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The Importance of Environmental Criteria for Kaunas City Pedestrian Zones

Abstract
Pedestrian streets are public areas, where vehicle traffic is completely or partially restricted. In these parts of the city people can take a walk, shop and ride bikes. Many scientific publications can be found on the social and economic significance of public areas; however, while seeking for the economic city growth and social advancement it is important not to waste natural resources and not to endanger ecological balance. It is noticed that environmental criteria are mentioned only as components of coherence and which have to interact with each other. Still, the pedestrian zones, as public areas intended for people, have to be safe (in the case of motor and non-motor vehicles) and protected from the vehicle emissions and noise. In addition, trees and green zones as well as the overall cleanliness are significant for the maintenance of ecological balance. Therefore, pedestrian zones not only have to meet economic and social needs but also should be a place that would be pleasant to come back to.
The object of this article is the main pedestrian zones of Kaunas city. The research was conducted by applying the analysis and synthesis research methods.

1. Introduction

Currently, urban population accounts for 54.5% of global population, however, it is believed that by 2050 urban population will constitute even 66% (World Cities Report 2016). In many developing countries and their cities such rapid urbanisation and urban development cause various environmental problems, such as water and soil pollution (Vardoulakis et al. 2016), waste disposal problems, climate change. Rapid urbanisation in cities also results in transport intensity, which increases the growth of environmental pollution and noise. As a result, work capacity, economic productivity, urban climate and human health deteriorate (Vardoulakis et al. 2015; Shathy and Reza 2016). This means that the quality of environment is closely linked to social and economic aspects.
It is noted that due to increasing traffic flows, noise and pollution, city centres became less attractive and people no longer want to spend time there. In order to improve the environment as well as social and economic aspects, the streets of city centres are turned into pedestrian zones (Soni and Soni 2016), which from ancient times to the end of the 19th century used to meet the needs of the city and its residents. It used to be the centre of public life of urban community where people came to communicate, do shopping, take a walk, relax, participate in celebrations, etc. (Jakovlevas - Mateckis 2012)

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However, as already mentioned above, the structure of the city has changed dramatically with the appearance of cars (Jou, 2011) as the streets became noisy and polluted with dust and gas (Blanco et al., 2009), thus making people feel insecure (Jakovlevas - Mateckis 2012). What is more, fossil fuel used by motor vehicles are the main source of greenhouse gases in urban areas (Costa 2014; Xia et al. 2015). However, a sustainable city must aim at mitigating the environmental impact and become the place designated for improving the quality of life of people (Dassen et al. 2013). In order to improve air quality and reduce greenhouse gas emissions in city centres, some European cities such as Hamburg (by 2034), Madrid (by 2020), and Oslo (by 2019) have decided to ban private transport in cities. Similar initiatives are being carried out in Helsinki, Paris, Copenhagen, Brussels, Dublin, Milan, Chengdu, and Bogotá by investing in public transport and bicycle infrastructure, and pedestrian streets (Nieuwenhuijsen and Khreis 2016). Thus, special attention is paid to more environmentally friendly and more people-oriented measures.

The object of the article is the main pedestrian zones of Kaunas city.

The aim of the article is to analyse the most important environmental criteria, such like air pollution and noise, of Kaunas city pedestrian zones.

The environment and its quality are very important factors influencing the attractiveness of the pedestrian zones. Therefore, it is important to recognize the benefit of pedestrian zones from environmental perspective, such like as air pollution and noise, as much as from social-economic perspective.

2. Materials and methods

Research object – one of the biggest (second by size) Lithuanian cities – Kaunas. Based on the data of 1 July 2017 provided by Statistics Lithuania, there were 290,068 thousand residents in Kaunas city. The main street of the New town is Laisvės avenue (Fig. 1), which together with Vilniaus street in the Old town is considered to be the longest pedestrian zone in Eastern Europe (Andriukeviciute et al. 2015).

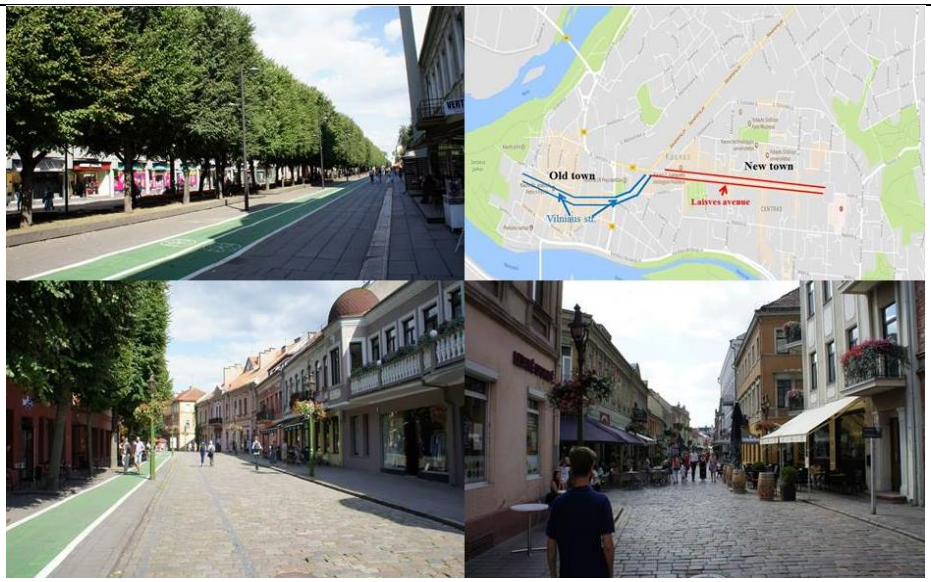

Figure 1: Kaunas city: Vilniaus street and Laisvės avenue

The research was carried out applying the analysis of secondary data and synthesis research methods.
The statistical data of air pollution and noise of Kaunas city pedestrian zones required for the research has been provided by the Environmental Protection Agency in Lithuania. In the course of the research, the analysis of the topic's relevance and related issues to the possible solutions were based on methods of analysis, synthesis and synthesis of literature sources.
The main statistical data related to the survey of air pollution and noise levels in Kaunas pedestrian zones were obtained from the Public Information Portal for Environmental Protection. These data are analyzed in detail, structured in comparison with the permissible limit values and summarized in tabular form.

Based on the results of the analysis of the results of the analysis of the environmental quality data of the pedestrian zones of Kaunas city, the conclusions and suggestions formulated.

3. Discussions and results

Environment is a very important factor that influences person's mental, physical and social wellbeing. Air pollution and noise of the city are the key factors that may worsen the life quality of the city and its residents as well as cause various diseases (Ballesteros et. al. 2014). The air pollution and noise of cities can be caused by motor vehicles. As the majority of vehicles are in the cities inhabited by the majority of population, it is plausible that the residents of cities are mostly affected by poor air quality and noise (Nieuwenhuijsen and Khreis 2016). Taking this into consideration, the majority of cities are currently seeking to reduce or stop using cars in cities and to develop pedestrian zones thus encouraging walking and reducing the greenhouse gas emission. However, it

is universally agreed that the benefits of pedestrian zones are not only environmental (Diciunaite-Rauktiene et. al. 2018) (Fig. 2).

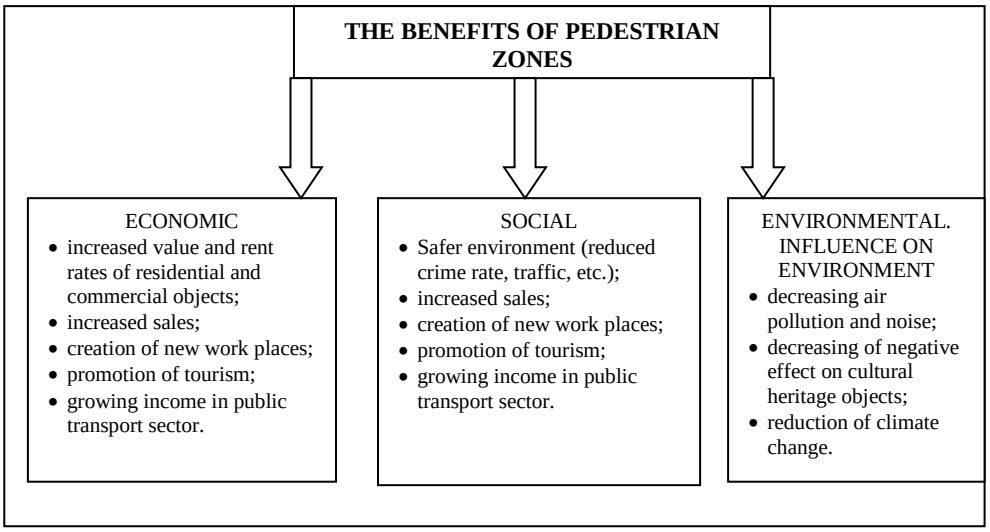

Figure 2: The benefits of pedestrian zones (Diciunaite-Rauktiene et. al. 2018)

Economic benefit. Pedestrian zones can increase the value and rent rate of residential and commercial objects. Furthermore, the majority of businessmen claimed that the conversion of areas into pedestrian zones doubled their sales. Excluding the increased sales, pedestrian zones increase the employment of residents as such zones allow creating new work places (Soni and Soni, 2016) and promote tourism (Saynajoki et. al. 2014). Limiting the use of private vehicles in a city and having a properly developed public transport infrastructure increases the number of people using public transport, while increasing the income received from public transport sector (Soni and Soni 2016).

Social benefit. The research has shown that pedestrian zones in a city influence the mental and physical health of its residents. Pedestrian zones promote walking, encourage social interaction, place attachment and greater safety. Furthermore, walking in pedestrian zones positively affects mood, thinking, relieves stress, symptoms of depression (Soni and Soni 2016), reduces the risk of high blood pressure, stroke, high cholesterol (Lee et al., 2010), overweight and obesity (Olabarria et al. 2014).

Pedestrian zones influence the reduction of noise level as well. Noise is considered the second factor (after air pollution) that causes the development of fatal diseases (Who 2014) and negatively affects life quality (European Environment Agency 2014). Is it speculated that in Europe, from 400 to 1500 million of residents suffer from diseases caused by noise (Hanninen et al. 2014). The studies have shown that the noise caused by cars causes cardiovascular diseases, sleep disorders (Basner et al. 2014), hearing impairment, headache and depression (Ko et al. 2011). On the other hand, the more time we spend sitting, driving a car, the higher is the risk of cardiovascular diseases, diabetes, various forms of cancer (McCormack and Virk 2014; Sugiyama et al. 2016), overweight

(Mueller et al. 2015). Based on the data acquired during the conducted research, it was observed that replacing riding a car with walking or riding a bicycle results in a positive effect on health (Humphreys et al. 2013; Kelly et al. 2014). In the majority of cases the pedestrian zones are characterised by a greater variety of green areas, which also positively affect the health of city residents (de Vries et al. 2013; Hartig et al. 2014), improve physical activity (Evenson et al. 2013), contribute to the social wellbeing of the residents (Mansor et al. 2012) and motivate their social interaction (Krellenberg et al. 2014).

Environmental benefit. Influence on environment. It is universally agreed that good quality pedestrian zones should firstly be safe in terms of motor vehicles (Sisman 2013; Asada-Shekari et al. 2015), including not only pedestrian safety, but also their protection against the pollution emitted by vehicles. Air pollution caused by vehicles is considered to be one of the most serious problems in cities (Guerreiro et al. 2014), as it causes hazard to the health of the residents (Costa 2014; Bhalla et al. 2014; Hansen et al. 2014) by increasing the incidence of respiratory, cardiac, nervous system and vascular diseases (Cesaroni et al. 2014), influencing lung oncologic diseases (Raaschou-Nielsen et al. 2013), exacerbations of asthma (Gasana et al. 2012), emergence of diabetes (Eze et al. 2015) and mortality (Héroux et al. 2015; Lelieveld 2015; Mueller et al. 2015). Specifically, air pollution caused by motor vehicles conditions early death and shortens the life of the residents of Europe by 9 months. It is believed that approximately 184 000 of people in the world die of air pollution (Bhalla et al. 2014). Therefore, it can be stated that air pollution undoubtedly has a negative effect on life quality. However, studies show that in city centres air pollution negatively affects not only the health and life quality of residents, but also historic buildings, monuments, cultural heritage (Ortiz et al. 2017). Based on the data of conducted research, the walls of buildings (especially those situated near the roadways) are directly affected by vehicle pollution, have a greater concentration of sulphate, nitrate and organic carbon (Ozga et al. 2013) which cause the black crust (Ruffolo et al. 2015).

Stopping the use of vehicles and using public transport, walking or riding a bike more frequently will reduce the emission of carbon dioxide (CO_2) and other greenhouse gasses, such as carbon dioxide, carbon monoxide as well as climate change (Saynajoki et al. 2014). The data of the conducted research shows that stopping/limiting the use of cars (at least one day a week, i.e. on Sunday) in some parts of the city, the amount of nitrogen dioxide dropped by 40 per cent (Willsheras 2015), the amount of black carbon – by 75-78 per cent (Invernizzi et al. 2011). Furthermore, in 2009, when a part of Broadway and Times Square in New York was closed for cars (for a trial period of 6 months the Square was accessible to pedestrians only) it was estimated that the concentration of NO and NO_2 pollutants was significantly lower, with NO pollution level decreasing by 63 per cent, and NO_2 level – by 41 per cent (NYC DOHMH 2012). Stopping the use of cars for at least a day (for instance Sunday), the noise level decreases by 10 dB (Brussels Environment 2015), which, as it has already been mentioned, negatively impacts the physical and mental health of a person. Although there are studies that argue that the speed limitation may reduce noise as well (as it is seen in the case of Austria, Graz city, where the reduction of speed (from 60 km/h to 30 km/h) in residential areas resulted in 2.5 dB lower vehicle noise (European Environmental Bureau Towards quieter cities 2011)), it is known that the reduction of speed increases air pollution.

Noise can be reduced with the help of green zones/areas. Green zones not only reduce noise, but also contribute to the elimination/reduction of air pollution (Escobedo et al. 2011), reduces high air temperature (Khreis et al. 2016) by casting a shadow and cooling the area, thus reducing the risk of heat-related diseases of the residents of cities (Wolch et al. 2014).

Thus, as it can be seen, pedestrian zones provide wide-ranging benefits including economic, social and environmental benefits. The article discusses environmental benefits and the importance of pedestrian zones in greater detail, since, as it has been mentioned, although pedestrian zones used to be developed for communication, shopping and socialisation, due to rapid urbanisation and increased traffic flows, pedestrian zones are now being developed primarily to improve the quality of environment and life of city residents.

The General plan of Kaunas city (2013–2023) indicates that road transport pollution accounts for 80% of overall pollution. The greatest level of pollution is observed in the city centre. What is more, based on the data of monitoring programme, pollution is increasing every year.

The greatest issue concerning air quality in European cities is the concentration of fine particulate matter (PM_{10}), which is above the level of the standards and the main source of which is motorised transport (European Parliament 2011). In the central part of Kaunas (as well as in pedestrian zones, i.e. Laisves ave. and Vilniaus street), the concentration of particulate matter (PM_{10}) is close to the limit value (50 μg/m3 (European Environment Agency 2016) (Table 1), however, it is presumed that at certain hours (peak hours) or when festivals are taking place in pedestrian zones, they may exceed the allowable rate. Consequently, although pedestrian zones in Kaunas are partially free of motor vehicles, pedestrian zones can still be affected by car emissions.

Table 1: The main indicators of air pollution and noise in Kaunas city pedestrian zones (Environmental Protection Agency 2016, Environment Agency, Noise and pollution map of Kaunas city 2017)

Indicator	**Indicator value**	**Limit value**
Maximum 24-hour particulate matter (PM_{10}) concentration ($\mu g/m^3$)	46–50	50
Maximum 24-hour sulphur dioxide (SO_2) concentration ($\mu g/m^3$)	26–27	125
Maximum 8-hour moving average carbon dioxide (CO) concentration (mg/m^3)	3.1–3.3	10
Annual mean benzo(a)pyrene (BaP) concentration (ng/m^3)	1.1–1.8	1
Maximum 1-hour nitrogen dioxide (NO_2) concentration ($\mu g/m^3$)	110–120	200

Noise	50–65	Up to 55 dBA during day Up to 50 dBA at night

The worst situation in the pedestrian zones of Kaunas city are observed in case of concentration of benzo(a)pyrene (BaP), as it exceeds the limit value (Table 1).

Noise is considered to be excessive when its level exceeds 55 dBA during day and 50 dBA at night (European Environment Agency 2014). Although pedestrian zones in Kaunas are partially free from the traffic, Kaunas City Strategic Noise Map indicates that the noise level in both Laisves avenue and the Old Town is 65 dBA, which exceeds the permissible limits.

Thus, having analysed air pollution and noise indicators of Kaunas city pedestrian zones, it can be stated that despite the fact that not all indicators reach limit levels, air quality in the central part of the city nevertheless poses a certain concern, in particular due to the excessive noise level and limit concentration of particulate matter in ambient air. Therefore, it is presumed that Kaunas city pedestrian zones are not adequately protected from pollution and noise, and as a result the main pedestrian streets of Kaunas city do not perform their main function, they are not used sustainably.

Kaunas City Municipality should take into account the diseases/illnesses and mortality rate caused by air pollution and noise, and seek to protect the public health by reducing the cars flow around pedestrian zones, while at the same time reducing greenhouse gas emission. In addition, Kaunas city municipality should pay a particular attention to improve the infrastructure for public transport cycling and green spaces.

Conclusions

The quality of health and life of city residents depends on the quality of ambient environment. Particular emphasis is paid to the importance and benefits of pedestrian zones, as increased air pollution and noise, the lack of green zones and insufficient physical activity in European cities cause the morbidity and mortality associated with these phenomena. Meanwhile, pedestrian streets not only improve people's physical and mental health, but also reduce noise levels, air pollution and greenhouse gas emissions.

Having carried out the analysis of the indicators of Kaunas city air quality and noise, it was observed that noise levels in Kaunas city pedestrian zones exceed limit levels and that there is an increase in the concentration of benzo(a)pyrene, while the amount of particulate matter reaches the limit value. Taking these results as well as the results of the reviewed research into consideration, Kaunas city municipality must pay particular attention to the limitation of traffic flows in the city, the development and improvement of public transport and bicycle infrastructure, and green spaces.

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