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Quality management applied to analyze the reduction of the pollution which is generated from road transportation in agglomerated urban areas

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Abstract. This paper uses a quality management tool called the fishbone diagram (Ishikawa diagram), which is based on non-numeric data, to show what solutions are to solve an analyzed problem: the reducing pollution from road transportation in agglomerated urban areas. This study aims to identify the possible, main and secondary causes that could generate the studied problem. The factors that determine the reducing pollution from road transportation are presented. Factors are grouped into several main categories. In the paper a new model of the fishbone diagram which highlights main and secondary categories of potential causes that determine the problem solving is presented. The diagram allows for a clear definition of the problem studied and provides a visual graphical chart of the factors that determine the studied problem. The fishbone diagram provides guidelines for city development to protect the environment and optimizing the level and type of road transport to reduce the pollution phenomenon. The paper aims to group the factors that determine the reducing pollution from road transportation in agglomerated urban areas on main categories, so that appropriate action will subsequently be taken by the main responsible actors. The paper presents four main factors: policies and legislation, local authority management, car manufacturers and car users.

1. Introduction

One of the topical issues of humankind is the quality of air that deteriorates year after year. The fastest growing metropolitan areas are the most contaminated, where the protection of humans, animals and plants is a serious challenge. Development in these cities is geared towards economic progress, and environmental sustainability is ignored.

From the point of view of a global environmental issue, much of the total greenhouse gas emissions are mainly caused by urban transport, especially road transport. At this time, environment-friendly urban transport systems play a crucial role in improving the quality of the environment. Following investments at European level, it is noted that infrastructure projects focus on road extension, electrification and more parking facilities. These lead to more carbon emissions, traffic congestion and air pollution. Although they have brought many benefits to the development of our productive and increasingly mobile lives, cars emit large amounts of carbon monoxide, hydrocarbons, nitrogen oxides, sulfur dioxide and a full spectrum of toxic substances such as fine particles and lead. Each of these contributes to causing serious effects on public health and the environment.

The transport sector has changed dramatically over the years. Especially in recent years, the number of vehicles and the construction of transport infrastructure has greatly increased. These have been a dominant form of urban pollution, which is why society is currently very preoccupied to solve this problem. In this respect, numerous researches and studies have been carried out that show the bad harm to people and the environment.

In this paper, potential factors contributing to the reduction of pollution from road transport in agglomerated urban areas are presented in the synthesis. We chose a classification of potential factors by main categories and approached the problem using a quality management tool - fishbone diagram.

In the practice of organizations, the seven classical tools of quality management are frequently used to analyze the causes that determine the variation of the characteristics of a product, process, event, etc. Once known, causes can be corrected in the desired way on the basis of appropriate methods. In addition to classical tools in quality management, modern tools also have been introduced as tools for non-numeric data. These modern tools apply when desired: Identify the issues to be solved and the causes that generated them; Finding solutions to solve the analyzed problems; Elaboration of the program for solving the problems on the basis of the proposed solutions.

The specialized literature includes many papers that present case studies on the application of classical and modern quality management tools such as fishbone diagram, tree diagram, relationship diagram, matrix diagram, affinity diagram, etc.

The fish bone diagram is a diagram in many studies that addresses the presentation of causes that cause a product defect, service deficiency or any non-quality problem.

A comprehensive study on the application of 5 management tools for quality improvement in universities was conducted by Al-Bashir Adnan and published in the paper [1]. The paper [2] addresses an important problem of quality management in the implementation of Quality Planning projects. Also, papers [3] and [4] present case studies on the application of quality management tools for assessing and improving the quality of cars. The defects of the welds were also analyzed using a quality management tool and a study is given in the paper [5]. The paper [6] presents the results of a study concerning the use of the Ishikawa diagram in analyzing the measuring process. A study of the quality of education in a university are given in [7], in which the quality management tool called Ishikawa Diagram is applied. An important application of quality management is given in the paper [8].

In the paper [9] are presented the causes that determine the occupational accidents. Applying the Ishikawa diagram in this paper allows: dealing with particular phenomenon comprehensively, to prioritise causes, to link phenomena with problems and to eliminate causes behind the problem.

Another article, [10]**,** reviews the current literature regarding the IT investment evaluation approaches and proposes an Ishikawa diagram that describes the factors that influence the success of the IT investment. In this paper, six factors of IT investments enablers are discussed which are Financial, Internal, External, Strategic, Technological, and Risk.

The paper [11] presents the results of a study concerning the use of the Ishikawa diagram in analyzing the causes that determine errors in the evaluation of the piece precision in the machine construction field. Quality management tools have also been applied in the field of services, an example of which is the work [12].

The development of the fishbone diagram in a detailed form for determining the possible causes of a problem has the advantage of giving the possibility of identifying and analyzing all the factors connected to the problem.

2. Potential factors influencing the reducing pollution from road transportation in agglomerated urban areas

Numerous research has been carried out to assess the current state of emissions of air pollutants in the road transport sector. Research aimed at determining the main causes and finding solutions to address pollution problems.

In this paper it is proposed to apply the fishbone diagram to highlight the relationships between a proposed problem and the actions taken to achieve it. For the diagram, the problem to be solved is established: the reducing pollution from road transportation in agglomerated urban areas. The steps of the diagram are proposed, according to the indications given in the paper [13]: define the effect; a list of all possible causes (or factors) is drawn up, using the Brainstorming method; group the identified causes and define the main categories of possible causes; the diagram is started by writing the effect into a box on the right side; the main cause categories are positioned as power channels for the effect box; the chart is developed by enrolling in the boxes all the secondary causes identified for each of the main causes.

The research of factors related to the reducing pollution from road transportation in agglomerated urban areas, has been addressed for many years, so the literature is relatively extensive on this subject.

In the paper [14], are presented the essential aspects related to the sustainable development, prevention, improvement and mitigation of transport emissions and resultant atmospheric pollution.

The study from the paper [15] focuses on Istanbul urban transport systems from environmental point of view. The paper shows basic data about Istanbul's transport system and transport policy. This study uses a SWOT analysis to study Istanbul transport system from the environmental point of view.

One proposed solution to congestion or, better, to the underusage of private vehicles, is the so called "carsharing", i.e., pools of vehicles to be rented for short periods of time (minutes, hours), usually at higher costs (per day) than standard car rental prices, [16].

A case study in California is reffering to transportation with light-duty vehicles and it is presented in the paper [17]. On- road light-duty vehicles (LDVs) play an important role in contributing to the decrease of the urban air pollution.

In the web page www.smartertransport.uk, they are proposed measures and ideas for reducing traffic congestion and pollution in urban areas, developed in the Greater Cambridge area. The measures are grouped into three categories: low capital investment, medium capital investment and high capital investment.

In Europe, the increase in traffic in city centers has led to a phenomenon of chronic agglomeration, with many adverse consequences in terms of delays and environmental pollution. The European Commission has adopted several directives to reduce pollution caused by transport by setting emission performance rules for different categories of vehicles such as cars, light commercial vehicles, buses, trucks and motorcycles as well as regulating fuel quality. Since September 2017, a more realistic vehicle test cycle has been used. In addition, Council Regulation (EC) 715/2007 and Regulation (EC) No. 595/2009, are being revised to improve the quality of the car market. In 2011, the European Commission adopted a comprehensive strategy called "2050 Transportation" aiming to achieving a competitive transport system.

Most studies in this field are conducted in universities and research institutes. University specialists are concerned about finding solutions to reduce pollution from road transport. In terms of new vehicle-building solutions, transferring technology from universities to vehicle manufacturers is very important. This topic on the technological transfer of universities - companies was also addressed in the paper [18], [19].

Knowing the potential factors that determine the problem proposed in this paper is absolutely necessary to subsequently apply the appropriate measures and to cope with urban traffic congestion and air pollution caused by traffic. Based on data collected from several published studies, but also as a result of a Brainstorming meeting, we have prepared a list of the factors that determine the achievement of the proposed problem.

This list contains a series of factors defined as follows:

a. Manufacturers of vehicles

- compliance of vehicle manufacturers with emission standards,
- vehicles with environmentally friendly, innovative technologies,

- introduction of hybrid or electric motors,
- designing automotive components with less impact on environmental pollution,
- promoting low-fuel vehicles.

b. Management of the local authorities

- developing a traffic management strategy for reducing pollution,
- investments in public transport with high level of comfort,
- investments in alternative public transport systems,
- low prices for public transport,
- developing an infrastructure with adequate characteristics,
- rational planning of public transport and urban attractions,
- investments in combined transport nodes (Park & Ride)
- organizing the road routes so as to ensure the fluency and continuity of the traffic,
- correlation of green light period with traffic indicators,
- using "carsharing",
- vehicle Traffic Routing System,
- intelligent Transportation Systems and Vehicle Ad-hoc Networks.

c. Man- Drivers of vehicles

- the driver's ecological attitude,
- vehicles equipped with quality tires,
- the use of good quality fuel,
- rational exploitation of the vehicle,
- maintenance of the vehicle according to quality standards,
- proper training on vehicle operation in the sense of reducing pollution.

d. Policies (European and National)

- policy of fuel price growth,
- car cost policies,
- policies for implementing ecological engine vehicles,
- regulations for reducing private traffic,
- policies to renew the fleet of motor vehicles,
- price policies in car parks in central areas
- policies to stimulate active transport (cycling and walking),
- policies to expand economic activities in the marginal areas of cities,
- population education policies on the negative effects of pollution,
- Investment policies in schools located in locations favorable to active transport.

3. A new model of the fishbone diagram for the reducing pollution from road transportation in agglomerated urban areas

This paper proposes a new model of the Ishikawa diagram to describe the potential factors that reduce the air pollution generated by road transport in agglomerated urban areas.

In order to achieve the fishbone diagram, we grouped the factors identified in 4 main categories: Management (by the territorial administrative units), Man- Drivers of vehicles, Manufacturers of vehicles, Policies (national and European in the field of road transportation).

Figure 1 shows the fishbone diagram with a new formula: 3M + P.

The head of the fish is the studied problem**:** the reducing pollution from road transportation in agglomerated urban areas**.** Fish skeleton has 4 main ramifications according to the 4 main categories of factors. For each of the main factor, specific secondary factors are highlighted.

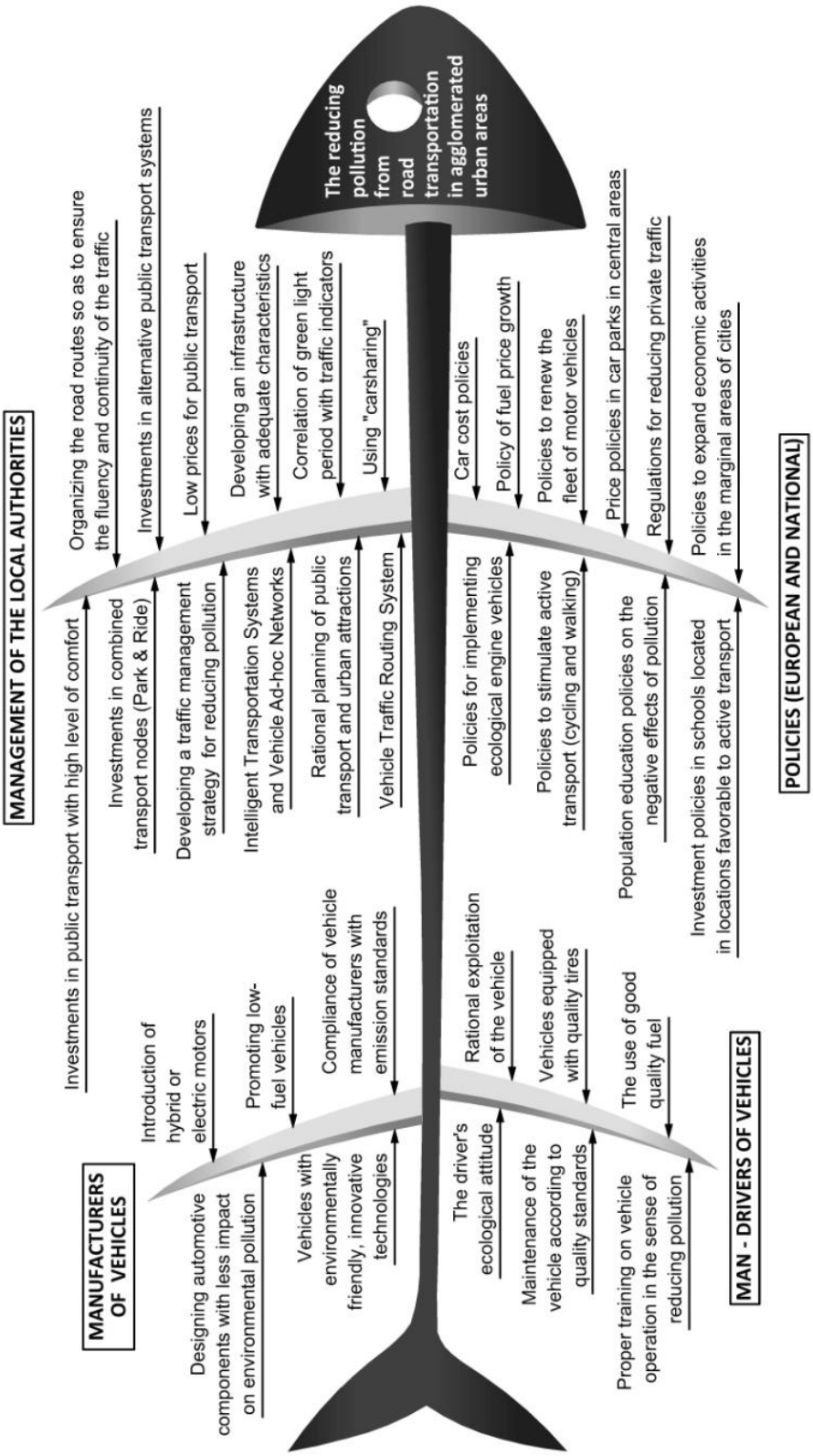

Figure 1. A new model of the fishbone diagram

The diagram allows for a clear definition of the problem studied and provides a visual graphical chart of the factors that influence the problem. The diagram highlights the factors that determine the reducing pollution from road transportation in agglomerated urban areas.

The results presented in the diagram will allow you to review the most effective solutions that provide guidance for city development to protect the environment and optimize the level and type of transport to reduce the pollution phenomenon. This chart can be used as a guideline for allocating resources and making the necessary investments to solve the problem proposed in this case study.

Conclusions

In all cases where the solving of quality problems cannot be done in an analytical way, use of techniques and tools for non-numeric data is used. Applying the fishbone diagram shows a number of advantages, such as: reducing the causes that generate nonconformities; reducing customer complaints; improving the image of the organization; increasing sales and increasing profit for the organization.

The fishbone diagram, through its design, stimulates creativity and challenges the imagination of the participants in search of suitable ideas for solving the problem.

Industrial organizations and public institutions should be interested in applying best practices in carrying out specific activities. Applying quality management tools guides organizations to improving quality. Quality assessment and finding solutions to eliminate non-compliances, based on world-wide methods that have shown positive effects, should be a primary focus in quality assurance and assessment policy.

This paper proposes a new Ishikawa diagram describing factors that influence the reduction of pollution generated by road transport in agglomerated urban areas. The results presented in the diagram will allow you to review the most effective solutions that provide guidance for city development to protect the environment and optimize the level and type of transport to reduce the pollution phenomenon. This diagram can be used as a guideline for allocating resources and making the necessary investments to solve the problem proposed in this case study.

Knowledge of factors that cause pollution from road transport is an essential element to the development of any strategy aimed at the reduction of air pollution in urban areas.

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