Empirical Research on Urban Public Transportation in the Context of Population Growth and the Demographic Development

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ABSTRACT
Urban mobility is one of the most important challenges cities face nowadays. Half of the world population is living in urban areas, and more of them is becoming city-based, going for jobs and studies in metropolitan areas.
The present paper aims to analyze different transport systems in order to obtain a series of conclusions on issues related to public transport worldwide in the context of increasing the population in urban areas. Therefore, the article will illustrate some of the major solutions and strategies used by public authorities all over the world.

KEYWORDS: *public transport, challenges, urban mobility, strategies.*

JEL CLASSIFICATION: *R41, R42.*

1. INTRODUCTION

Nowadays, public transport systems around the world are forced to face significant challenges, while at the same time providing quality services to users. Transportation plays a key role in the urban life because it touches hundreds of millions of lives every day. Nonetheless, public transport has undergone extensive changes in the previous periods, being influenced by a number of factors, such as: demographic development, environmental restrictions, population growth, a substantial increase in the consumer demands along with others.

The present study examines some of the particular effects that population growth has on the transport systems, and therefore upon users satisfaction. Future development of the public transport network is strongly influenced by the way in which the decision-makers adopts suitable strategies and solutions according to the realities of public transport worldwide.

At the present time the urban congestion has growth exponentially, which directly affects the quality of life for the citizens. The authorities may adopt two major categories of alternative solutions:

- improving the road infrastructure;
- improving the public transportation system.

As a result, through this paper we aimed at investigating different transportation systems within Europe in order to analyze a range of solutions and innovations implemented by the public transit operators.

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With this intention, we started to analyze the European Commission global planning, particularly the transport strategy for 2050.

Generally speaking, the first conditions for a more prosper Europe includes reducing the urban congestion, fewer emissions, increasing the employment rate and sustainable economic growth. Furthermore, the transport system is not considered yet sustainable by the EU reprezentatives due to some of the following facts:

- The oil usage for conventional transport might be still around 90% until 2050;
- Renewable energy sources are around 10% of the target set for 2020;
- Costs related with urban congestion will rise by approximately 50% by 2050;
- The CO2 emissions from transport will remain 30% higher than the levels recorded in 1990 (European Commission, 2011).

In order to achieve a comprehensive analysis of the public transport system is imperative to investigate different transport networks and statistics in direct comparison both from the European Union, and also at an international level. In these circumstances it is necessary to present a short overview of the public transport at European level and the dynamics of the indicators considered representative.

2. METHODOLOGY OF RESEARCH

This paper seeks to explain the influence of the demographic development upon public transport and how transport operators can face the upcoming challenges.

Our research approach followed three main stages:

1) Identification of the demographic development word-wide together with the trend in the European Union countries.

We conducted information-based research on recent population growth statistics at a global level, and in the same time for the European countries. We focused on the urban areas data due to the fact that the public transport is mainly used there. Similarly,

2) Analyze the solutions used globally by transport operators, their innovations in the field, and the easiness that these projects can be implemented in other transport networks. -re

After identifying the general information about population development, we focused on public transport models or projects used successfully world-wide, as well as analyzing important factors for the transport network:

- Demographic development;
- Transport trends and patterns;
- The degree of motorization in urban areas;
- Mobility factors.

3) In-depth analysis upon the main objectives for public transport authorities in order to increase the satisfaction levels for the users.

The final part consists in understanding how population development influences urban congestion, transport, and the general users satisfaction. In the same time, this study is a work in progress, and it will be finalized with the creation of a macroscopic transport model, on urban regions or for an entire city.

3. LITERATURE REVIEW

The demographic growth along with the urban congestion have been studied intensively, taking into account that it represents an essential part for the development of any modern society. Specialized literature provides nowadays a lot of detailed studies and researches on public transport worlwide, as well as future trends, forecasts and transport patterns.

As a result, we should take into consideration other relevant studies on this subject.

As an illustration, a **relevant study on mobility trends** was conducted by (Goletz, Feige, & Heinrichs, 2016) in four international cities: Paris, Vienna, Santiago de Chile and Singapore. The researchers studied a wide range of transportation modes including private cars, public transport and even non-motorized transport. Through this study, the authors approached an explorative method in order to define the transport trends, as well as answering the following questions:

- "What are the causes of recent mobility trends in the selected cities?
- What are the drivers of these trends from an individual perspective?
- What patterns, if any, can be found in those trends, and can our findings be scaled up to a broader context? (Goletz, Feige, & Heinrichs, 2016)".

Altough the researchers identified different mobility trends for every case study, they also revealed similarities across the transport systems, between car users in Singapore and Santiago, or in the case of public transport users in Paris and Vienna. Under those circumstances, we can have a better understanding of why public transport should be interconnected and transit models used by one transport authority can be successfully implemented elsewhere.

Another relevant study was conducted by the researchers from University of Zilina - Faculty of Civil Engineering **on the topic of transport and the influences of dedicated systems for transportation management and planning**. The authors studied the travel pattern and traffic volumes in Slovakia cities in order to develop transport forecastings or prediction models. "The prediction of future travel demand is an essential task of the long-range transportation planning process for determining strategies for accommodating future needs [...] The transport model is defined more often as a requirement in the specifications of area traffic plans (Drliciak & Celko, 2016)".

The scientists gathered demographic information on the Slovak Republic transport systems, mainly on the traffic in Zilina and Martin. Both of this cities have strategic traffic plans, but in reality the analysis revealed some critical points regarding the degree of transport saturation or urban congestion. With this in mind, The Slovak Road Aministration published the traffic trends for the future years, and also grow coefficients for every region using different types of vehicles.

Therefore, forecasting in transport is a useful tool in the event of a dynamic population growth and transport operators should concentrate their attention on creating transport models and developing public transport patterns.

In the authors opinion, "the process of data gathering is a challenge for every transport departments. The incorporation of transport model to the transport area plans is the basic and the main condition (Drliciak & Celko, 2016)".

(Pasquale, Santos, Leal, & Tozzi, 2014) have recently presented **a study about innovative solutions used by public transport authorities around Europe, Asia and Latin America**. The solutions presented in the research belong to different topics of public transportation: intelligent platforms for ticketing, inter-mobility, mobility management, financing projects, urban congestion solutions. "In the last few decades, sustainable transport solutions have been developed and implemented in many cities across the world. These transport solutions not only improve quality and the efficiency of transport in a city, but they also reduce significantly local air pollution and greenhouse emissions, making a positive contribution to citizens' quality of life (Pasquale, Santos, Leal, & Tozzi, 2014)".

The researchers analyzed 15 public transport solutions implemented all around the world. A part of the solutions can be found in Table 1.

Table1. Transport public solution implemented world-wide

	Public transport solution	Area of implementation
1.	BIP Integrated Smart Ticketing	Piedmont Region (Italy)
2.	Public Transport Interchanges Plan	Madrid (Spain)
3.	Metrobus Bus Rapid Transit System	Istanbul (Turkey)
4.	Traffic Density Map	Istanbul (Turkey)
5.	Gondola Lift system	Rio de Janeiro (Brazil)
6.	Eco-Frota Programme	São Paulo (Brazil)
7.	Bus Rapid Transit for large events	Brazil
8.	Intelligent ticketing systems in Brazilian PT	Brazil
9.	Zaozhuang City Bus Rapid Transit System	Shandong Province (China)
10.	Combined Rail and Property Investment	Shenzhen (China)
11.	Land Transport Master Plan	Singapore
12.	Diversification of services	Singapore
13.	Travel Smart	Singapore

Source: adapted from (Pasquale, Santos, Leal, & Tozzi, 2014).

All the studies were conducted during the City Mobility Showcases through Viajeo Plus Project, an international project developed by the European Commission with the main objective to "benchmark outstanding solutions for innovative and green urban mobility in Europe, Latin America, China and Singapore and subsequently facilitate the uptake of these solutions across different cities in these regions, and Mediterranean Partner Countries (European Commission, 2014)".

4. POPULATION GROWTH AND DEMOGRAPHIC BEHAVIOUR

The first reason why public transport is facing a lot of challenges nowadays is the constant annual population growth. According to United Nations data, the current growing rate in 2016 is 1.13% per year. Therefore, the average population increase is approximately 80 million individuals every year.

Furthermore, the world total population has doubled in just 40 years, from 3 billion individuals in 1959 to 6 billion people in 1999. Also, the study from UN, *2015 Revision* of *World Population Prospects*, claims that until 2038, the world population will grow up to 9 billion individuals (United Nations, 2015).

Secondly, the rates for urban population growth are even higher than nationwide averages. In this conditions, the public transport systems have to cope with different challenges due to the demographic development.

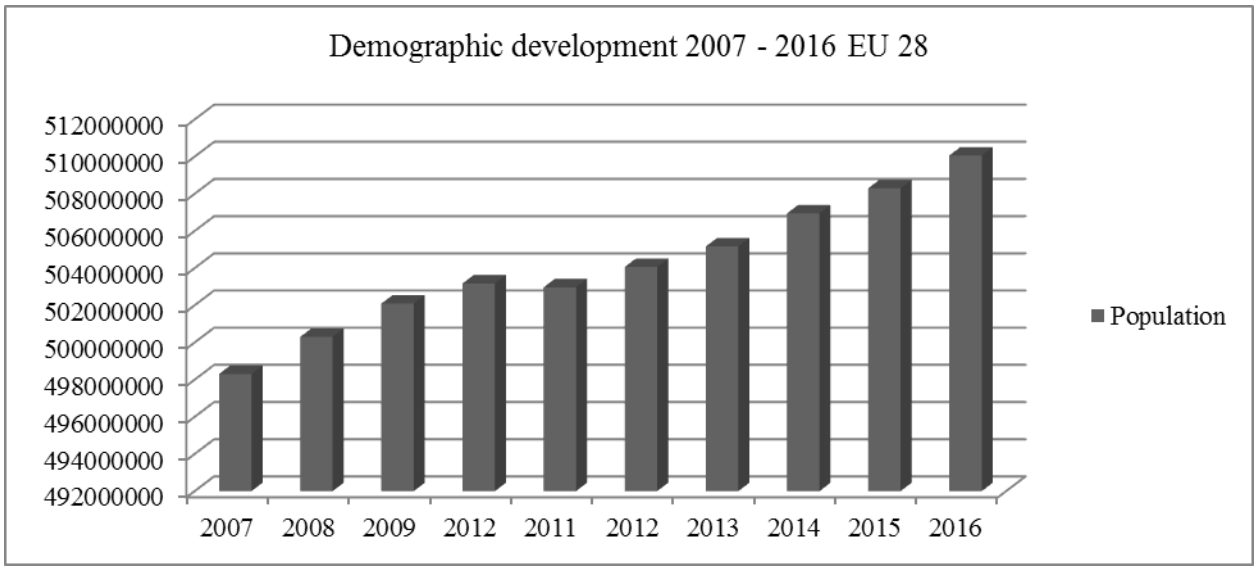

Figure 1. Demographic development in the European Union - 28 countries
Source: adapted from (Eurostat, 2016).

Accordingly to the official statistics from Eurostat "the current demographic situation in the EU-28 is characterized by continuing population growth" (European Commission, 2016). The study shows that the population in the EU-28 states increased from approximately 407 million individuals in 1960 to 510 million individuals today.

In other words, the structure of the population increased in 2015 with 1.8 million people compared to 2014.

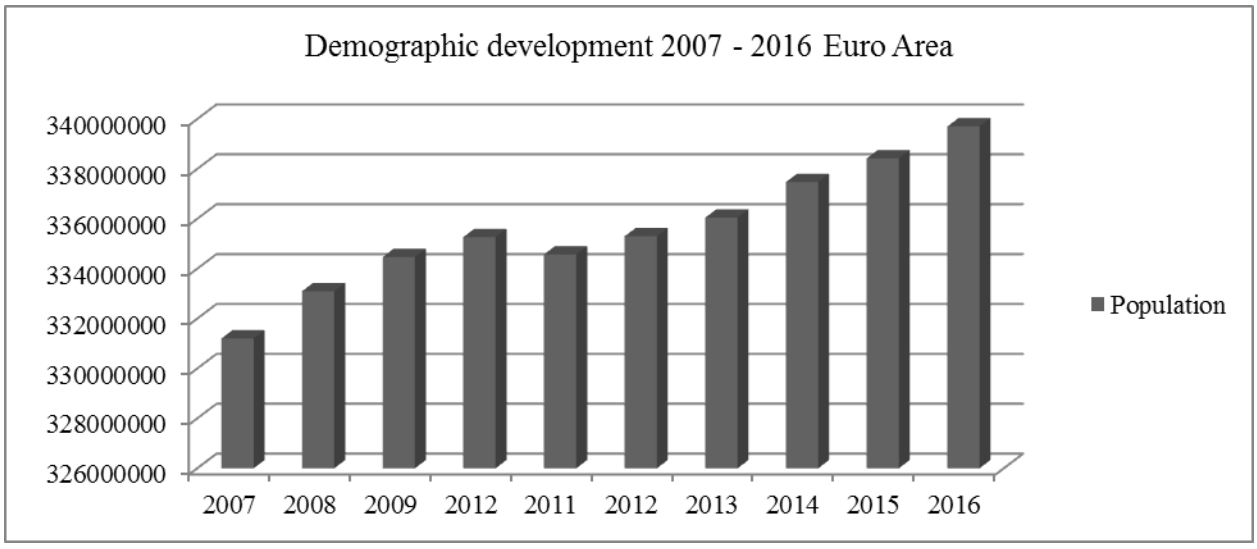

Figure 2. Demographic development in the Euro Area - 19 countries
Source: adapted from (Eurostat, 2016).

At the same time, the official statistics provided by the International Association of Public Transport for 2012, shows that only in Europe were recorded 57 billion passengers trips using the public transport systems.

The statistics are presented in Table 2 and Figure 3.

Table 2. The use of public transport systems at European level in 2012

Mode of transportation	Number of recorded trips (billions)	Percentage of the total trips
Bus + trolley	31,7	56%
Tram	8,1	14%
Subway	9,2	16%
Extra-urban lines	7,8	14%

Source: adapted from (The International Association of Public Transport, 2014).

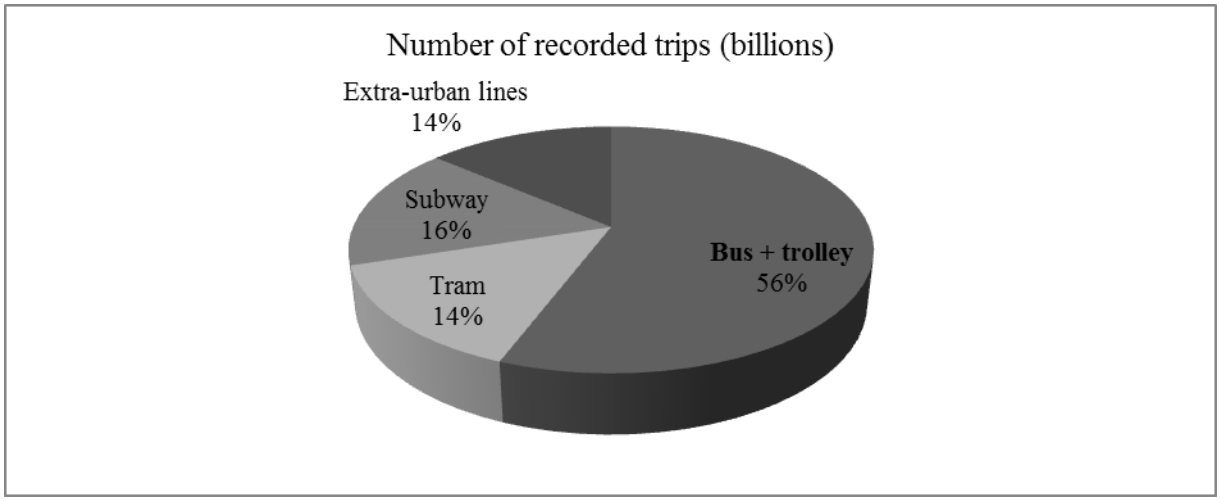

Figure 3. The use of public transport systems at European level in 2012
Source: Data processed by the authors.

On the other hand, in 2014, were available underground transport systems in 148 cities worldwide, which transports an average number of 150 million passengers daily. From the total subway networks, 45 of the systems are found in Europe. Furthermore, London is ranked third globally in terms of total network length, exceeding 420 kilometers of underground metro line, being outrun in this regard only by Shanghai and Beijing (The International Association of Public Transport, 2014).

At the same time, in agreement with the UITP (International Association of Public Transport) official statistics we must specify the information about the public transport modes average usage by a European citizen:

- An average EU citizen makes approximately 152 trips per year using the public transport;
- 185 million passengers are daily in the European Union;
- 28 EU Member States record for public transport was recorded in 2014, when were registered 57.6 billion public transport journeys (The International Association of Public Transport, 2014).

5. DATA RESEARCH AND ANALYSIS

The European Commission brings to the attention of transport operators the necessity of implementing the concept of **Intelligent Transport Systems** *(ITS)* because "there are vital to increase safety and tackle Europe's growing emission and congestion problems. They can make transport safer, more efficient and more sustainable by applying various information and communication technologies to all modes of passenger and freight transport (European Commission, 2016)".

In order for those systems to prove their effectiveness in the implementation process it is necessary for the public transport authorities to analyze the specific requirements for each transport network, and to build an appropriate framework

Likewise, the ITS systems used in the European countries requires to be coordinated and managed in an efficient manner so that it will function like as a single central system.

I. The Smart City model

Under those circumstances, working groups dedicated to this issue and researchers from around the world have established the foundation for the **smart city concept.**

Starting with 2007, the scientists from Vienna University of Technology, as well as researchers from the Department of Geography at University of Ljubljana and the OTB Research Institute for Housing, Urban and Mobility Studies in Netherlands have developed the notion of **smart cities.** Similarly, the European Commission had started "The European Innovation Partnership on Smart Cities and Communities (EIP-SCC)", a project through which European cities should work together in order to improve the urban life for citizens.

According to (Giffinger R. et al., October 2007) a smart city is a "city well performing in 6 characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens".

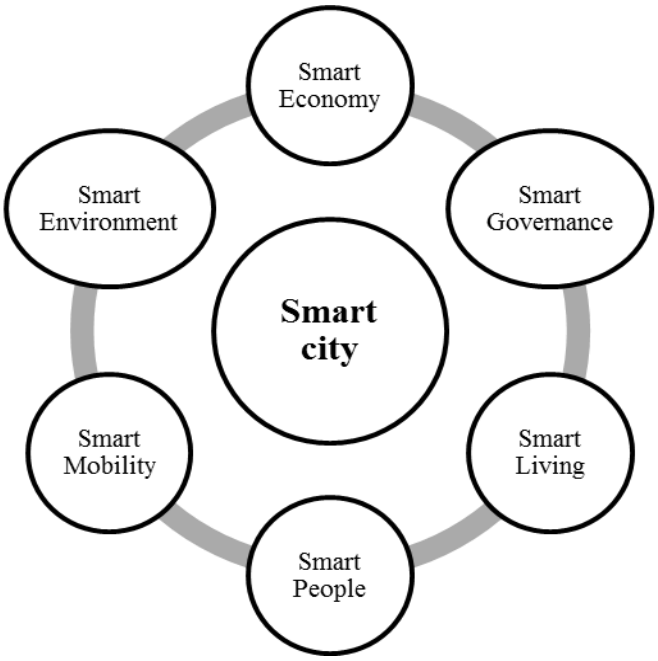

Figure 4. The smart city model
Source: adapted from (Giffinger R. et al., October 2007).

In terms of smart mobility, the indicator is composed of four key aspects:

- Local accessibility;
- International accessibility;
- Availability of Information and Commmunication Technology infrastructure;
- Sustainable, innovative and safe transport systems.

For this reason, we can understand more accurately the significance of the public transport system, and in particular the necessity for a complex and sustainable system that can satisfy the constantly changing consumer demands.

Comparatively, P.A. Consulting, an organization from the United Kingdom with 16 global locations (Europe, United States, Mexico, Middle East and North Africa, New Zealand, Singapore etc.), dealing with consulting and innovation since 1943, analysed the transport systems in more than 50 cities around the world in order to obtain a series of conclusions concerning aspects related to public transport internationally in the context of ongoing population growth in urban areas. The researchers identified five key trends:

i. "The city transport solutions being developed in cities worldwide are multimodal solutions which seamlessly connect different modes of transport according to customers' specific needs
ii. City mayors are leaning towards a 'one-stop-shop' to enable urban mobility, with public tenders focused on integrated urban solutions
iii. City governments are feeling increasing pressure to work on climate change-related issues and there is growing competition among global cities to be the greenest
iv. There is a move from single to multiple local strategies
v. Urban growth is shifting to Asia. Chinese cities will contribute about 29% to the world's GDP growth, and seven Chinese cities will make it into the top 25 in terms of GDP, by 2025 (P. A. Consulting, 2015)".

II. The BEST Project

The European Metropolitan Transport Authorities (EMTA) launched in 2014 the BEST Project, or "Benchmarking in European Service of public transport", in order to facilitate the communication between public transport authorities.

In addition, another purpose for the project was the development of a platform where the PTA's could have the possibility of exchanging information and best practices used in public transport.

The BEST Project included in the study a survey conducted into different European cities (Copenhagen, Geneva, Helsinki, Oslo, Stockholm, Vienna) which analyzed over 30 characteristics of the public transport network.

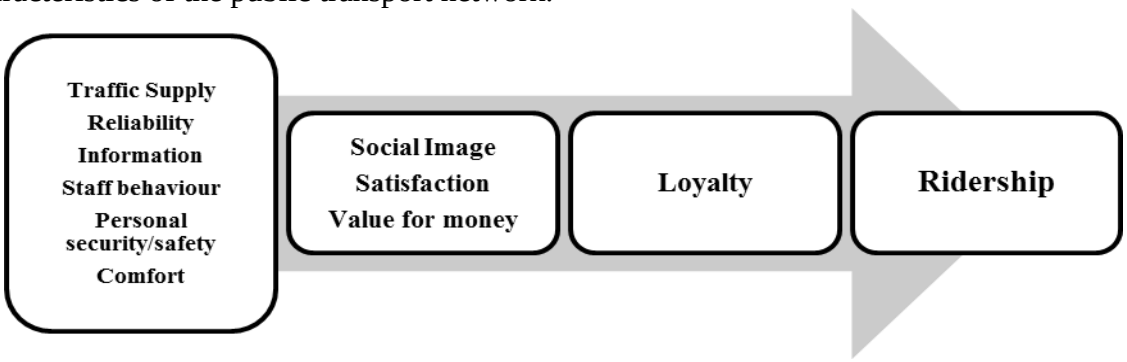

Figure 5. Public transport aspects analyzed in the BEST Project survey
Source: adapted from (European Metropolitan Transport Authorities, 2014).

The project outcomes represent an important decision tool for the policymakers in the PTA's because it allows them to really understand what is considered important for the public transport users, as well as it provides a lot of data and information throughout the entire year.

III. The Findland Case - Public Transport in Helsinki region

At the present time, the Helsinki Metropolitan Area becomes more and more congested, the public network providing more than one million trips every day.

Equally important is the fact that the use of public transport is declining in non-urban regions. For these reasons, the PTA's in Finland analyzed the information and the statistics and implemented an integrated public transport area: **The HSL's Strategy**, characterized by two main aspects:

- Easy traveling;
- Affordable services.

"The planning guidelines also support HSL's strategy which aims at increasing the modal share of public transport. The starting point of the planning is to make public transport as attractive as possible. This can be done by investing in the reliability and accessibility of public transport services (Helsinki Regional Transport Authority)". As an illustration, the new transport network has an **integrated ticketing platform**, with valid tickets on all the transport modes (subway, buses, trains, tram and ferry) for an urban area composed by seven municipalities and cities: Helsinki, Kirkkonummi, Vantaa, Espoo, Kauniainen, Kerava, and Sipoo.

Another key point, is the fact that the same ticket can be used to transfer from one transit mode to another.

The Helsinki Regional Transport Authority also conducts periodical passenger satisfaction surveys every year in order to measure the quality for the transport services and how the users reacts to HSL current strategy. The number of respondents is approximately 20.000 individuals per year, and the HLS is also a member in the BEST Project, previously presented here.

After analyzing the fast developing transport in Helsinki, Finland, the researchers from the Benchmarking European Service of public Transport concluded that "public transport cities can be successfully planned in keeping with these principles if city planners, transport planners and public transport providers are able to work well together (Rosenberg, et al., 2011)".

IV. Vienna and Linz cities - Public Transport

Vienna is the capital of Republic of Austria and also the cultural, economical and political center of the country. Vienna has the largest population in the state, with approximately 1.7 million people. In the same way, Linz is ranked third in terms of population in Austria, being in the same time the second potent economic region in the country.

According to the official statistics, **25% of Austria's population will reach the age of 65 years old, and by 2050 more than 30% of the people will be in this age group**. In the same time, the group of people with aged over 80 will steadily grow (Statistics Austria, 2016).

Considering this demographic change, it is obvious that some major changes will be recorded regarding the use of personal or private transportation.

With this in mind, in both of the cities, the public authorities have invested successfully in the public transport systems, as well as in promoting the pedestrian and bicycle traffic in detriment of private transport modes.

Therefore, the PTA's should take into strong consideration the necessities for different sociodemographic groups and try to satisfy their accessibility and mobility needs.

6. CONCLUSIONS

As can be seen, examples at an international level are encouraging. First of all, the decision-makers should concentrate their attention into goal-setting and sustainable investment. In this manner, efficient managerial tools and different types of resources can be identified in the interest of achieving the objectives.

In essence, it is important that the main objective for the transportation contractors should be to provide efficient and qualitative travel facilities in order to increase the consumers satisfactions and the general quality for the transport network. Furthermore, the increased quality of the transport system can positively influence the general quality of life in the entire urban region.

Most compelling evidence should be the European Commission Strategy developed for a long period of time, up to 35-40 years, with a specific objective to optimize the transport performance, and increase the efficiency for public transport systems. A broad perspective and understanding of the public transport pattern is useful for the public operators in order to predict the future travel demand.

In conclusion, governments should improve the public network implementing methodologies used and tested at an international level in order to increase the odds of success. In addition, developing the public transport will develop the urban quality of life for the citizens.

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