

IMPROVING THE ROMANIAN PUBLIC TRANSPORT SERVICES BY USING LEAN SIX SIGMA METHODOLOGY

Alexandru-Mihai BUGHEANU^{a}, Ruxandra DINULESCU^b*

^a The Bucharest University of Economic Studies, Romania

^b The Bucharest University of Economic Studies, Romania

ABSTRACT

The Romanian public transportation services need to identify innovative managerial methods in order to reduce or even eliminate waste from transportation management.

Thus, for achieving this objective, the current paper will present an overall analysis of the Romanian public transport services quality and how this affects the customers' satisfaction.

Furthermore, the paper aims to identify and analyze the risks to which users are exposed, as well as highlighting the causes that lead to a decrease in the general quality of the services.

By presenting the main types of wastes from the public transportation system, this study examines the necessity for introducing a methodology aimed to improve the quality of the transportation management by reducing wastes.

The purpose of this article is to offer a short review of the literature and to evaluate the main deficiencies observed in the transportation management. In addition, the paper will present a number of methods for reducing these issues by applying Lean Six Sigma methodology.

KEYWORDS: *Lean Six Sigma, public transport, risk management, strategies, urban mobility.*

1. INTRODUCTION

In the current global economy, public transport networks throughout the world are forced to cope with significant challenges, while still maintaining a high quality standard.

Nowadays, transport services have a significant role in the quality of urban life since a large part of the population uses the transport systems daily. Public transport facilitates access to education, to the labour market, leisure, as well as having a key role in the overall economy of the state (European Commission, 2015).

On the other hand, we need to take into consideration a number of factors that directly influence the public transport networks like: risk factors, population growth, health regulations, transport policies, or environmental restrictions.

The effects of public transportation on human health are widely recognized and many countries at European level faces this challenge. As an illustration, in Bucharest approximately 2.657 million passengers are transported daily and more than 20% of the total number of vehicles recorded in Romania are registered in Bucharest. In other words, the urban congestion has increased significantly with particular effects on the users satisfaction. Furthermore, in order to increase the sustainability of the transport system, the authorities need to decrease car dependency in favor of public transportation (Banister, 2008).

As a result, public transport authorities and operators need to investigate the main causes that could lead to users' dissatisfaction and to implement a range of methods and solutions according to the realities and the demands in each city.

* Corresponding author. E-mail address: mihai.bugheanu@man.ase.ro

Therefore, this paper will focus on finding the main issues that affect the customers and for that we will use a questionnaire based method. After applying this questionnaire and finding users' answers and opinions regarding their main reasons for dissatisfaction, we will present a methodology process based on Lean Six Sigma method. First of all, this methodology is useful for measuring the variability level and secondly, for eliminating the wastes from public transportation system.

2. LITERATURE REVIEW - AN OVERVIEW PRESENTATION OF THE ROMANIAN PUBLIC TRANSPORTATION SYSTEM

Specialized literature provides nowadays a lot of detailed analysis and studies on public transport services around the world, as well as innovative projects, management methods and transport patterns. For instance, studies by (Makarova et al., 2016), (Janiak, 2016), (Koziol & Gromek, 2017), have shown that the concept of risk management should be an integrated part of any public transport operator strategy in order to obtain a sustainable system.

Public transportation is an essential activity for any developed and modern society.

As an illustration, The World Health Organization highlights the most important transportation effects on human health and also on the environment: "Many countries in Europe are concerned with the numerous effects of transport policies on health, and governments want to ensure that these are addressed in the most effective and efficient way [...] The challenge is to select the policies with the most overall benefits to society (The World Health Organization, 2000)".

Specifically, risk management in the field of public transport services is of major importance since managing transportation networks implies extremely complex and detailed activities. The international standards defines risk management as "the effects of uncertainty on objectives (International Organization for Standardization (ISO), 2009)". For instance, public transport agencies should explicitly manage risks because is their responsibility to ensure high quality standards and certain risks can affect an operator or a public administration capacity to achieve its objectives.

"International organizations use risk management to align the strategic objectives within their organizations [...]. The standard risk management process of risk identification, assessment, management, and monitoring is being used for making many risk-based decisions. International transportation agencies use risk analyses to make programmatic investment decisions (U.S. Department of Transportation - The Federal Highway Administration, 2012)".

Another relevant research is conducted annually by the researchers from Gallagher Institute for Insurance, Risk Management and Consulting on risk management programs for transport operators. Through this study, the experts approached different solutions tailored to the size of the public transport administration or the economic sector, including:

- "Identifying potential sources of loss;
- Reducing the frequency and severity of losses;
- Reducing exposure to liabilities and losses
- Advanced analytics integrating GPS and cloud technologies with transit services;
- Health and safety advisory service (Gallagher Transportation Practice, 2017)".

Another explorative method in order to identify and analyze various risk in the sector of public transport was conducted by the The Research Council of Norway through the *The RISIT research programme – Risk and safety in the transport sector*. The authors studied different measures to increase safety within public transportation as well as documenting the major risks occurred in road traffic: "There is some degree of risk of an accident connected to the use of all forms of transport. [...] The transport sector needs to develop its own system for risk-based management (The Research Council of Norway)".

In conclusion, the literature review highlights the necessity of approaching the public transport services in terms of potential risks for passengers and their life quality and also, using Lean Six Sigma

principles, we will emphasize the need for improving users’ satisfaction by eliminating the potential sources of wastes and decreasing the variability level.

3. RESEARCH METHODOLOGY

Before we start a campaign for improving our public transportation system, we should first ask ourselves what exactly we are trying to accomplish and also, what is required to get us there (Larson, 2003). Starting an improvement plan just for the sake of applying some theoretical models, will result in waste of time, financial resources, human resources and so on, exactly what we are trying to avoid. For this reason, we have firstly created a SWOT analysis, to have a better perspective over the situation of the Romanian public transportation system:

Table 1. SWOT analysis of the Romanian public transportation system

STRENGTHS	WEAKNESSES
<p>Partially upgraded fleet with 1000 modern buses and 100 modern trolleybuses and approximately 50 improved trams;</p> <p>Good subscriptions options;</p> <p>Low subscriptions’ prices compared to European Union countries;</p> <p>Bucharest public transport allows a good variety of options;</p> <p>Dense and potential network.</p>	<p>There is no integrated ticketing system (for example between buses/trams and subways);</p> <p>Lack of unique lanes for public transport;</p> <p>Lack of special parking places lead to frequent blocking in public transport’s traffic;</p> <p>Lack of a specialized authority that control both surface and underground transport;</p> <p>Less European funds which led to intensive use and even immobilization of some buses;</p> <p>Passenger information is very poor (there are no machines that could inform the passenger when the next bus/tram is going to arrive);</p> <p>No specialized internet site for verifying or checking the correct route from one point to another (implicitly by showing also the public transport connections);</p> <p>No vehicle monitoring or central dispatching (sometimes route times do not match the actual situation).</p>
OPPORTUNITIES	THREATS
<p>Since there are crowded areas, this demonstrates an increased need for public transport;</p>	<p>Compared with personal cars, the public transport does not bring any advantage;</p>

<p>For improving the efficiency level, a revision for the transport network and circulation programs could be realized;</p> <p>Park & Ride system – parking spots in peripheral areas correlated with public transport terminals;</p> <p>New urbanization projects that could attract new passengers’ flows.</p>	<p>New urban plans for new residential neighborhoods do not foresee the integration of public transport from the beginning.</p>
--	---

Source: The authors

In order to better understand the deficiencies from the Bucharest public transportation system and also, what exactly could decrease users’ satisfaction, we have created a qualitative questionnaire to study users’ opinions regarding the public transport and, in this way, to find out what areas could benefit from the implementation of Lean Six Sigma methodology.

Thus, the questionnaire’s main objectives were:

- ü Obtaining information regarding the degree of customers’ satisfaction of the public transport service;
- ü Identifying the main problems that users may encounter while using the means of public transport;
- ü Obtaining information for improving the quality of services.

3.1 Research hypothesis

Before initializing the study, we have considered that the users’ satisfaction level would improve if the waiting time for buses/trams would decrease (for example, this assumption would be valid if the number of vehicles would be supplemented) and also if there would be a digital system that could allow the users to see when the bus/tram will arrive in the station.

3.2 Research variables

As for research variables we have taken into consideration the following aspects:

- ü Factors’ influence: chairs, acclimatization conditions, space, safety, etc.;
- ü Factors’ importance: subscriptions’ price, waiting time, quality, different reductions for subscriptions, comfort, etc;
- ü Users’ age;
- ü Frequency of utilization the public transport means;
- ü Users’ revenue.

In order to facilitate the methodology, we have built a table for presenting the main aspects of the questionnaire:

Table 2. Main aspect of the questionnaire

Research type	Qualitative
Sample size	80 people
Sampling method used	Online, anonymous questionnaire
Response rate	100%
Percentage of used questionnaires	100%
Data for conducting the survey	1 month - 23.05.2018/23.06.2018

Source: The authors

4. METHODOLOGY'S RESULTS

Regarding the results, we will present only the actions that are relevant for the present research, like the respondents' age, preferred type of public transport and the main deficiency that affects, in their opinion, the quality of the public transport system.

First of all, the socio demographic aspects can be observed in the picture below:

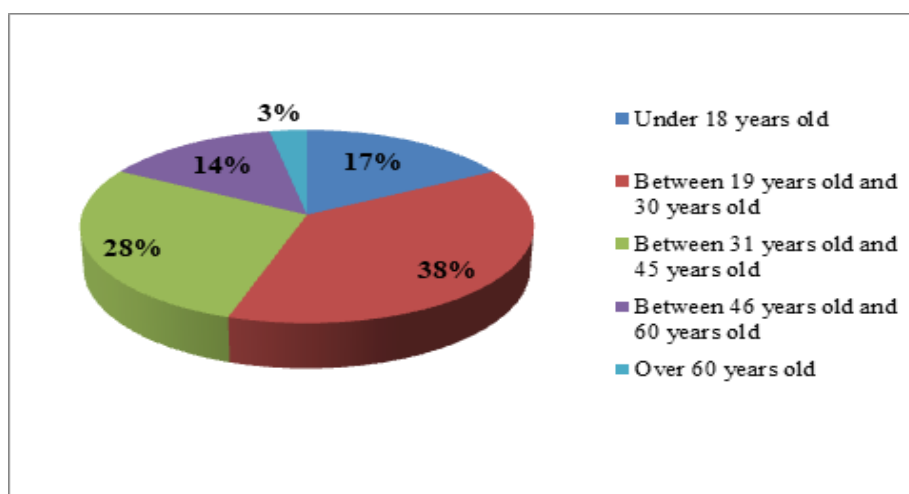


Figure 1. Socio demographic aspects

Source: The authors

Regarding the age, from the figure above, we can observe that the majority of answers came from those with ages between 19 and 30 years old – 38%, immediately followed by those between 31 and 45 years old – 28%. Few respondents were from the category with over 60 years old, respectively only 3%.

Continuing the research, we asked the respondents which public transportation mean they prefer; their answers were presented in the figure below:

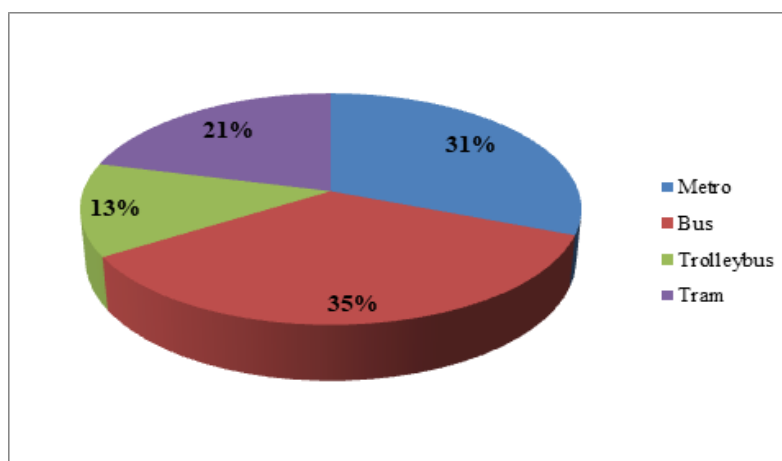


Figure 2. Preferred mean of transport

Source: The authors

Judging from the resulted figure above, the main public transportation mean is represented by the bus with a percentage of 35%, immediately followed by the metro with a percentage of 31%. In Bucharest, people often prefer using the metro or tram for several reasons like: avoiding heavy traffic from the roads, lack of parking places and also because the mean of transport are normally cheaper than taking the personal car.

The last question, which we also find the most relevant to our study, was regarding the main deficiencies that affect the users' satisfaction level (especially concerning the bus as a mean of transport). The answers and their afferent percentages can be seen below:

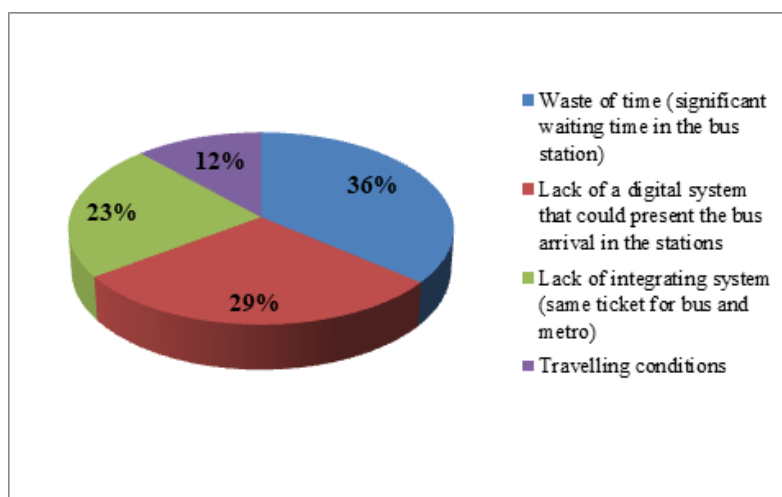


Figure 3. Main deficiencies reported by users

Source: The authors

Lean Six Sigma is practically a new methodology in Romania. People are now starting to use it in banks, manufacturing and other fields, but mostly the accent is on the theoretical part of the methodology (practice still needs some time before establishing properly).

Regarding the public transportation system, we believe that if a methodology like Lean Six Sigma would be introduced, the users' satisfaction would increase (by eliminating the waste of time and reducing variability). Moreover, by mixing Lean management with Six Sigma methodology, the process would be visibly improved and also, the quality level would have the potential to reach 5σ , which would lead us to a rate of perfection of 99.8%.

The methodology brings value to the many industries that apply it, thus, even the General Electric’s CEO, Jack Welch describes the methodology as being one of the most challenging and rewarding initiative that they have undertaken (Lowe, 1998).

The Romanian public transportation system still has some deficiencies that have to be solved in order to offer the users the desired experience. Studying the transportation management, we were able to discover that between the seven types of wastes (from the Lean methodology), one is more accentuated than the others, respectively, the waste of time, more exactly the passengers’ waiting time in the stations before the buses arrive.

Unfortunately, buses don’t have a defined schedule for arriving in the station and often passengers have to wait for more than 20 minutes before their bus arrive. Also, since there are several bus numbers stopping at the same station, the bus station becomes overcrowded, so passengers besides the fact that they have to wait an undefined timeframe for the bus arrival, they also have to deal with discomfort. These two actions result in a clear level of dissatisfaction from the users’ part.

As a title of example, after completing the questionnaires and gathered the answers, we have decided to measure the level of variation regarding the users’ waiting time (in minutes) in a bus station for a certain bus line. The study was initially conducted on a 24 hours basis. Below are the control charts resulted after recording the time intervals at which the bus arrived in the station:

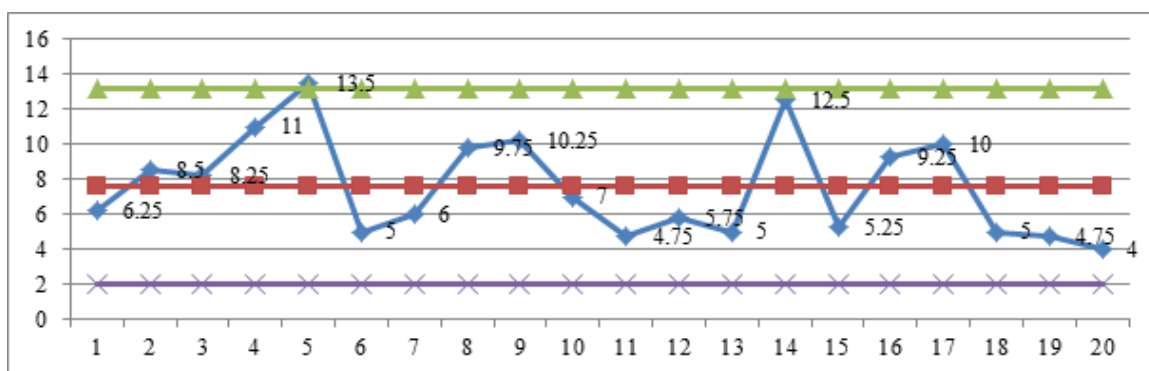


Figure 4. X-bar regarding the variation level

Source: The authors

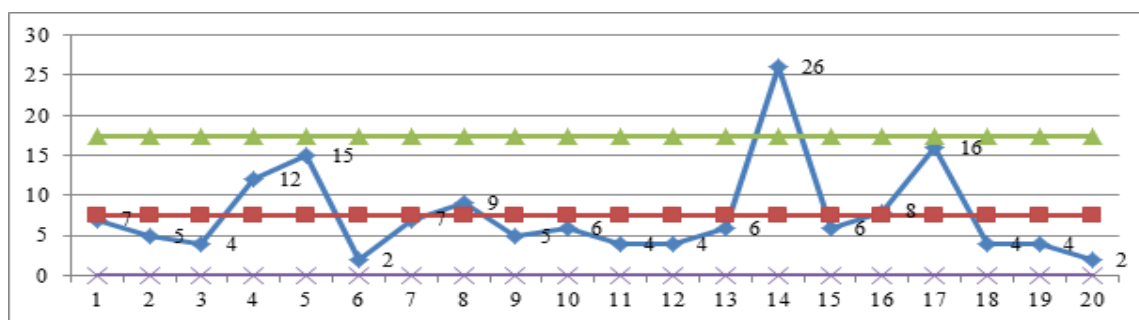


Figure 5. R-chart regarding the variation level

Source: The authors

As observed from the above graphics, both X-chart and R-chart, the interval at which the bus came presents a clear level of variation, with significant differences. For example, there were times when the bus came at a four minutes distance, but there were also times when the next bus (same bus line) came after 26 minutes. Such differences prove that the process is irregular and presents high levels of variation.

The ongoing study aims to reduce these variations, and this is why we believe that a methodology like Lean Six Sigma could improve the transportation management.

Also, as solutions, after a Lean Six Sigma process would be implemented, for reducing the users' waiting time in the bus station, we could introduce two actions:

1. A digital screen in each bus station that could announce the users in how many minutes the next bus will arrive;
2. An online platform that could allow users to introduce their destination and then presenting them the options for arriving there (what buses should be taken, when those buses leave from a certain bus station, etc).

5. CONCLUSIONS

Lean Six Sigma methodology is about people and their satisfaction and will for qualitative processes. Trying to offer an improved process, by eliminating wastes and reducing variability is the main objective of this method.

The initial study is still an ongoing research and we wanted to introduce a part of this improvement methodology in the Bucharest's public transportation system since there are some deficiencies that may affect the users.

Risk as a perception and a management instrument doesn't have a distinctive tradition among the Romanian public transport authorities.

In addition, the specific research literature in the field of public passengers transportation risk in Romania is minimal.

Research on the effectiveness of reducing risks for public transport passengers could help public administrations and transport operators to improve their services and also to reduce future losses.

In essence, this analysis provides an in-depth insight into the topic of risk management in public transportation and how public services can be studied with the use of Lean Six Sigma methodology.

In Romania, unfortunately, delays on the road network are common attributes in today's transportation system, especially in urban areas and during peak times (morning or afternoon rush hours). When traveling conditions are worse than expected (from random or unusual circumstances like a crash, work zones, planned special events (PSEs), or bad weather), these conditions directly affect the networks' reliability that travelers may have come to expect (Burgess et al., 2016).

Even if the study it's only at the beginning, at the theoretical part, we believe that by presenting the methods and tools that could improve the public transportation system, in time, we could apply and introduce these methods in practice also.

ACKNOWLEDGEMENT

"This study was conducted through the post-doctoral advanced research studies for the academic years 2018-2020, Management field, coordinator The Bucharest University of Economic Studies".

REFERENCES

- Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy*, pp. 73–80.
- European Commission. (2016). *European Commission. Mobility and transport*. Retrieved September 20, 2016, from http://ec.europa.eu/transport/themes/its/news/2016-01-21-c-its_en
- European Commission. (2015). *Measuring access to public transport in European cities*. Regional and Urban Policy. European Commission.
- European Metropolitan Transport Authorities. (2014, 08). Retrieved September 20, 2016, from <http://www.emta.com/spip.php?article943&lang=en>
- Gallagher Transportation Practice. (2017). *Risk Management Solutions for Passenger Bus Transportation*. Rolling Meadows: Arthur J. Gallagher & Co.

- Helsinki Regional Transport Authority. (n.d.). *HSL HRT*. (Helsinki Regional Transport Authority) Retrieved October 22, 2016, from <https://www.hsl.fi/en/transport-planning-and-research>
- International Organization for Standardization (ISO). (2009). *ISO 31000 Risk Management—Principles and Guidelines*. Geneva, Switzerland.
- Joanna Koziol, Pawel Gromek. (2017) *Creating Safety in Transport – Traffic Risk Approach*, Procedia Engineering Volume 192, 2017, pp. 457-462.
- Larson A. (2003). *Demystifying Six Sigma, A company – wide approach to continuous improvement*, Amacom.
- Lowe, J. (1998). *Jack Welch Speaks: Wisdom From the World’s Greatest Business Leader*, John Wiley & Sons, New York, NY.
- Maja Kiba-Janiak. (2016) *Risk Management in the Field of Urban Freight Transport*, Transportation Research Procedia Volume 16, 2016, pp. 165-178.
- Makarova I., Khabibullin R., Belyaev E., Mavrin V. (2016) *Increase of City Transport System Management Efficiency with Application of Modeling Methods and Data Intellectual Analysis*. In: Śładkowski A., Pamuła W. (eds) *Intelligent Transportation Systems – Problems and Perspectives*. Studies in Systems, Decision and Control, vol 32. Springer, Cham.
- P. A. Consulting. (2015). *P. A. Consulting*. (P. K. 2016, Producer) Retrieved August 27, 2016, from <http://www.paconsulting.com/>: <http://www.paconsulting.com/our-thinking/city-transport-solutions-embracing-the-future-of-urban-mobility/>.
- The Research Council of Norway. *Risk and safety in the transport sector - A state-of-the-art review of current knowledge*. The RISIT research programme – Risk and safety in the transport sector. PrintHouse.
- The World Health Organization. (2000). *Transport, Environment and Health*. Copenhagen: WHO regional publications. European series, No. 89.
- U.S. Department of Transportation - The Federal Highway Administration. (2012). *Transportation Risk Management: International Practices for Program Development and Project Delivery*. International Technology Scanning Program.