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# How Local Authorities are Engaged in Implementation of Projects Related to Passenger and Freight Transport in Order to Reduce Environmental Degradation in the City

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**Abstract**

The main aim of the paper is to analyse the impact of urban projects related to passenger and freight transport undertaken by local governments on the reduction of environmental degradation. The authors have presented the survey results conducted among 36 cities with administration county rights in Poland. In addition in the paper the multidimensional comparative analysis, including correspondence analysis, has been applied. This analysis enabled different classes of cities to be obtained related to the passenger and freight transport and targeted at environmental protection projects. The study results quite clearly show that there are no standards in the measurement of urban projects' efficiency according to their impact on environmental protection and the range of implemented projects in this field depends on the city population size.


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*Keywords:* city logistics; passenger and freight transport; local authorities; correspondence analysis; environmental protection.

## 1. Introduction

Increasing urban transportation causes congestion, noise pollution, air pollution and accidents. As a result it has an impact on premature mortality, disability, sleep disturbance and it also contributes to the effects of climate change (Browne *et al.*, 2012). Year after year, air pollution and noise are becoming increasingly burdensome. Urban traffic is responsible for 40% of all CO2 emissions and 70% of other pollutants. Basic environmental problems in

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cities are related to the predominance of oil as a transport fuel, which causes air pollution and noise. As a result of this phenomenon, the European economy loses every year nearly 100 billion euros, or 1% of EU GDP. The European Council has set a target to reduce greenhouse gas emissions in the EU by 20% by 2020 (Green Paper, 2007). To fulfil this local governments are required to undertaken certain activities.
In Poland, the problem of congestion and pollution in the city came to the attention of the authorities only relatively recently. Despite the fact that there have been some targets established by the European Council the number of local governments in Poland, which have taken steps to improve traffic and environmental protection in the city is in a minority. In addition only a small number of local governments in Poland measure the efficiency of implemented urban projects according to environmental protection.

The main aim of the paper is to analyse the impact of urban projects related to the people and goods flow on environmental protection.

The authors attempt to verify the sets of hypotheses:

- Polish local governments do not implement a sufficient number of projects related to passenger and freight transport in order to decrease environmental pollution in cities.
- There are no standards in the measurement of urban projects' efficiency according to their impact on environmental protection.
- The number of implemented projects related to people and goods flow in order to decrease environmental pollution in cities depends on the population size.

In the course of the research the authors have conducted a survey among cities with the county rights. A survey elicited answers to the following questions:

- What kind of activities related to the organisation of efficient passenger and freight transport have been taken so far by the surveyed cities taking into account their population size, and what kind of impact did these projects have on environmental protection?
- Do Polish local governments measure the impact of implemented urban projects related to people and goods flow on environmental protection?

As a result of the research, the impact of realised projects related to the movement of people and goods in the city on environmental protection (reduction of CO2 emissions, noise reduction, etc.) was analysed. The authors have also noted which cities (according to the population size) carried out the measurements of projects' efficiency. In order to achieve this aim, the authors have used measures based on statistics Chi^2. They have also made an attempt to use the methods of multidimensional comparative analysis, including correspondence analysis to study the interactions between these areas.

The paper is organised as follows: the second section presents the role of city logistics in the field of environmental protection. Following that, the authors have described the role of local authorities in implementing projects related to passenger and freight transport in terms of environmental protection. The fourth section presents research methodology and study results. The final part of the paper presents conclusions.

## 2. The role of city logistics in the field of environmental protection

The origins of city logistics can be traced to the early 1970s, when the first actions started to be taken towards urban freight transport. However, many cities began to notice the problem of congestion, when the problem of freight transport in the city significantly increased in the '90s (Crainic *et al*., 2009).

Urban freight transport is related to city logistics (Benjelloun, *et al*., 2009; Taniguchi et al., 2000; Würdemann, 1992). However, some definitions of city logistics include both freight and passenger transport (Klatte, 1992; Hesse, 1992; Szoltysek, 2005; Witkowski & Kiba-Janiak, 2012). In the authors' opinion "city logistics can be definied as planning, implementation and monitoring of economic efficiency and effectiveness of people, cargo and relevant information flows in urban areas in order to improve the citizens' quality of life" (Witkowski & Kiba, 2012). According to Taniguchi (Taniguchi *et al*., 2001) the main aim of city logistics is mobility, livability and sustainability (figure 1).

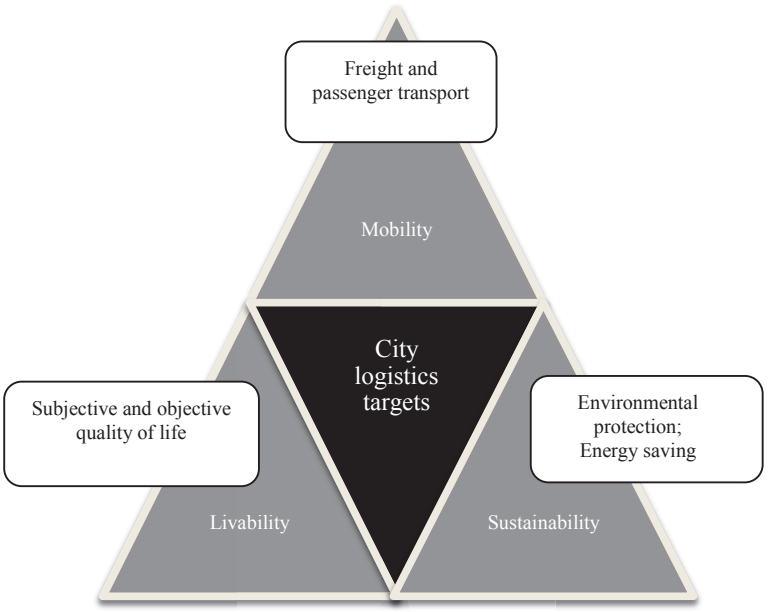


Fig. 1. Targets for city logistics.
Source: own work based on (Taniguchi, Thompson, Yamada 2003, s. 1-2).

Livability is associated with the improvement of quality of life. Increase in income, changing lifestyle in the cities and the development of technology (Internet, GPS) contribute indirectly to greater mobility of the population and consequently increase the congestion in the city (Kiba-Janiak & Witkowski, 2014). Another important problem is the increasing number of elderly people in cities, who require an efficient movement through the city.
Mobility refers to facility of movement of people and goods in the city (Jones, 1981; Levine & Grab, 2002). The criteria for the assessment of urban logistics in the area of mobility include, among other things, a reduction of the number of trucks and cars within the city, in order to improve traffic and decrease the cost of cargo transport.
Sustainable development encompasses economic, social and environmental aspects. The latter is particularly significant. This topic is discussed in many works (Taniguchi *et al*., 2003; Gonzalez-Feliu *et al*., 2010, Russo *et al.,* 2012). Air pollution, noise and vibrations are the results of increased freight and passenger transport. Therefore, city logistics planning should be carried out in a harmonised and friendly environment (Taniguchi *et al*., 2001; Szołtysek, 2005; Witkowski et al., 2012; Benjelloun *et al.*, 2009; Würdemann, 1992; Klatte, 1992; Hesse, 1992).

The challenge for urban logistics in the field of sustainable development is so difficult because it requires both the improvement of the quality of life associated with efficient movement around the city and environmental protection. This requires that common activities be undertaken on the implementation of innovative and sustainable solutions for urban transport, so that traffic in the city be more efficient and the environment less polluted (Green Paper, 2007). Environmental degradation in the city is largely the result of freight and passenger transport. The most significant problems in this field are: uncoordinated deliveries within the city, transport of goods and materials to the shops and manufacturing companies using heavy freight vehicles, an increasing number of residents and visitors moving around the city by private cars. Among the most important targets of city logistics in the field of environmental protection one may distinguish: reduction of emissions of CO2, NOx, PM, reduction of fuel consumption (Chen *et al*., 2008) and also reduction of noise, vibration, energy consumption (figure 2). These tasks can be accomplished through law regulation, infrastructure investment, actions to promote public transport, activities to improve traffic flow in the city through the use of telematics and IT solutions, organisation of collective delivery of goods, etc. The implementation of these solutions requires the involvement of all stakeholders of city logistics, which include: freight carriers, residents (consumers), shippers, administrators (local authorities) and public transport operators (Witkowski & Kiba-Janiak, 2013). However the most important role in the execution of

projects for environmental protection in the city is played by local authorities. Local government is responsible for a reduction of environmental degradation in the city. Therefore it should, in cooperation with other stakeholders, develop a strategy (policy) for green logistics in the city (de Oliviera *et al*., 2013).


Fig. 2. Targets for city logistics in the field of environmental protection.

The local authorities constitute an important role in city logistics and have a major impact on the efficient traffic in the city. They also, through various activities, shape ecological behaviour of society in the city (Kiba-Janiak & Witkowski, 2014).

## 3. The role of local governments in implementing projects related to passenger and freight transport in order to protect environment

The main objective of local government in the area of urban logistics is to improve the quality of life through striving to achieve environmental standards and efficient use of urban road network (Taniguchi & Tamagawa, 2005). Protection of the environment in the city is essential for local authorities not only from the point of view of improving the quality of life of residents but mainly it is a result of national and European guidelines imposed on local governments. According to the objectives of the European Commission the number of cars in the city conventionally-fuelled should be halved by 2030 and their complete elimination should be obtained by 2060. Another target concerns the organisation of goods supplies to large urban areas with the use of environmentally friendly transportation means, the transition to principle "polluter pays" and the involvement of the private sector to eliminate disruption to transport and the environment (White Paper, 2011). Local governments face a difficult task concerning implementation of the above objectives. On the one hand, residents expect a high quality of life in the city, clean air, efficient and secure traffic in the city. On the other hand, increasing number of urban communities use private cars to move around the city, thereby contributing to the degradation of the environment and decelerating of the traffic in the city. In turn, private companies are mainly interested in receiving goods / materials at the right time and place. They do not look for the supply of goods through the prism of the whole city but only through the prism of their own interests. Therefore it is mainly local government who have instruments and tools for taking initiatives related to improving traffic in the city and environmental protection. These actions, however, can be effectively implemented only with the cooperation of other stakeholders of city logistics. Perhaps the awareness of all stakeholders about the effects and costs of the traffic in the city can motivate them to cooperate for the improvement of urban logistics. The costs resulting from increased traffic transport in the city are huge and are borne by all stakeholders. These can be costs associated with congestions, with a delay of delivery, medical expenses due to injury in a road traffic accident (Lindholm & Blinge, 2014). According to the report “Handbook on

estimation of external costs in the transport sector" among the costs associated with environmental pollution and resulting from increased traffic in the city there are: air pollution costs: human life lost, health costs, building damage, cost related to the damage of nature and biosphere; noise costs related to: the loss of health, annoyance and rent costs; climate change costs including: prevention in terms of risk reduction of climate change, damages caused by increasing temperature; nature and landscape costs are related to the reduction of separation effects, compensation of ensuring biodiversity, etc. (Maibach *et al.*, 2008).

According to the Crosby theory costs incurred for prevention will be significantly lower than the costs that stakeholders of city logistics may bear as a result of increased passenger and freight traffic in the city (Southworth, 1997). Therefore, the task of local government is to implement such activities, which may reduce or eliminate the environmental and economic negative consequences arising from passenger and freight transport in the city (Iwan & Kijewska, 2014. Munuzuri et al. has classified activities related to the freight transport into four groups of solutions related to (Munuzuri *et al*., 2005): public infrastructure (Witkowski *et al.*, 2010), land use management, access conditions, traffic management, enforcement and promotion. In the authors' opinion all those solutions can relate to passenger transport as well. Table 1 presents groups of activities related to passenger and freight transport, examples of projects and impact of these projects on the reduction of environmental pollution.

Table 1. Type of projects related to the passenger and freight transport undertaken by local government in order to reduce environmental pollution.

| Type of activities related to passenger and freight transport | Example of solutions/projects related to passenger and/or freight transport | The impact of the projects on reduction of environmental pollution |
|---|---|---|
| Public infrastructure | Building new roads or adaptation of existing roads to the increasing demand on passenger and freight transport in the city | Reduction of CO2, PM, NOx emission |
| | Building new car-parks (for example Park and Rides) | Reduction of noise and CO2 , PM emission |
| | Building city distribution centres (collective delivery from the centre by Light Freight Vehicles - LFVs) | Reduction of noise, vibration, energy consumption and CO2 , PM emission |
| | The use of public infrastructure (trams, underground) for the purpose of cargo delivery | Reduction of noise, vibration, energy consumption and CO2 , PM emission |
| | Building bicycle lanes | Reduction of CO2, PM, NOx emission |
| Land use management | Land allocation for city logistics operations (trucks' unloading/loading) | Reduction of traffic jams caused by trucks' unloading/loading will contribute to the reduction of energy consumption, and CO2, PM, NOx emission by other road users |
| | Parking space planning in the city centre | Restriction of parking zones in city centre will enforce cars users to use public transport means. This will cause reduction of CO2, PM, NOx emission |
| | Urban space planning taking into account road traffic | Planning manufacture and logistic zones outside city centre. This will decrease number of heavy freight vehicles (HFVs) in the city centre and will reduce noise, vibration, energy consumption and CO2, PM, NOx emission. |
| Access condition | Spatial restrictions (according to the weight and volume, pedestrian zones, congestion charge zones, etc.) | Reduction of noise, vibration, CO2, PM, NOx emission |
| | Time restrictions (access time windows, parking Kiss and Ride) | Reduction of noise, CO2, PM, NOx emission |
| Traffic management | IT and telematics solutions (real information about traffic) | Reduction of energy consumption and CO2, PM, NOx emission |
| | Regulations for passenger and freight transport (coordination of collective transport, freight zone classifications) | Reduction of noise, energy consumption and CO2, PM, NOx emission |
| Promotion of collective and ecological transport | Promotion of collective or ecological individual transport (residents encouraging to use collective transport, bicycles, etc.) | Reduction of fuel and energy consumption and CO2, PM, NOx emission |
| | Promotion of ecological freight transport (electric freight vehicles, the use of alternative fuels (biodiesel, hydrogen, natural gas, vegetable oil, others biomass sources; goods delivery by bicycle, etc.) | Reduction of noise, and CO2, PM, NOx emission, the use of alternative fuels, reduction of energy consumption |

Source: own work modified based on (Munuzuri *et al.* 2005, p. 15–28).

The responsibility for implementing the projects presented in table 1 lies mainly with the local governments. It is worth noting that the scope and type of projects should be determined by the size and needs of the city. The first step should consider solutions that will utilise the existing infrastructure in a better way by, for example, the reorganisation of certain tasks related to transport in the city. Examples of these types of activities may be found in cities such as Berlin, London, Stockholm, which, thanks to the introduction of the low emission zone (LEZ) have reduced the level of air pollution. In Berlin the low emission zone was established in 2008 with the higher restriction from 2010. A low emission zone is an area which can be entered only by vehicles which meet certain standards for exhaust fumes. This area in Berlin is located within the S-Bahn route. Vehicles with particularly high emission levels must remain outside this area. Group of pollutants are distinguished by Euro standards for vehicles with diesel engines. Access to the zone is granted to vehicles bearing the so-called „green sticker". (http://www.lowemissionzones.eu/countries-mainmenu-147/germany-mainmenu-61/Berlin, 17.06.2014). The implementation of the LEZ in Berlin effected in a reduction of diesel emission by 24% and $PM_{10}$ by 8% (http://www.lowemissionzones.eu/low-emission-zones-main/impact-of-lezs, 17.06.2014). A Similar LEZ to that in Berlin was also introduced in Greater London in 2008. All registered vehicles (those from outside of Great Britain need to be registered in advance) are recognised by cameras, which read the plates' numbers. The numbers are checked with the database of registered vehicles in terms of meeting the LEZ emission standards. In London in the period from 2008 to 2010 the Low Emission Zone resulted in reductions of $PM_{10}$ and $NO_x$ (Mayor's Air Quality Strategy, Mayor of London, 2010). A Low Emission Zone in Stockholm was established in 1996. In the years which followed the rules were changed several times and finally in 2007 the national regulation - Swedish Road Traffic Ordinance was introduced (SFS 1998:1276, Chapter 10). This new rule is based on the European environmental classification system and contains such regulation as: heavy, diesel-powered trucks and buses are allowed to enter the LEZ for at least six-years. Euro 2 or 3 vehicles can be driven in the LEZ for eight years. Euro 4 and Euro 5 vehicles can be driven in an Environmental Zone up to 2016 and 2020, respectively. All cases are calculated from the first registration of the vehicle (Trafikkontoret, 2009, Environmental Zones, Heavy vehicles – trucks and buses in Sweden, Regulations, Göteborg Stadt, 2009). The research conducted in 2007 shows that the LEZ in Stockholm has reduced PM and $NO_x$ emissions by 13-19% and by 3-4%, respectively compared to the situation without the environmental zone in the city (Trafikkontoret, 2008, *Miljözon för tung trafik i Stockholm 1996-2007,* Stockholm Stad).

In European cities, one may find many of these kinds and other solutions, which may result in reduction of environment degradation (Green Paper, 2007). However, the effective implementation of all those solutions requires the involvement of city logistics stakeholders (Kramarz *et al.*, 2011).

## 4. Research methodology and study results

### *4.1. Overview of the research subject*

Poland since 2004 has been a member country of the European Union, with a population of 38,533,000. More than 60% of the Polish population lives in cities (Central Statistical Office, 2013). In Poland there has been a three-tier structure of local government from 1 January 1999. The country is divided into 16 provinces, 379 counties, including 66 township districts (until December 31, 2012, there were 65), performing either tasks of municipalities and cities with county rights and 314 country district concentrating few or several neighbouring municipalities (Central Statistical Office, 2012). The basic unit of local government in Poland is the municipality with a legal entity. Municipalities have the right of ownership and other property rights. Local government revenue can be divided into: their own, including property tax, general subsidies and grants from the state budget. Responsibilities of the municipalities can be divided into equity (to satisfy local authorities' needs and to improve the quality of life in the city) and commissioned by the government (Drożyński & Urbaniak, 2011). Among the municipality tasks, in addition to the above, are also: building and maintaining municipal roads, streets, bridges and squares, environmental and nature protection, planning corporate spatial, traffic organisation, supervision of local public transport, maintaining cleanliness and orderliness, disposal of municipal waste (The Act on Municipal, 2001; Witkowski & Kiba-Janiak, 2013).

The tasks in the area of urban logistics carried out by the Polish cities include: the protection of the environment and nature, construction and maintenance of municipal roads, streets and bridges, traffic organisation and supervision of local public transport. Unfortunately freight transport has not been included in tasks performed by

local authorities. The studies conducted in cities with county rights indicate that freight transport is included in the strategic objectives only in large cities. In most Polish cities this area is neglected (Witkowski & Kiba-Janiak, 2012). In Poland, a significant problem of congestion is noticeable for several years. The scale of the problem is confirmed by the statistical data, according to which index of inland freight transport growth amounted to 140% by 2010 (measured in tonne-km/GDP in chain-linked volumes at 2000 exchange rate, 2000=100) (Eurostat, 2014). This result has located Poland on the third - worst position among other European Union countries. Major problem in Poland also provides passenger transport. Within the five-year period from 2005 to 2010 the motorisation rate of passenger cars has increased by nearly 140% (number of passenger cars/ 1000 inhabitants). Those problems have caused an increase in PM and NOx emissions. According to "Air quality in Europe — 2013 report", from 2009 to 2011 Poland had a substantial average increase in PM10 concentrations beside such countries as: Austria, the Czech Republic, Germany, Italy and the Netherlands. The report shows that Poland next to Portugal and Luxemburg presented significantly increasing trends in NO2 concentrations, in a period between 2002 - 2011. In addition Poland is one of two countries (together with Estonia), who registered a growth of this indicator at rural areas. The research showed that CO emission had decreased from 2002 to 2011 at traffic stations by 37%. These results arose mainly because of "Euro" standards for motor vehicles in terms of CO emission limits [Air Quality in Europe, 2013].
Among other reasons hampering traffic in the city and causing environmental pollution one may include: an increase in the population living in cities, poor traffic management in the city, poorly developed public transport, urban development (the formation of the so-called suburbs), deficiency of adequate transport infrastructure in the city, the failure of standards for the collection and analysis of data relating to the movement of people and goods in the city, etc.

### *4.2. Research Stages and the sample selection*

In order to verify the hypothesis the authors have conducted the study, which comprised six stages. The first phase consisted of a literature review of Polish and foreign sources in the field of city logistics, especially including ecological aspects. On the basis of the literature review (Lindholm, 2012) a questionnaire was developed, which four experts subsequently tested. The developed survey was conducted between the end of December 2012 and the beginning of the 2013 in all cities with county rights in Poland. The sample was a target screening. The questionnaire was sent to 65 cities with county administration rights via e-mail address. Since in the survey were included various aspects, such as: passenger transport, freight transport, information system, the questionnaire was sent directly to the presidents of all cities with county administration rights. Finally questionnaires were filled out by directors of various departments (responsible for freight transport, passenger transport, IT and environmental protection). In order to obtain all detailed information about some solutions interviews with representatives of seven city councils were also conducted (Witkowski & Kiba-Janiak, 2013). During the interviews the authors received information about the selected solutions and also explained some questions to respondents. The survey response rate was at 55% (36 out of 65 towns with county rights filled the questionnaire). Among the cities that have sent the completed questionnaire were: nine cities with the population up to 100,000, 14 cities with a population between 100,000 and 200,000, 13 cities with over 200,000 inhabitants (table 2). Despite the fact that the authors were unable to obtain answers from all cities with county rights, the participation of representatives of cities of all size categories has been assured. The information collected in the study implies to formulate preliminary conclusions in this respect, which is important from the point of view of further research.

Table 2. The sample selection

| Population size of the research cities / Specification | Below 100,000 | 100,000-200,000 | Above 200,000 | Total |
|---|---|---|---|---|
| The amount of questionnaires sent | 23 | 22 | 20 | 65 |
| The amount of questionnaires received | 9 | 14 | 13 | 36 |
| The amount of questionnaires received in % | 39% | 64% | 65% | 55% |

The survey was focused on the role of local government in developing solutions in the field of people, goods and information flows. However, for the purpose of this paper, the authors have concentrated only on questions, which related to the projects, which have an impact on environmental protection. In the survey, the authors have asked,

among others, the following questions to the respondents:

- What kind of projects in the field of people and goods flows have been implemented ?
- What kind of impact do those projects have on environmental protections?
- Do city councils measure the environmental effects of implemented projects?

To identify projects in the field of people and goods flows, related to environmental protection, the correspondence analysis was used, which aims to identify the simultaneous coexistence of different categories of nominal variables (Andersen, 1997). Correspondence analysis as a factor method allows the identification of relationships between variables and objects mainly in a graphical form (Panek, 2010). Determining category coordinates in multiple correspondence analysis is carried out in analogy to the classical approach. The starting point is the choice of the notation of the observed number of category features. There are four possible ways: a record based on an indicator matrix, Burt table (matrix), multiple analysis of contingency and combined contingency table (Bąk, 2010).

In this paper the calculation of the multiple correspondence analysis was based on the Burt matrix. It is a symmetric block matrix where the main diagonal are diagonal matrices containing the number of each category . Off- diagonal blocks are contingency tables between pairs of variables. The Burt matrix (B) is the product of an internal matrix markers (Z):

$$B = Z^T Z \tag{1}$$

However, the matrix markers (code system) is constructed in such a way that each row corresponds to another observation, and the column - variants of all variables. Dimension of real space comorbidity (K) is determined by the formula:

$$K = \sum_{q=1}^{Q} (J_q - 1) \tag{2}$$

where:

$J_q$ – the number of categories of variable $q$ ($q$ = 1,2, …, $Q$),

$Q$ – number of variables.

The Greenacre criterion is used in selecting the eigenvalues ($\lambda k$) which are significant, on the basis of the following formula:

$$\lambda_k > \frac{1}{Q} \tag{3}$$

where:

$\lambda_q$ – eigenvalues ($k$ = 1,2, …, $K$),

$Q$ – number of variables.

In addition Greenacre in his works introduces a way of improving outputs of variables analysis presented as a Burt matrix:

$$\lambda_k = \frac{Q}{q-1} \cdot \left( \overline{\lambda_{B,k}} - \frac{1}{Q} \right)^2 \tag{4}$$

where:

$Q$ – number of variables,

$\lambda_{B,k}$ - eigenvalues ($k$ = 1,2, …, $K$),

$\overline{\lambda_{B,k} = \gamma_{B,k}}$ ,

$\gamma_{B,k}$- $k$- peculiar value of matrix **B**.

The formula 4 is applied in order to calculate eigenvalues of matrix B higher than (1/Q)2. If eigenvalues are lower than (1/Q)2 then they are not taken into account in the further analysis.

In order to improve the quality of the image modification of own values is carried out , as proposed by Greenacre based on the formula (Greenacre, 1984; Bąk & Wawrzyniak, 2009):

$$F = F^* \cdot \Gamma^{-1} \cdot \Lambda \tag{5}$$

where:

F – the modified matrix of coordinate values for the category of the tested variables of the dimension *Kxk,*
$F^*$ - the matrix of primary coordinate values for the category of the tested variables of the dimension *Kxk,*
$\Gamma^{-1}$ - the inverse of diagonal matrix of singular value of dimension *kxk,*
$\Lambda$ –*kxk,*
*K* – the number of dimension.

In order to conduct the survey the author used an electronic questionnaire, which was sent via e-mail to all city councils (Witkowski, Kiba-Janiak, 2013). In order to analyse the data the author used two tools: Statistica and Excel. Research results allowed the drawing of conclusions.

### *4.3. Research Stages and the sample selection*

The study shows that local authorities have implemented several projects related to passenger and freight transport in order to reduce environmental degradation. Presented in table 3 projects undertaken by studied cities are probably not all projects which have been implemented till now in all these cities. However, results indicate some trends in the implementation of projects related to the passenger and freight transport. Among the studied cities it can be observed that the access condition is the most common solution for improvement of urban traffic and the reduction of environmental pollution. Access condition relates mainly to restrictions or prohibitions on entry to the city centre for cars or trucks and all vehicles, determining supplies of goods outside peak hours or during the night-time (these restrictions were provided in two surveyed local authorities temporarily and resulted from the weather conditions that prevented entry of heavy freight vehicles into the city during the day). The next most popular solutions were investments in infrastructure for the construction of bicycle paths, ring roads or reconstruction of major artillery roads. As a result of these projects the city freight traffic has been moved outside the cities' centres. These investments have largely contributed to the reduction of CO2, NOx and PM.

Table 3. Number of projects undertaken by studied local governments in relation to passenger and freight transport in order to reduce environmental degradation.

| Number of population of studied cities | Number of studied cities | Number of projects related to the passenger and freight transport undertaken by studied local government in order to reduce environmental pollution | | | | | Total number of projects | The average number of projects per type of the city (according to the number of population) |
|---|---|---|---|---|---|---|---|---|
| | | Public infrastructure | Land use management | Access condition | Traffic management | Promotion and educational programmes on ecological transport | | |
| <100,000 | 9 | 1 | 1 | 16 | 6 | - | 24 | 3 |
| 100,000 < 200,000 | 14 | 10 | 5 | 21 | 5 | - | 41 | 4 |
| Over 200,000 | 13 | 25 | 11 | 33 | 13 | 2 | 84 | 5 |

During the research, local authorities were asked about the results of implemented projects. Unfortunately, the respondents pointed out the effects for only 61 projects, of which 52 projects were resulted in environmental protection. Of these 52 projects, 80% resulted in a reduction of emissions of CO2, NOx and PM, while approximately 20% reduced noise in the city. Unfortunately, these opinions are mostly intuitive and do not arise from accurate measurements. Respondents provided precise calculations for the reduction of noise and CO2, NOx and PM emissions for only 15 out of all completed projects. Respondents did not always mention environmental aspects as the most significant outcomes of completed projects, but rather emphasised obtained efficient traffic flow in the region. However, it can be assumed that the improvement of traffic flow and the shorten of cars' downtime at a traffic light also helps to protect the environment by reducing energy consumption and CO2 PM and NOx, emissions. Research shows that the number of projects implemented in cities depends on the population of the city; the larger the city in terms of resident population, the greater the number of completed projects. This situation may be due to the fact that large cities are most affected by the problem of congestion and environmental pollution.

These conclusions are confirmed by correspondence analysis carried out by the authors.
In order to conduct correspondence analysis and verify the work mentioned in the responses from the surveyed cities, the following numbering and grouping of data and information was used for the subsequent analysis:

- The implementations of projects in the field of movement of passenger and freight transport directly related to the protection of the urban environment. During the study identified 14 cities that have carried out, at most one such project (PO1), 14 cities, which have carried out such projects 2-3 (PO2) and eight cities that have met four or more of such projects (PO3).
- The implementations of all projects related to the passenger and freight transport (with various effects resulting in reducing: transport costs, environmental degradation, travel time within the city, etc.). In the course of the study six cities were identified that have carried out at most 3 projects dedicated to urban logistics, 23 cities, which have carried out from 4 to 9 such projects, and 6 cities that have met at least 10 of these projects, these criteria were used to divide the cities studied for 3 analogous groups covering the city that P1 - have carried out a small number of projects dedicated to passenger and freight transport, P2 - have carried out the average number of projects dedicated to passenger and freight transport and P3 - including the city, where the number of completed projects was the largest.
- DL1 - the separation in the organizational structures of city council the department or employee dealing with issues related to passenger and freight transport, DL2 - no such department, DL3 – there is an employee performing tasks related to passenger and freight transport in other departments.
- D1 – narrow scope of passenger and freight transport data collection, including the collection of only basic information about the traffic cars and trucks in the city, D2 – the average scope of data collection in the range of passenger and freight transport, including apart from the basic information also some other data collected by established institutions for this purpose e.g. environmental inspectorates concerning noise and CO2 emissions in the city, the D3 – a wide range of data collection in the range of the passenger and freight transport, in addition to the basic information and data concerning the factors influencing the quality of the urban environment as well as additional information related with e.g.: filling up transport vehicles or the quality of communication services within the city;
- The size of cities. In the sample identified 9 towns with a population of less than 100,000 (M1), 14 cities with a population in the range of 100-200,000 residents (M2) and 13 cities with a population of over 200,000 (M3).

For presented purpose of the study Burt table was created of size 15x15[†]. By using the criterion of Greenacre'a was examined to which extent the eigenvalues of a lower dimension explain the total inertia (λ = 2.0000). The results of this phase of the study are presented in table 4.

Table 4. The results of the correspondence analysis.

| Number of dimension K | Eigenvalues $\gamma_k$ | Singular values $\lambda_k$ | Percentages of intertia $\lambda_k/\lambda$ | Cumulative percentages of intertia $\tau_k$ |
|---|---|---|---|---|
| 1 | 0,6738 | 0,4540 | 22,7014 | 22,7014 |
| 2 | 0,6046 | 0,3655 | 18,2740 | 40,9754 |
| 3 | 0,5233 | 0,2739 | 13,6935 | 54,6690 |
| 4 | 0,4548 | 0,2068 | 10,3404 | 65,0094 |
| 5 | 0,4353 | 0,1895 | 9,4755 | 74,4849 |
| 6 | 0,4309 | 0,1856 | 9,2816 | 83,7665 |
| 7 | 0,3420 | 0,1169 | 5,8473 | 89,6138 |
| 8 | 0,3062 | 0,0937 | 4,6865 | 94,3003 |
| 9 | 0,2892 | 0,0836 | 4,1804 | 98,4807 |
| 10 | 0,1743 | 0,0304 | 1,5193 | 100,0000 |

The information provided in the presented table shows that relevant research is the main host of eigenvalues, at most 4, ($\frac{1}{Q} > \frac{1}{5} > 0{,}2$ ). In this case, the eigenvalues of the four first to describe only allow 65% of the total inertia and three first to describe approximately 55% of the total inertia. In contrast, as a result of modification of the

[†] Significant main inertia is determined by the formula: $\frac{1}{Q} > \frac{1}{5} > 0{,}2$

solution obtained in accordance with the criterion of Greenacre failed to improve the solution obtained and get the result according to which the degree of inertia describe a modified integer by the first three ownership increased to 84.77%. This means that the result of the adoption of the first three dimensions could be explained larger than before modification, the percentage of the total inertia. The results of this phase of the study are presented in table 5.

Table 5. The results of the correspondence analysis after the modification according to the criteria Greenacre'a.

| Number of dimension K | $\lambda_k$ | $\lambda_k/\lambda$ | $\tau_k$ |
|---|---|---|---|
| 1 | 0,3106 | 38,1190 | 38,1190 |
| 2 | 0,2074 | 25,4598 | 63,5788 |
| 3 | 0,1727 | 21,1955 | 84,7742 |
| 4 | 0,1241 | 15,2258 | 100,0000 |
| | $\lambda_k = 0{,}8147$ | | |

As proposed in the work of (Stanimir, 2005; Bąk, 2010) to show the links between the variables of considered variants Ward's method was used. The results of this phase of the study are presented in Figure 3, the horizontal line marked the phase of interrupting the combination of classes.

On the basis of multiple correspondence analysis in combination with the results obtained with using Ward method it can be indicated that there is a link between the categories of analysed variables of describing cities.

The results allowed to define the different classes according to the way of the realisation of projects related to the passenger and freight transport in order to protect environment. The classes are presented as follow:

Class I (**PO1**, P1, M1, DL2): comprises cities with a population less than 100,000 inhabitants, which have carried out a small number of projects to improve the movement of people and goods within the city, including a small number of projects with the impact on environmental protection. These groups of cities do not have separate departments in the organisational structure related to freight transport.

Class II (**PO2,** P2, M2, DL1, DL3, D1, D2): is made up of medium-sized cities with a population between 100,000 and 200,000, which have implemented the average number of projects in order to improve the movement of people and goods within the city, including the average number of projects with the impact on environmental protection. These cities have included in the organisational structures employees involved in the tasks related to the movement of goods and in which besides the basic data some additional information about the passenger and freight transport was also collected.

Class III (**PO3**, P3, M3, D3), covers the biggest surveyed cities with a population of over 200,000, implementing the largest number of projects related to the movement of people and goods, including projects dedicated to environmental protection. Moreover, these are cities in which the range of data collection concerning the movement of persons and goods within the city is the largest.

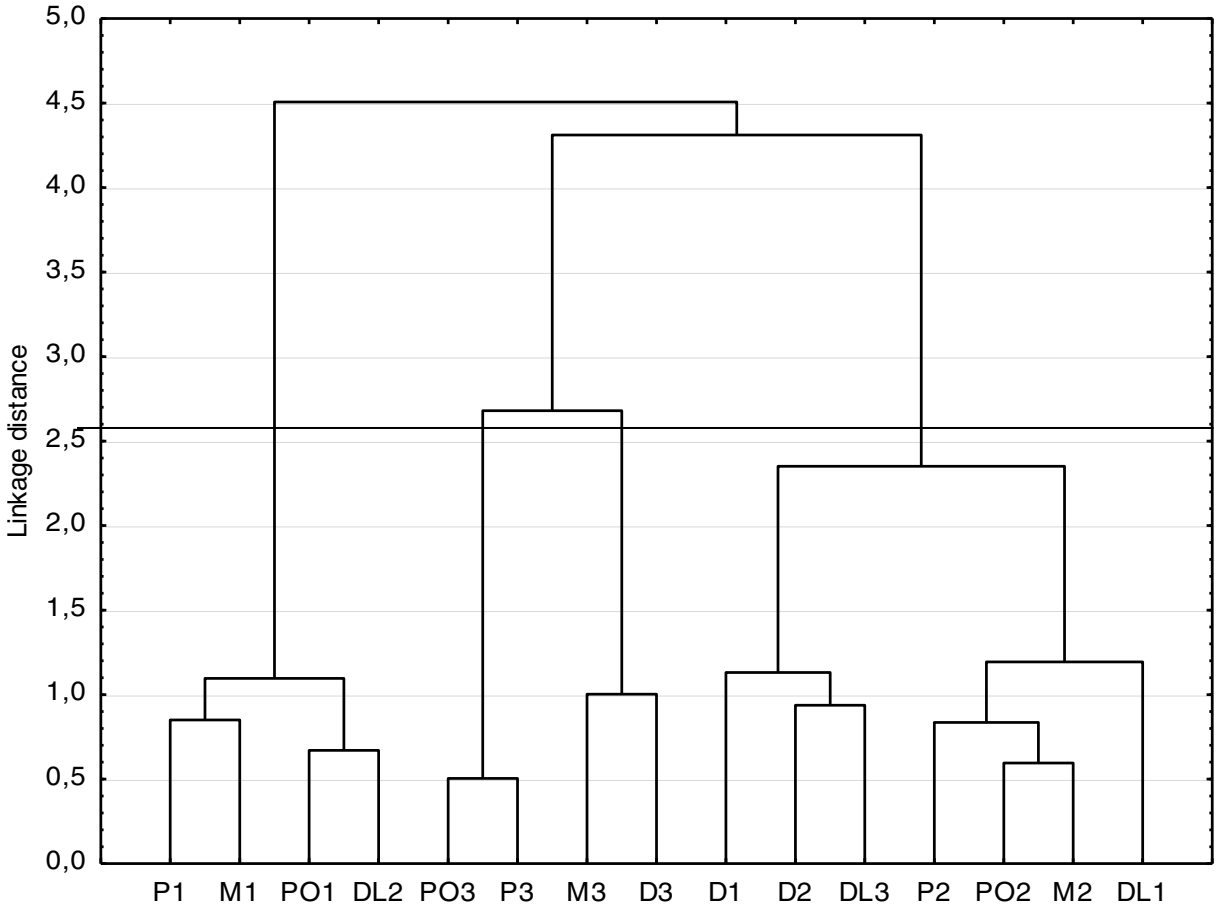


Figure 3. The results of correspondence analysis including the modification of eigenvalues in combination with the results of Ward's analysis. Source: own calculations.

Obtained classification of studied cities allows the factors determining the implementation of the projects related to the passenger and freight transport targeted at environmental protection to be identified. As may be expected, the projects dedicated to environmental protection are implemented primarily by large cities and, to a lesser extent, by the medium-sized cities. Small towns carry only a slight range of projects in this field. The interest of cities in the implementation of this kinds of solutions is directly related to the execution of all projects in the area of passenger and freight transport. The greater the number of projects in this area the greater the interest in the project dedicated to environmental protection. The number of these kinds of projects is also related to the organisation of work tasks related to the movement of people and goods in the organisational structure. The higher the organisation of work in this area (having extracted department/employees in terms of freight and passenger transport, a wider range of data collection), the greater is the interest in the implementation of projects dedicated to environmental protection.

## 5. Conclusion

The main aim of the paper was to introduce the urban projects related to passenger and freight transport undertaken by local government in terms of the reduction of environmental degradation. The increase in passenger and freight transport in the city causes not only congestion but also considerable environmental pollution. Therefore there is a need to take action to solve these problems in order to improve the quality of life of residents.
The survey carried out among 36 cities with county rights can be concluded as follows:

- a significant number of the implemented projects in the field of passenger and freight transport contributed to the reduction of environmental degradation primarily focused on solutions related to the access condition (33 projects out of 84)
- there are a large number of projects related to the improvement of public infrastructure in terms of bad condition of Polish roads (25 projects out of 84)
- there continues to be an insufficient number of projects related to land use management and traffic management, (11 and 13 projects, respectively)
- projects related to promotion and educational programmes on ecological transport represent a negligible share of all studied projects (only 2 out of 84).

The research confirms the guidelines of the European Commission, according to which, the first step in improving passenger and freight transport and reducing pollution in the city should be activities related to the better way of utilising the existing infrastructure (Green Paper, 2007). However, no Polish city has introduced a low emission zone, which could significantly help to decrease environmental pollution. Examples of such cities are London, Berlin and Stockholm, which successfully reduced PM, CO and NOx emissions.

Efficient use of existing infrastructure and organisation of educational and information campaigns for clean transport could largely contribute to the reduction of environmental pollution in the city (Green Paper, 2007, Bindzar, et al., 2010, Witkowski, et al., 2013). However, it is important to include in the implementation of these kinds of projects all stakeholders. Unfortunately, studies show that in the surveyed cities, most projects have been realised by the local authorities without the participation of other city logistics stakeholders. Even the so-called delivery of goods during the night-time were realised as a result of regulations imposed arbitrarily by the local government to private companies. A disturbing fact is that the prevailing majority of local respondents do not conduct accurate measurements of the impact of implemented projects related to passenger and freight transport on the reduction of environmental degradation. Therefore it is difficult to verify the hypothesis that Polish local government do not implement a sufficient number of projects related to passenger and freight transport in order to decrease environmental pollution in cities. However, studies have confirmed the hypothesis that there are no standards in the measurement of urban projects' efficiency according to their impact on environmental protection. This is a problem in most studied cities and results mainly from insufficient funds.

For further research the authors would like to analyse the development strategies of the cities in terms of sustainable aims related to passenger and freight transport.

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