

Marko Slavulj, PhD¹

E-mail: mslavulj@fpz.hr

Julijan Jurak, MSc¹

E-mail: jjurak@fpz.hr

Matija Sikirić, MSc¹

E-mail: -

Marko Emanović, MSc²

E-mail: marko.emanovic@gmail.com

Matija Vuger, MSc³

E-mail: matija.vuger@zagreb.hr

¹ Faculty of Transport and Traffic Sciences

Vukelićeva street 4, Zagreb

² The Center for Vehicles of Croatia

Capraška 6, Zagreb

³ City of Zagreb, City Office for the Strategic Planning and Development of the City

Republic Austria street 18, Zagreb

OPTIMIZATION OF VEHICLE TESTING CENTER LOCATIONS IN ZAGREB COUNTY

Key Words

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Vehicle testing
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Service
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Abstract

In this paper the emphasis is placed on the vehicle factor from the aspect of roadworthiness. In order to determine whether it is a technically correct or defective vehicle, vehicles are subjected to vehicle technical inspections at vehicle testing centers. There are 161 vehicles testing centers in the Republic of Croatia, and 9 more that deal exclusively with preventive vehicle inspections. The aim of the paper is to optimize the locations of vehicle testing centers in relation to the demand for its service. The methodology of the work is as follows, based on the obtained and available statistics from the Center for Vehicles of Croatia (CVH), an analysis was made according to the requirements for the needs of the vehicles testing center. The paper consists of the following chapters: introduction, review of previous research, methodology, analysis of service requirements at vehicle testing centers, discussion and conclusion with the proposal of measures for optimization of services at vehicle inspection stations.

1. INTRODUCTION

This paper presents influence of technical soundness of vehicles as a factor in the road safety. There are 170 vehicle inspection stations in the territory of the Republic of Croatia. The aim of this paper is to show the relationship between supply and demand at vehicle inspection stations in Zagreb County and possibility of optimization. The methodology of the paper is next: based on the statistics of the Croatian Vehicle Center, an analysis of demand for services was made for the vehicle's technical inspection stations, which will provide a clearer insight into the relationship between supply and demand in the observed stations over a period of 3 years (2015, 2016 and 2017).

2. LITERATURE OVERVIEW

According to Repin, Maksimov, Golovkov, and Kuzmichev, the paper entitled: Method of Optimizing Placement of Mobile Car Service Stations in Sparsely Populated Areas (2016), considers the development of an optimization method for the deployment of vehicle maintenance stations in less populated areas. The method involves analysing the territorial location of settlements, the number of vehicles in the observed settlements, calculating the travel time between settlements, and determining the optimal location and location of vehicle maintenance stations according to a series of criteria. The necessity to develop a method of optimizing the location of mobile vehicle maintenance stations is caused by insufficient coverage of vehicles in sparsely populated areas, where technical services are provided for inspection and repair of vehicles, and therefore the number of traffic accidents increases due to technically defective vehicles. Fifteen settlements were taken into consideration with data such as: population, number of vehicles, travel time and others. By studying the presented settlements data, it is concluded that there are two variants of station placement. The first variant is in the settlement, while the second is in a special place outside the settlement. There are two basic ways of computing that are carried out in a settlement (with included population and without included population in settlements) [1].

According to Guangdong, Mengchu, Peigen, Chaoyong and Hongfei in a paper entitled: Multiobjective Optimization Models for Locating Vehicle Inspection Stations Subject to Stochastic Demand, Varying Velocity and Regional Constraints, this paper presents a new statistical multi objective optimization solution to address the issue of selecting a vehicle inspection station location as a typical example in the automotive industry. This paper is based on two practical stochastic multi objective programs dependent on stochastic demand, variable speed and constraints. To solve the proposed programs, a hybrid intelligent algorithm is proposed that integrates a stochastic simulation and a multiobjective learning-based optimization algorithm. This approach is already being applied in China to solve the problem of selecting a vehicle inspection station location, and the results have proved satisfactory [2].

According to Hong - Feia, Qiang and Guandong, the paper entitled: A Multi - Objective Optimization Model for Locating a Vehicle Inspection Station with Fuzzy Demands determining the location of vehicle inspection stations is a very important issue in the field of logistics research. To solve all the uncertainties, some researchers have looked at finding the location of stations for vehicle inspections, according to time and cost factors according to Fuzzy. The travel time factor in selecting the location of a vehicle inspection station is also vague due to the influence of some other unpredictable factors. In order to solve this problem, a Fuzzy multiple objective approach is proposed to implement optimization. To solve the problem, a multicriteria programming model has been developed, which determines the most favourable locations according to the set requirements. To solve the problem, a hybrid algorithm model is proposed that integrates fuzzy simulations, neural networks, and genetic algorithms [3].

According to Guandong, Liu, Guang, Dai, Ren in a paper entitled: Analysis of network layout optimization problem for vehicle detection station in random environment, suggests that given the impact of uncertain factors, the problem of randomly positioning a network of vehicle inspection stations was introduced to describe the real circumstances. Furthermore, stochastic programming models for accessible and inaccessible location for vehicle inspection stations have been established, and at the same time a genetic algorithm based on stochastic simulation is used to solve the problem, using the model [4].

Described papers dealing with the optimization of vehicle inspection stations in different areas, using available data such as: number of vehicles in specific areas, analysis of territories of specific areas, average travel time in areas, based on spatial and other constraints using different methods like: stochastic, different algorithms, using Fuzzy logic and various simulations. By studying the above papers, it is possible to optimize the locations of the stations for the technical inspection of vehicles.

3. EXAMPLES OF SYSTEMS FOR TECHNICAL INSPECTIONS OF VEHICLES IN THE EUROPEAN UNION

The vehicle inspection system in the Republic of Croatia is very similar to system of The Federal Republic of Germany. The regular technical inspection of vehicles in Germany is also carried out by an expert organization as in the Republic of Croatia, which is a private legal entity, and which is authorized by the provincial administration in accordance with provincial legislation. In relation to the Croatian system, in which public authority is granted to the Croatian Vehicle Center (which performs technical inspections directly) and the Croatian Auto Club (which performs professional supervision), there are several expert organizations in Germany performing technical inspections (Dekra, TUV, GTU etc.). The reason is that Germany is a federal republic, which has a different administrative structure than Croatia. There are over 61 million vehicles registered in Germany, so it is simply impossible for all these vehicles to be tested by a single expert organization. Vehicle inspection stations in Germany also cannot be opened according to market

criteria. The regulations do not contain detailed criteria for determining the network of stations for technical inspection, but the system is organized in such a way that each provincial administration independently determines the area where a new station can be opened. Obviously, there were different characteristics of the areas of individual provinces (population, number of vehicles, etc.), which should be considered when opening stations [5].

Regular technical inspections of passenger cars in the Republic of Ireland are also carried out by Applus + Car Testing Service Ltd., a private law body. The mentioned legal person performs the technical inspections in its 46 test sites and is the only one authorized for these tasks. The authority is granted by the public authority in charge for transport road safety, with the consent of the minister of transport and the minister of finance. Authorized legal examination centres must be within an acceptable distance (within 30 miles of 90% of vehicle owners as well as in major cities connecting or adjacent to state roads). Also, they must satisfy construction, safety and aesthetic criteria's [5].

4. ANALYSIS OF SERVICE QUALITY IN VEHICLE INSPECTION STATIONS

The analysis carried out in this paper refers to the demand for service at vehicle inspection stations in the Zagreb County area, which has ten vehicle inspection stations. The first reason for this selection is the appropriate available data, which can be analysed and see is it possible to implement the optimization of vehicle technical inspection stations in relation to the demand for the service. Another reason for choosing precisely Zagreb county is because of the highest number of registered vehicles compared to other counties [6], [7].

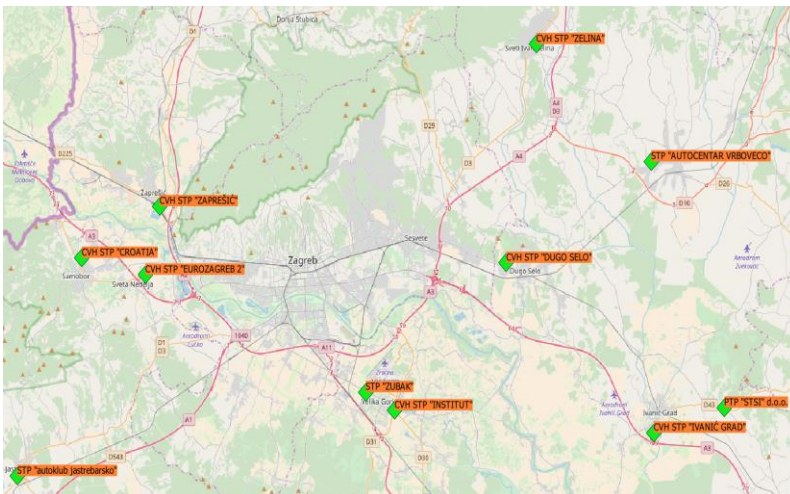


Figure 1. Locations of technical inspection stations in the Zagreb county

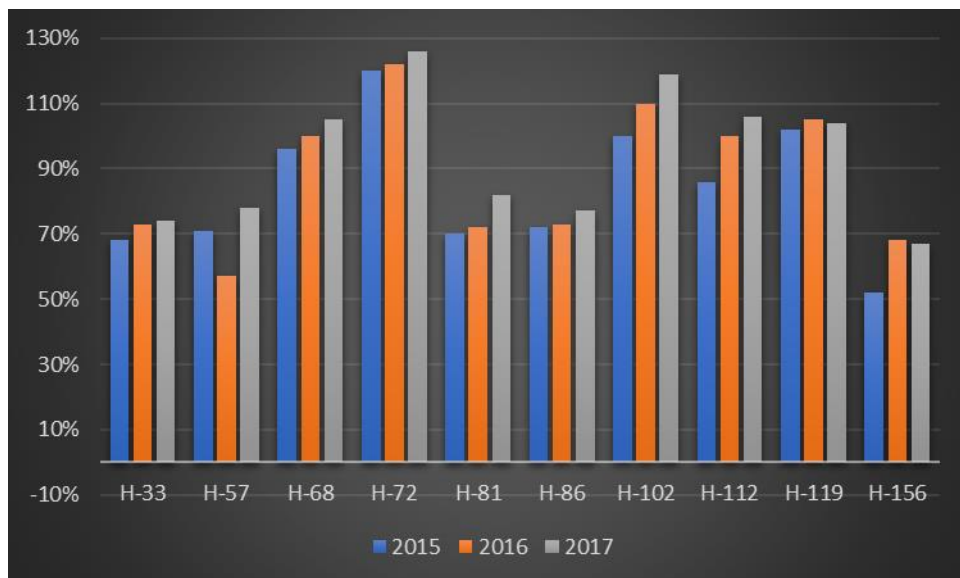
The time period covered through the analysis is 3 years (2015, 2016 and 2017). The services provided at vehicle inspection stations are: regular technical inspections, exceptional technical inspections, preventive vehicle inspections, Periodic vehicle technical inspections (PTPK), vehicle testing (approvals) and approval of vehicles [9], [10]. Table 1 shows the data from the observed stations for the technical inspection of vehicles in Zagreb county, which will be analysed. Table also show information such as the name of the station, its location, the county municipality and the type of vehicle inspection station.

Table 1. Data of vehicle technical inspection station in Zagreb county

Name of station	City of settlements	Station type	Station mark (H)
cvh stp "dugo selo"	Dugo Selo	STP	112
ptp "stsi" d.o.o.	Graberje Ivaničko	PTP+PTPK	9
cvh stp "ivanić grad"	Ivanić Grad	STP	86
stp "autoklub jastrebarsko"	Jastrebarsko	STP	81
cvh stp "croatia"	Samobor	STP	156
cvh stp "zelina"	Sveti Ivan Zelina	STP	57
cvh stp "eurozagreb 2"	Sveta Nedelja	STP	119
cvh stp "institut"	Velika Gorica	STP	33
stp "autozubak"	Velika Gorica	STP	72
stp "autocentar vrbovec"	Vrbovec	STP	68
cvh stp "zaprešić"	Zaprešić	STP	102

5. DISCUSSION

Graph 4 show data as a result of capacity utilization of the observed stations in Zagreb county over a period of three years. Of the ten vehicle inspection stations, five stations with their scope of inspection exceed 100%, which means that such stations are over their capacity. In sequence, these are stations (STP): H-68, H-72, H-102, H-112 and H-119. Of the five stations mentioned over the period of 3 years, 3 of them exceeded the capacity limit every year (H-72, H-102 and H-119). Furthermore, the largest increase in the observed period was recorded in the station H-57, in 2016 the figure was 57%, while in 2017 it was 78%, which is an increase of 21%. There are also stations that have seen a negative trend when it comes to vehicle inspection, and is H-119 station, where a slight decrease of 1% between 2016 and 2017 is noticeable, and station H -156. where a decrease of 1% was also observed.



Graph 1. Capacity utilization of vehicle technical inspection stations in Zagreb County for the period 2015 to 2017

6. CONCLUSION

Increased demand for service at vehicle inspection stations is a great challenge to find the right optimization solution. In this paper, used available and obtained data shows that the implementation of the optimization process is possible, and in some cases necessary. Further collection of relevant data is needed in order to conduct better and more accurate research. Analysis show, that five from ten observed vehicles technical inspection stations in Zagreb County were over capacity used, while the remaining five operate within the prescribed limits. The implementation of optimization is necessary above because of the laws and regulation, and to the satisfaction of all service users, and also to respond properly to the demand for the requested service.

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