitor in Tirana are personal vehicles, an analysis of income and savings should be included as an economic factor. According to INSTAT the average salary in public sector in Albania increased with only 1.3% from 2016 to 2017. Also keeping in mind, the effects of the crisis in 2008 are still present, the consumer confidence

of people has decreased. For this reason, more and more, people are looking to increase their savings for unpredicted future events. Buying secondary products is not in the priority of citizens. In this regard, public transport is not compromised by substitution services.

Social

In 2017, the population of Tirana reached 862,361, from 374,483 in 1997²⁴, or an increase of almost 230% in just 20 years. A rapid urbanization is always a positive impact in public transportation.

Another demographic factor that has a positive impact in public transportation is the group age. According to INSTAT, 31% of population in Tirana is between 09-29 years old. Since the population is so young, the chances of them being open to innovative technologies is higher.

Also, a young population is more informed about environmental issues, increasing the chances of public transportation being their first choice of transportation in order to reduce pollution created by personal cars.

A negative impact related with social factors is that people are seeking for efficient ways of transportation. Currently the public transportation of Tirana, covers the fundamental areas of the city, but the transfers are not adjusted to make the travelling in some specific routes efficient. The absence of predictability because of traffic can push people to find alternative ways of transport.

Technology

The proposed smart system for the public transportation in Tirana is based in technology and it is important to analyse this factor.

One of the risks that the proposed system considers is technophobia. Technology can have a negative impact on public transportation if the proposed system is too advanced / complicated for the commuters. This can create a negative perception for the system and make travellers look for alternative ways of travelling. For this reason, the proposed system, takes into account the social influence and the technology used tries to keep the system as easy and comfortable possible. Currently, 62.8% of citizens have internet access.⁶³

⁶³ Internet live statistics <http://www.internetlivestats.com/internet-users/albania/>

90% of mobile users have internet access through a smartphone (touchscreen technology). (Idaver Sherifi, 2015)The expectations that citizens will accept the proposed smart system are high.

4.1.4 Impact categories and risk analysis

Number	Impact Categories	Description
1	Loss of Revenue	The interruption of the process that impacts directly the revenues and no service is provided to the travelers.
2	Central budget planning	Currently the municipality of Tirana makes a request for infrastructure investments, the Ministry of Transport and Ministry of Finance need to approve in order for the project to start the implementation.
3	Risk of not achieving the expected impact	Lack of timely implemented projects, insufficient reporting tools, and weak capital budget preparation.
4	Penalties, Fines, Sanctions	Public transportation service providers are monitored by public sector. The lack of service, the ability to meet requirements and expectations leads to penalties and fines.
5	Productivity Loss	Obligation to pay employees and daily processes in case of service interruption.
6	Insurance coverage	Risk to pay accident costs in case the insurance doesn't cover it.
7	Customer Service and Loyalty	Not meeting customer expectations with the new system, will impact the customer loyalty.
8	Operations Impact	Interruption of the service creates impact in the daily routine of the processes.
9	Organizational Risks	The absence of an Integrated Transport Master Plan creates space for mistakes during fund and resource allocation.
10	Maintenance Risks	The work norm of contractors is also considered a risk in effective management of road maintenance
11	Image and Reputation	The service provider can be impacted by the public confidence and trust in the company.
12	Safety and Security of employees	Any interruption of service that affects the safety and security of the employees has impact in the company.

Table 16- Impact categories and description⁶⁴

Number	Impact Categories	Impact classification
1	Loss of Revenue	Scale 4- Critical
2	Central budget planning	Scale 3- Serious

⁶⁴ BIA example <https://bcmmetrics.com/business-impact-analysis-example/>

3	Risk of achieving the expected impact	Scale 2- Marginal
4	Penalties, Fines, Sanctions	Scale 4- Critical
5	Productivity Loss	Scale 5- Catastrophic
6	Insurance coverage	Scale 1-None to Negligible
7	Customer Service and Loyalty	Scale 3- Serious
8	Operations Impact	Scale 2- Marginal
9	Organizational Risks	Scale 2- Marginal
10	Maintenance Risks	Scale 3- Serious
11	Image and Reputation	Scale 4-Critical
12	Safety and Security of employees	Scale 5- Critical

Table 17- Impact categories classification ⁶⁵

The classification of the impact categories is made using a scale from 1 to 5 where scale one represents an impact that is negligible and scale represents an impact with catastrophic consequences. While proposing the impact categories classification the RPO was analysed.

4.2 Measuring the smartness of the proposed system

4.2.1 Performance assessment matrix

After proposing a smart system for public transport in Tirana and analysing its impact, it is important to test the performance of the system, how it can be integrated into the future with other smart modules and how much the expectations are met.

Performance will be reviewed in three perspectives: service users (citizens of Tirana), service providers (public transportation private companies) and government (municipality of Tirana-public sector).

⁶⁵ BIA example <https://bcmmetrics.com/business-impact-analysis-example/>

Perspective	Parameters	Measuring				
		1	2	3	4	5
Service users	Availability	System is never available when needed	Low availability <40%	Moderate availability (<60%)	High availability >85%	System is always available.
	Service Quality	System didn't meet expectations	Low achievement of expectations	Moderate achievement of expectations	Expectations met.	Expectations exceeded
	Affordability	Significant cost increase	Slight cost increase (>20%)	Moderate cost increase (<10%)	No cost increased	Cost reduction
Service Providers	Economic viability	Over 20 years period of capital return	Up to 20 years of capital return	Up to 15 years of capital return	Up to 10 years of capital return	Up to 5 years of capital return
	Scalability	Specific and not scalable system	Low scalability and not flexible	Moderate scalability	High scalability	Scalable in any context
	Maintenance	High cost and difficult maintenance	Slightly expensive maintenance	Moderate costs in maintenance	Insignificant maintenance	No maintenance costs
Government	Regulatory requirements	Complex regulatory requirements	Slight complexity of regulatory requirements	Moderate complexity of requirements	Simple and straightforward regulatory requirements	No extra regulatory requirements
	Integration	No possibility to integrate with future systems	Slight possibilities to integrate with future systems	Moderate integration possibilities	High possibilities for future integration	Certain integration possibilities
	Innovation	No innovation	Slight innovation	Moderate innovation	High innovation	Exceptional innovation

Table 18- Smart public transportation performance assessment matrix (Orchestrating infrastructure for sustainable Smart Cities , 2014)

4.2.2 Conceptual model on the acceptance level of the proposed system

The use of proposed system in public transportation is closely related to the acceptance level. Being a monopoly service, it is quite easy to leave aside the acceptance level by thinking that the travellers will use it anyway. In this case, the refuse of using the system will not be direct, but identifying the factors that affect the user acceptance is very important. Let's take an example of a traveller who does not feel familiar with the use of touch devices. In one way or another, the traveller will avoid buying tickets through touch devices installed in every bus station. They would prefer to buy tickets through ticket offices that would not be as frequent. This process will create in them a negative attitude towards the entire system. It is important to make sure that users understand how the system works, how do they perceive the improvements, are they happy with the security or if they feel they are getting a better

service or not. In a more structured way, to answer all these questions, a conceptual model on the acceptance level is described below. Based on this, a survey on the acceptance level is proposed in appendix 7.4.

The conceptual model includes five aspects:

- **Social impact** – This feature of the model analysis the ability of the proposed system to impact social relationship, how does the system effects the values and beliefs of users. As an illustration example of this aspect is the reason why an honesty based charging system couldn't work in Tirana as easily as it does in Vienna and Prague. Being used to have a controller every time they get into a bus and buy directly the ticket by paying in cash and switching to a system where the ticket is bought from vending machines and use a travel service without being checked, is a substantial impact in the values and beliefs of users. Best practices recommend avoiding such a change. In case an honesty charging system would be implemented in Tirana, many travellers will just travel without paying the service they are getting. Service providers will interpret this as a failure of the implemented system. The proposed system tries to avoid this by requiring check in of every traveller. The efficiency of this proposed solution will be evaluated throughout the survey.
- **Meeting expectations** – While the service provider will work on the first phases of the implementation (mostly including technological implementations) informing travellers is very important. New systems require to never let the user guess. To evaluate this aspect, the survey includes sectors where the users are presented with the definition of a technology and alternatives of what they expect as main functionality. The evaluation of those results will help the service provider to understand where an informative campaign is needed.
- **Frequency use** – This aspect of the conceptual model is intended to measure the use frequency of different components of the system. The results can be used for marketing purposes, maintenance and to understand the perceived ease of use.
- **Perceived efficiency** – To analyse how people perceive the use of technology and how it will improve their performance, is described in this aspect of the conceptual model. The perceived efficiency is directly connected with the perceived quality of the service.

- **Using attitude** - To explain the purpose of using one module of the system, using attitude can be a valid aspect. It is important to evaluate if travellers have a positive or negative attitude while using the service, if they believe that the use of the technology included in the system doesn't require hard work or effort to understand it. (A survey on the level of Information Technology Acceptance and proposition of a Comprehensive model, 2013)

5 Conclusion

There are several responses why developing countries should implement smart cities, where urbanization trends being one of the main ones. The number of people living in the cities in developed countries will increase 67% until 2050. Another main reason for developing countries to keep an eye in smart cities implementation is the lack of critical infrastructure and services. By incorporating the smart city vision right from the inception and building everything from scratch, they have a better flexibility towards new implementations.

Initially a review of the latest literature regarding smart cities was presented. Another sector of the theoretical part of this thesis included a comparison between three European cities: Vienna, Prague and Amsterdam.

By analysing the practices followed in those cities, a smart public transportation system for Tirana was proposed, taking into consideration technological and social impacts of the system, analyzing and providing a deeper understanding of the use of information management in smart cities.

To have a better understanding of what citizens think and know about the smart city concept a survey was conducted. As a methodology, to analyze the citizen's knowledge, the survey includes 14 general sectors where each participant had to indicate with a scale from 1 to 5, how much they think the city is working towards smartness in each sector. 56% of the participants had no information regarding smart city projects being implemented in Tirana. 55% answered with no to the question if they think the city is publishing enough smart initiatives. 75% of people working in the public sector are aware of smart cities projects being implemented in Tirana. This is related directly with the communication channels, where people from public sector get the information more easily. As a conclusion, the government and business private should pay more attention on using all the communication channels to provide information regarding smart city projects in order to include as many groups possible. Public transportation was the chosen sector where, according to the participants, the investments should focus.

Bearing in mind, the simplicity of the system, how absorbable it can be for the users, the changes that are required in the current one, a time-based system is proposed. The suggestion of this thesis proposes a merged version between the system used in Vienna-Prague (time-based) and Amsterdam (chip-card). To improve the security perception for the travelers,

video surveillance was proposed to be implemented. The proposed system facilitates the process of buying tickets for travellers. The interface is kept simple, allowing the user to buy short trip tickets with only 3 clicks and offers 2 possibilities of paying: by card or cash. Fraud is decreased by using cryptography methods, real time data exchange, black list concept and check in process.

The proposed system aims to achieve 4 levels of integration, with interoperability being the last one. By reaching this level, different suppliers and technologies can interconnect together thanks to common standards. Today in a world where technology is part of a revolution, fulfilling just technological interoperability is not enough. Furthermore, business and social impact are considered.

The use of proposed system in public transportation is closely related to the acceptance level. Being a monopoly service, it is quite easy to leave aside the acceptance level by thinking that the travellers will use it anyway. In this case, the refuse of using the system will not be direct, but identifying the factors that affect the user acceptance is very important. A conceptual model with 5 aspects that include: social impact, meeting expectations, frequency use, using attitude and perceived efficiency is used to suggest a survey on the acceptance level of the proposed system.

5.1 Future work

Many different sectors that include smart cities and high level of integration have been left for the future due to lack of time. This thesis focuses in proposing a smart public transportation for Tirana. The following ideas can be evaluated in the future:

- Conducting a more detailed survey and wider participation in order to identify clearly the sectors that need emergent interventions.
- Integration of the proposed system with the existing smart platforms in Tirana. Given that the proposed system includes data retention as an open-ended concept, the integration with the e-Albania platform would provide access to data that so far did not exist.
- Based on best practices followed in Amsterdam, Vienna and Prague, following the same structure, a system proposal for e-Health and e-Education is needed (identified during the survey as the second and third most urgent sectors)

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7 Appendix

7.1 List of acronyms

IoT –Internet of Things

ITU-International Telecommunication Union

M2M-Machine to Machine Communication

IoV-Internet of Vehicles

V2V-vehicle to vehicle

V2R-vehicle to road

V2H-vehicle to human

HVAC- Heating, ventilation and air conditioning

VIX-Vienna Internet Exchange

UHD-Ultra-high definition

RPO – Recovery Point Objective

DPP - Dopravní podnik Prahy

7.2 Graph data

7.2.1 Renewable energy-Total, % of primary energy supply, 2006 – 2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	21.92	23.9	25	27.6	26.9	26.25	29.72	29.93	30	29.43	30.05
Finland	23.22	23.5	25.8	24.1	25.5	25.98	29.42	29.77	30.2	32.28	31.19
Latvia	30.49	29.3	30	35.6	31.8	33.31	37.39	37.12	37.17	36.05	39.06
Sweden	28.66	30.6	31.5	34.8	33.4	32.9	36.94	34.58	35.92	42.23	36.96

Table 19-Data for renewable energy versus primary energy supply (graph 7)

7.2.2 Survey results about question number 6.

	1	2	3	4	5	Blank	Average rating
Finance	35	36	16	9	2	2	2.01
Economy	39	30	20	8	2	1	2.01
Health Care	35	30	17	10	5	3	2.11
Fire and emergency response	38	29	21	7	3	2	2.02
Public Transportation	36	29	23	8	2	2	2.05
Citizens participation	42	28	19	8	1	2	1.92
Environment	42	26	11	15	4	2	2.07

Energy	30	24	15	16	13	2	2.52
Water resource management	47	23	12	12	4	2	1.97
Safety	43	23	21	5	7	1	2.07
Recycling	38	23	20	16	2	1	2.18
Education	17	22	33	18	7	3	2.67
Digital Infrastructure and Online Services	23	20	31	13	8	5	2.48
City Governance	29	18	18	20	11	4	2.54

Table 20- Resource data table for graph 17

7.2.3 Survey results about question number 7

	Choice 1	Choice 2	Choice 3	Sum
Public Transportation	22	22	11	55
Education	19	19	5	43
Health Care	13	7	20	40
Environment	3	18	6	27
Digital Infrastructure and Online Services	12	7	7	26
Safety	6	3	10	19
Energy	6	2	7	15
City Governance	4	4	7	15
Economy	3	4	5	12
Finance	2	3	6	11
Water resource management	6	3	2	11
Citizens participation	1	3	5	9
Recycling	2	1	6	9
Fire and emergency response	1	4	3	8

Table 21- Resource data table for graph 19

7.2.4 Survey results about question number 10

	1	2	3	4	5	Blank	Average rating
Data Transparency	11	22	24	21	19	3	3.06
Quality of life	8	20	23	25	19	5	3.12
Violation of privacy and personal data	12	14	31	14	24	5	3.09
Business development	11	14	24	21	24	6	3.15
Misuse and misinterpretation of data	12	20	24	14	24	6	3

Table 22- Resource data table for graph 21

7.3 Survey ⁶⁶

The following survey consists of 10 questions, the responses of which require about 10 minutes. The purpose of the survey is to show how much the citizens of Tirana know about the smart projects.

Based on this survey, we will propose the implementation of a smart system with wide impact in different sectors of daily life.

1.Are you currently living in Tirana?

- Yes
- No

2. What group age do you belong to?

- 18-24
- 25-44
- 45-65
- 65-...

3. Choose the level of your education:

- Elementary school
- High School
- Bachelor
- Master
- PhD

4.Currently you are:

- Unemployed
- Student
- Employed in the private sector
- Employed in the public sector
- Retired

5.Are you aware of the implementation of Smart City projects in Tirana?

⁶⁶ This version of the survey is in English for reference purposes, but the survey was conducted in local language(Albanian) Screen shot of an example can be found in the end of this appendix, included the link to the survey.

Smart City is a concept that uses digital, information and communication technology to improve the quality of life in cities. It focuses on efficient use of existing resources and finding new resources, reducing energy consumption, eliminating environmental burdens, optimizing traffic and sharing data for public purposes.

- Yes
- No

6.Can you tell which of these general sectors includes the projects you know? Tirana is working ...

For each sector, evaluate with a scale from 1 to 5, where 1 represents "few investments in this sector" and 5 represents "multiple investments in this sector"

Digital Infrastructure and Online Services 1 2 3 4 5

Education 1 2 3 4 5

Public Transportation 1 2 3 4 5

Energy 1 2 3 4 5

Environment (air quality, noise, green areas, biodiversity)

Water resource management 1 2 3 4 5

Fire and emergency response 1 2 3 4 5

City Governance 1 2 3 4 5

Health Care 1 2 3 4 5

Citizens Participation 1 2 3 4 5

Safety 1 2 3 4 5

Recycling 1 2 3 4 5

Economy 1 2 3 4 5

Finance 1 2 3 4 5

7.Do you think your city is doing enough to publish its activities?

Yes

No

8. Can you tell how important do you consider each of these sectors when evaluating the importance and impact of a smart city project? Please select 3 sectors:

Choice 1...

Choice 2...

Choice 3...

9. Do you know about the "open data" initiatives that Tirana is implementing?

Open data are data that can be freely used, re-used and distributed by anyone. This concept has brought many innovations to different cities around the world, since open data is being used to create applications, anticipating emergency situations and scientific research. Usually open data are government data that include maps, medical records, mathematical, chemical, historical and statistical data.

- Yes
- No

10. The publication of "open data" has some positive and negative sides. How important do you think are the following influences of "open data"?

Data Transparency 1 2 3 4 5

Quality of life 1 2 3 4 5

Violation of privacy and personal data 1 2 3 4 5

Business development 1 2 3 4 5

Misuse and misinterpretation of data 1 2 3 4 5

Thank you for your answers.

Smart city dhe Tirana

Anketa e meposhtme perbehet nga 10 pyetje, pergjigjet e te cilave kerkojne afersisht 10 minuta. Qellimi i anketes eshte te nxjerre ne pah sa njohuri kane qytetaret e Tiranës per projektet ...

1. Aktualisht po jetoni ne Tirane?

Po

2. Ciles grupmoshe i perkisni?

25-44

3. Zgjidhni nivelin e edukimit tuaj:

Master

4. Aktualisht jeni:

I punesuar ne privat

5. A keni dijeni per implementin e projekteve Smart City ne Tirane?

Smart City është një koncept që përdor teknologji dixhitale, informative dhe komunikuese për të përmirësuar cilësinë e jetës në qytete. Ai fokusohet në përdorimin efikas të burimeve ekzistuese dhe gjetjen e burimeve të reja, reduktimin e konsumit të energjisë, eliminimin e ngarkesave mjedisore, optimizimin e trafikut dhe ndarjen e të dhënave për qëllime publike.

Jo

6. A mund të tregoni se në cilat prej këtyre sektorëve të përgjithshëm perfshtin projektet që njihni? Tirana po punon ...

Infrastruktura dixhitale dhe shërbimet online

Per secilin sektor, vleresoni me nje shkalle nga 1 ne 5, ku 1 perfaqeson "investime te pakta ne kete sektor" dhe 5 perfaqeson " investime te shumta ne kete sektor"

3

Edukim

2

Figure 16- Preview of the survey in the local language (Albanian)

The original survey was created using online version of excel and uploaded in onedrive. The survey is available in the link below:

<https://onedrive.live.com/survey?resid=C33A079C7F61CCE4!15468&authkey=!AARPBIpocQ0-Zko>

7.4 Survey on the acceptance level of the proposed system

1. Did you take this survey before?

- Yes
- No

2. Did you use the bus today?

- Yes
- No

3. How many times a week do you use the bus:

- Daily
- A few days a week
- Often
- Never

4. Do you own a car?

- Yes
- No

5. If yes, do you use your car as a substitute of public transportation?

- Yes
- No

6. What is your favorite method to pay for your travel:

- Anonymous chip card
- Personal chip card
- Paper ticket

7. If you use the chip card (anonymous or personal) where do you reload it:

- Ticket machines
- Ticket offices
- Online
- I don't use the chip card

8. What is the fare you use the most?

- Monthly ticket
- 6 Months ticket
- 1-year ticket

- Short trip tickets

9. Are you satisfied with the frequency of the buses?

Yes

No

10. Do you need to transfer in your daily routes?

Yes

No

11. Do the dashboards in the station help you with planning?

Yes

No

12. Are you comfortable with the check-in process?

- Yes
- I am starting to get used to it
- I don't understand it
- It is complicated

13. If you choose "It is complicated" please explain why below:

14. What is your opinion for the new fares: (you can choose more than one option):

- It is complicated to understand them
- They fit my needs
- They don't meet my expectations
- New fares are better than the old ones.
- New fares make me save money.

15. Do you have problems on using touch ticket machines?

- Yes
- No

16. Are you comfortable with the process of buying travel services from a ticket machine?

- Yes
- No

17. Are you satisfied with the language package of the ticket machines?

- Yes
- No, I would like (please specify language) _____

18. Do you think your service provider has offered enough information regarding the new system?

- Yes
- No

If no, please elaborate more.

19. Do you find the logos, signs and banners user friendly and intuitive?

- Yes
- No

20. Do you perceive an increase of security after applying the video surveillance in public transportation?

- Yes
- No

21. Do you think the new system has lowered the fraud possibilities (example, everyone pays their ticket)?

- Yes
- No

Thank you for your answers!