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DIMENSIONALITY OF AN URBAN TRANSPORT SYSTEM BASED ON ISO 37120 INDICATORS FOR THE CASE OF SELECTED EUROPEAN CITIES

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ABSTRACT
The study aims to assess transport systems in terms of ISO 37120 indicators in selected European cities. Using the principal components analysis, the research identified significantly correlated variables associated with urban transport. Three principal components explained almost 87% of input data variability. The first principal component was mainly related to transportation fatalities, the second component — to the length of bicycle paths, and the third component — to the length of the network used by light passenger public transport. A strong correlation was found between the length of high capacity public transport and transportation fatalities. Furthermore, the analysis proved that the Aalter transport system was an outlier. The paper concludes by identifying several recommendations on the improvement of urban transport management and the development of low-carbon mobility systems.

KEY WORDS
urban transport, ISO 37120, urban management, spatial management, principal components analysis

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INTRODUCTION

Urban development is dominated by and dependent on transport (Tomanek, 2018). According to the United Nations (United Nations, 2016), 56% of the world's population resides in cities, whereas forecasts indicate an increase to 69% in 2050. Approximately 85% of the EU's GDP is generated in cities. Additionally, the European Union claims that passenger transport will increase by about 34% in 2030 and more than 50% in 2050 in comparison to 2005. According to the White Paper (European Commission, 2016), cities should reduce greenhouse gas emissions by 60%. Ribeiro et al. note that road transport is responsible for approx. 75% of CO2 emissions worldwide (Ribeiro, 2007). Within the economic, social and ecological dimensions, urban development and transport should be consistent with the principle of sustainability.

The paper aims to discover the relationships between key indicators of urban transport, primarily from the point of view of the principles of the ISO 37120 norm. The discussion within the study focuses on some key questions: What does sustainable transport really mean? Why is a new approach to urban transport needed? What do the indicators of transport for smart cities demonstrate? The research problem focuses on determining the possibility of using the ISO 37120 norm to evaluate urban transport. The article shows dependencies between the theoretical and practical considerations of urban transport. Firstly, the paper organises the terminology used in the field of sustainable urban transport. Secondly, the article is concerned with measuring the performance of urban transport in terms of sustainability. The empirical part focuses on the assessment of transport indicators for selected European cities using the principal components analysis. In addition, outstanding transport systems are identified. The article is based on literature studies and the methods of statistical analysis.

1. Literature review

The scientific literature contains many papers on the topic of urban transport. Crainic et al. elucidated that city logistics aimed to reduce the nuisances associated with freight transportation in urban areas while supporting their economic and social development (Crainic et al., 2007). Fistola supposed that urban mobility meant distribution, quality and use of urban activities with ICT as well as needed different users (Fistola, 2017). Moreover, Tirachini et al. analysed a multimodal social welfare maximisation model with spatially disaggregated demand (Tirachini et al., 2014). In one of such works, Neuenfeldt prepared a bibliometric analysis of publications within the context of urban transport. Many et al. pointed out issues of sustainable development in urban areas (Neuenfeldt, 2016). Batagan et al. identified urban development models for sustainability (Batagan et al., 2012). Ahmad and Mehmood argued that enterprise system would have a pivotal role in future smart city settings and would be able to offer social, environmental and economic sustainability (Ahmad & Mehmood, 2015). Ahvenniemi et al. claimed that a general goal of smart cities was to improve sustainability with the help of technologies (Ahvenniemi et al., 2017). The multidimensional and variable character of the sustainability concept makes it difficult to define sustainable transport. Banister guessed that the improvement of urban sustainability in terms of transport was dependent upon the high-quality implementation of innovative systems and the need to gain public confidence and acceptability through active involvement and action (Banister, 2008). Goldman and Gorham identified four emerging areas of innovation: new mobility, city logistics, intelligent system management and livability (Goldman and Gorham, 2006). According to Richardson, physical, psychological and social needs are primary influencers of sustainable transportation indicators for passenger transport (Richardson, 2005). Tab. 1 shows some of the main differentiating features between traditional and sustainable transport.

Contemporary challenges faced by urban centres change the way cities are managed. Dablanc suggested that the provision of appropriate urban logistics services was slow despite growing needs (Dablanc, 2007). Mingardo elucidated how cities should maintain economic growth, stay accessible and, at the same time, improve the quality of life (Mingardo, 2008). The New Public Management model promotes the corporate style of management in the public sector and the use of benchmark, crowdsourcing, reengineering, controlling, outsourcing, and e-governance. Public transport is one of the significant challenges of urban management. According to the European Commission and the United Nations, all activities must be conducted in line with the principles of sustainable development (European Commission, 2007; United Nations, 2016, Winkowska et al., 2019). Noworól showed another way of looking at urban management in terms of transport, which contained management solutions directed at the inside and the outside (Noworól, 2011). On the one hand, it involves identifying a person responsible for the coordination of the flows of people and goods within the organisational structure of the city hall and. It is their task to formulate long-term strategies in this area (Darie et al., 2019). On the other hand, it is the municipal government in cooperation with residents, forwarders, recipients, transport companies and public transport operators who should improve the urban flows of people and goods. Nevertheless, the municipal government should become the initiator of all activities coordinating the urban transport system. Additionally, basic components of the integrated traffic management system include traffic monitoring, the control of traffic lights and

Tab. 1. Main differences between traditional and sustainable transport

Features	Traditional transport	Sustainable transport
Main aim	traffic	people
Primary objectives	traffic flow and speed	accessibility, economic viability, social equity, health and environmental quality
General approach	infrastructure focus	an integrated set of actions to achieve cost-effective solutions
Planning period	short- and medium-term	long-term vision
Scope of activity	administrative area	functional area
Approach to participation	only by an expert	involving of all stakeholders
Evaluation	limited impact assessment	regular monitoring

Source: elaborated by the authors based on (European Commission, 2014).

variable message signs, and the management of the urban public transport. Munuzuri et al. showed the solutions that could be implemented by local administrations to improve freight deliveries in urban environments related to public infrastructure, land use management, access conditions, and traffic management (Munuzuri et al., 2005).

The European Union requires cities to develop sustainable mobility strategies, including both passenger and freight transport. Another important strategic document is the local spatial development plan referring to the location of road and transport infrastructure (European Union, 2007; European Union 2013). Many Polish cities have no such plans. The average planning coverage is 49.6% for cities (30.2% for Poland) and 15.6% for areas that only own a draft version of such a plan (Hajduk, 2016). Additionally, planning coverage is highly uneven, i.e., the planning coverage of Lodz is only 16.1%, but Gdansk has 65.4%.

Contemporary cities need to improve the use of available technical and organisational solutions to improve the current urban transport situation (Hajduk, 2017). There is a demand for innovations regarding the functional and spatial structure of the city (reducing the transport-imposed limitations on life and economy). Modern solutions should replace conventional means of transport. It is necessary to use environmentally friendly means of transport, such as trams, trains or electric vehicles as well as to exploit waterways and alternative fuels. The sharing economy solutions, such as car-sharing, car-pooling and bike-sharing, has become very popular in cities. Thus, Basaric et al. examined findings of user satisfaction surveys, impacts of bike-sharing on modal split and the emissions of pollutants (Basaric et al., 2012). Glotz-Richter created arguments for car-sharing. Local governments should develop park&ride and bike&ride as well as encourage people to cycle and walk (Glotz-Richter, 2012). De Stasio noted that urban mobility plans were important documents of urban transport policy (de Stasio, 2016). On the other hand, cities should use solutions which reduce the attractiveness of cars by limiting allowable parking time, raising parking fees, introducing fees for driving into city centres and create eco-zones.

The measurement of urban transport is rather a great challenge because of a diversified approach to this issue. Medda et al. studied the relationship between transport and business development in the city using the Solow-Vickrey model (Medda et al., 2003). Scientists distinguish two approaches: quantitative and qualitative. Fielbaum et al. proposed a parametric description of cities for the normative analysis of transit systems (Fielbaum et al., 2017). The quantitative approach to measurement is generally easier to measure directly while quantitative data is recognised as more objective, e.g. the length of linear infrastructure, the number of kilometres travelled per vehicle or person, the number of traffic accidents or fatalities, transport expenses or revenues. On the other hand, the qualitative measurement approach to specific transport phenomena is more difficult to estimate with qualitative data relating to different types of information, e.g. user preferences, aesthetic feelings, as well as user perceived convenience and comfort. The next method of dividing transport indicators reflects its economic, social and environmental impacts. Its economic dimension shows the profitability of transport while the social dimension indicates the mobility of a transport user. The environmental dimension reflects various transport emissions. It is, therefore, advisable to use this approach to measure sustainable transport. Nieuwenhuijsen suggested that the improvement in environmental quality needs multi-sectoral approaches to tackle the environmental problems in relations to urban planning, mobility and transport (Nieuwenhuijsen, 2016).

Using the cluster analysis, Huang et al. showed that urban agglomerations of the developing world were more compact and denser than those of the developed countries of Europe or North America (Huang et al., 2007). While Kasanko et al. used the comparative analysis to divide European cities into three groups: compact southern cities, northern and eastern cities with looser structures and lower densities, and central and western cities midway between the extremes (Kasanko et al., 2006). Nicolas et al. assessed the sustainable transport system in the city of Lyon while Schwarz used the principal component analysis (Nicolas et al., 2003; Schwarz, 2010). Since 2014, cities can use the ISO 37120 norm to estimate their performance, which ensures that they are managed sustainably (Fox, 2015; Deng et al., 2017). It measures the efficiency of cities in terms of environmental aspects, including carbon emission, waste production, pollution and water consumption as well as social and economic aspects, such as economic activity, health and education (Dall'O', 2017; Fox, 2018).

Moreno and Garcia-Alvarez compared European countries based on the Resource-Efficiency Capacity Index, in which transport is one of the dimensions. Denmark, Sweden and Finland received the highest ranking (Moreno and Garcia-Alvarez, 2018). Moreover, Persia et al. carried out a comprehensive study to define a methodology able to indicate effective strategies and measures, allowing to increase the sustainability level of different kinds of cities (Persia et al., 2016). Castillo and Pitfield presented the Evaluative and Logical Approach to the Sustainable Transport Indicator Compilation method for monitoring and reporting progress related to sustainable transport (Castillo and Pitfield, 2010). Later and Dziekan evaluated measures in the field of sustainable urban transport by analysing successful mechanisms (Dziekan, 2012). Alonso et al. proposed a sustainability analysis of urban passenger transport systems based on composite indicators using the benchmarking approach (Alonso et al., 2015). According to Dons et al., the Physical Activity through Sustainable Transport Approaches promotes active mobility (Dons et al., 2015). Multidimensional comparative research aims at identifying certain accurateness in statistical collectivity, where units are described using a relatively abundant set of indicators. Multidimensional comparative research is also widely applied in the economy and environmental protection since it enables the assessment of the level of development of analysed objects and serves as a basis for making right decisions concerning, e.g., the assessment of the implementation of sustainable development for chosen protected areas.

Akande et al. obtained similar results by analysing the EU cities using the Principal Component Analysis and (Akande et al., 2019). Moreover, Ling et al. applied the Principal Component Analysis to study the relationship between the transport infrastructure system and the urban macroeconomic (Ling et al., 2018). Additionally, Shen et al. assessed smart city performance in the context of China by applying the entropy method and the Technique for Order Preference by Similarity to Ideal Solution (Shen and Lou, 2018). This study highlighted that in general, Chinese cities were at a relatively low level of smart performance. Lynch (2015) suggested that the ISO 37120:2014 standard helped to compare cities in terms of urban transport and service performance as well as the quality of life. Many scientists analysed transport from a national and regional perspective (Łatuszyńska and Strulak-Wójtowicz, 2013). Moreover, scientists used the latest future-oriented methods to evaluate transport (Ejdys et al., 2015). While Rotoli et al. attempted to integrate fundamental operational parameters in accessibility through rail including a composite approach combining the Data Envelopment Analysis and the Analytic Hierarchy Process (Rotoli et al., 2015). Furthermore, Gonzalez-Garcia et al. evaluated Spanish cities based on the ratio of people at risk of poverty and social exclusion, the unemployment rate, criminogenic ratio, educational places, the level of education, the net disposable income as well as an environmental endpoint (Gonzalez-Garcia et al., 2018). Additionally Zinkeviciute et al. examine problem concerning to implement a concept green logistics with reference to IT applications (Zinkeviciute et al., 2013). Furthermore, Emilia et al. present some of the measure adapted to reduce the greenhouse emissions produced by the transport (Emilia et al., 2012).

The most popular measurement for smart cities is the International Organisation for Standardization 37120: Sustainable Development of Communities (ISO). Lynch suggested that the ISO 37120:2014 standard helped to compare cities in terms of urban service performance and the quality of life (Lynch, 2015). The Open Data Portal of the World Council on City Data (WCCD), which is based on the ISO 37120 international standard on city data, allows the examination and monitoring of 56 member cities (Steele, 2014; Fox, 2015; McCarney, 2015). Most cities are from Europe (31%) and North America (30%).

According to Marsal–Llacuna, the ISO 37120 norm uses 46 basic and 54 additional indicators, including 17 thematic groups, such as economy, education, energy, environment, finance, fire and emergency response, governance, health, recreation, safety, shelter, solid waste, telecommunication and innovation, transport, urban planning, wastewater, water and sanitation (Marsal-Llacuna, 2015). Most indicators (ten in total) are focused on solid waste. The wastewater has only five core indicators.

2. Materials and methods

The principal component analysis is a method used to transform initial, observable variables into principal components which can be defined in the same way as the initial variables. Moreover, the principal component analysis allows the reduction of the number of variables without a significant loss of information contained within them and to detect hidden relationships between variables. Principal components are characterised by a linear combination of initial variables, orthogonal with respect to each other, and a decreasing number of the total variance of variables explained by subsequent components as well as the sum of component variances equal to the sum of initial variable variances.

The selection of indicators in transport is an enormous challenge because this issue is approached in many different ways used in the scientific literature, international strategic documents and reports of various organisations. The selection of variables and cities was made based on the ISO 37120 norm (Attachment 2). These were all European cities and core indicators. In the end, the following indicators (diagnostic features) were selected for the analysis: the length of high capacity public transport system per 100 thousands population, the length of light passenger public transport system per 100 thousands population, the annual number of public transport trips per capita, the number of personal automobiles per capita, the length of bicycle paths and lanes per 100 thousand inhabitants, the number of transportation fatalities per 100 thousands inhabitants. The data were analysed using STATISTICA version 13.1. Appendix 1 presents a list of analysed European cities with general characteristics.

The test procedure consisted of several successive stages: (I) the selection of transport indicators and European cities from the WCCD base; (II) the computation of basic statistics; (III) the standardisation of variables (indicators); (IV) the estimation of the number of principal components based on the Kaiser criterion; (V) the determination of eigenvalues of the correlation matrix; (VI) the calculation of eigenvectors of the correlation matrix; (VII) the identification of the value of principal component coefficients; (VIII) the selection of the configuration of variables in the space of the two principal components; (IX) drawing the configuration of objects in the space of the two principal components; (X) finding the recommendations.

3. Results

The research began with computing the basic statistics for transport indicators by measuring the position ($\overline{x}$ — the arithmetic mean) and variability (S_X — the standard deviation; V — the variation coefficient). The most diverse indicator is the number of transportation fatalities, while the least — the number of personal automobiles. Tab. 2 presents information on the general statistics of each indicator. Afterwards, indictors were standardised using the following formula: $\frac{x-\overline{x}}{S_X}$

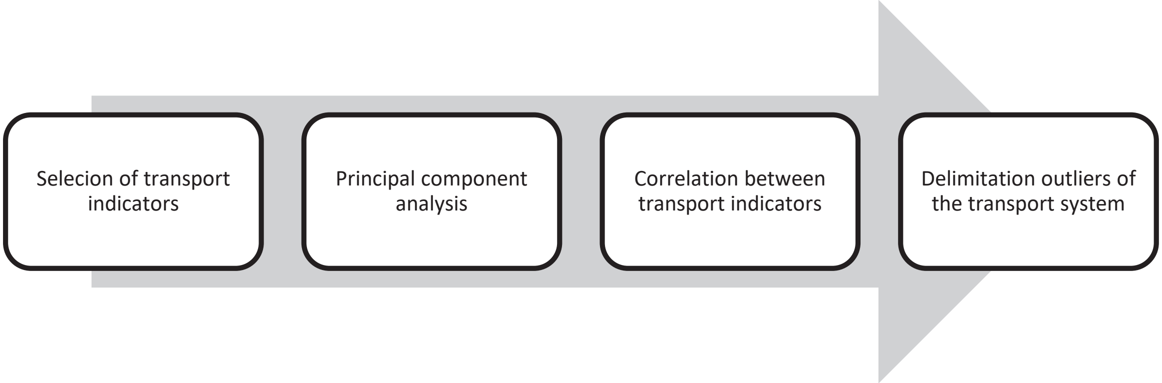


Fig. 1. Research design

Tab. 2. Basic statistics of urban transport indicators

	Units	$\overline{x}$	S_X	V	Min		Max	
HC_PT	kilometres/100,000	18.8981	29.3196	155.1454	0.00	Koprivnica	121.08	Aalter
LC_PT	kilometres/100,000	144.6369	190.6609	131.8204	1.5	Zwolle	670.9	Kielce
PT_T	units/ capita	218.3400	182.5537	83.6098	0.01	Koprivnica	636.5	Porto
PA	units/ capita	0.4481	0.1211	27.0277	0.28	Amsterdam	0.68	Sintra
BP	kilometres/100,000	72.9881	81.7551	112.0115	0.00	Aalter	226.74	Koprivnica
TF	units/ 100,000	3.5494	6.9976	197.1513	0.00	Koprivnica	29.61	Aalter

Legend: HC_PT — the length of high capacity public transport system per 100 000 inhabitants; LC_PT — the length of light passenger public transport system per 100 000 inhabitants; PT_T — the annual number of public transport trips per capita; PA — the number of personal automobiles per capita; BP — the length of bicycle paths and lanes per 100 000 inhabitants; TF — the number of transportation fatalities per 100 000 inhabitants.

Source: elaborated by the authors based on WCCD ISO37120.

The next stage involved determining the eigenvalues of the correlation matrix (Tab. 3). It reflected the significance of the principal components in explaining the information of the input variables. The number of principal components was determined using the method of eigenvalues greater than 1. A higher correlation coefficient of a variable with a component means a higher significance of the variable for a given component.

The subsequent step was the interpretation of the obtained principal components based on the value of their coefficients, which were also the linear correlation coefficients between the input variables and principal components (Tab. 4).

The next stage involved the preparation of shared volatility resources (Tab. 5). The degree of transfer of information resources contained in the input variables by the principal components was assessed using the sum of squares of a principal component for a given variable.

Next, the dependence between input variables and the obtained principal components was presented graphically (Fig. 2). Each variable was represented by a vector. The direction and length of the vectors determine the degree of the impact made by an individual variable on the principal components. The location of an input variable near the circle meant that most of the information contained in this variable

Tab. 3. Eigenvalues of the correlation matrix

Value number	Eigenvalues	Variance [%]	Cumulative eigenvalues	Cumulative Variance [%]
1	2.208224	36.80374	2.208224	36.8037
2	1.628348	27.13913	3.836572	63.9429
3	1.374224	22.90373	5.210796	86.8466
4	0.486512	8.10853	5.697308	94.9551
5	0.242702	4.04503	5.940010	99.0002
6	0.059990	0.99983	6.000000	100.0000

Tab. 4. Values of principal components coefficients

	Principal component 1	Principal component 2	Principal component 3
HC_PT	0.893311	-0.078337	-0.401026
LC_PT	0.204660	-0.417999	0.757983
PT_T	-0.441280	-0.782018	-0.239636
PA	0.465899	0.245224	0.702906
BP	-0.290545	0.879273	-0.100911
TF	0.933878	-0.051766	-0.277807

Tab. 5. Values of shared volatility resources

	Principal component 1	**Principal component 2**	**Principal component 3**
HC_PT	0.798004	0.804141	0.964963
LC_PT	0.041886	0.216609	0.791148
PT_T	0.194728	0.806280	0.863706
PA	0.217062	0.277197	0.771274
BP	0.084416	0.857537	0.867720
TF	0.872128	0.874808	0.951985

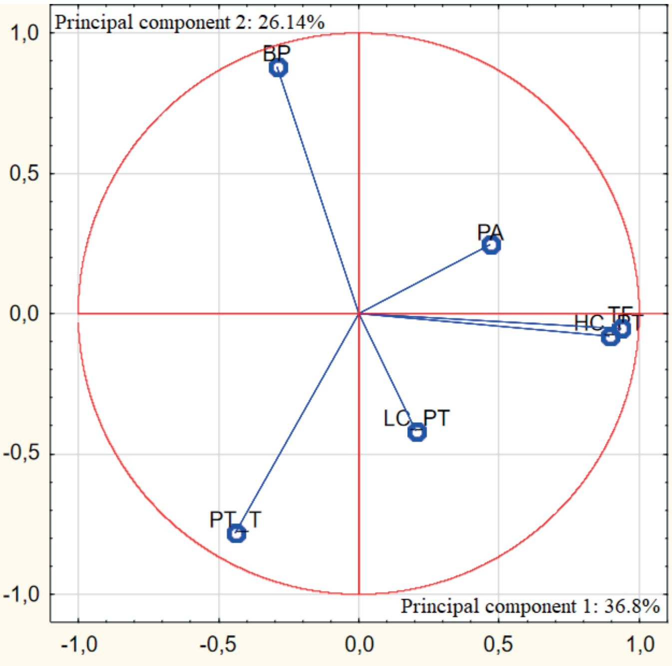


Fig. 2. Configuration of variables in the space of two principal components

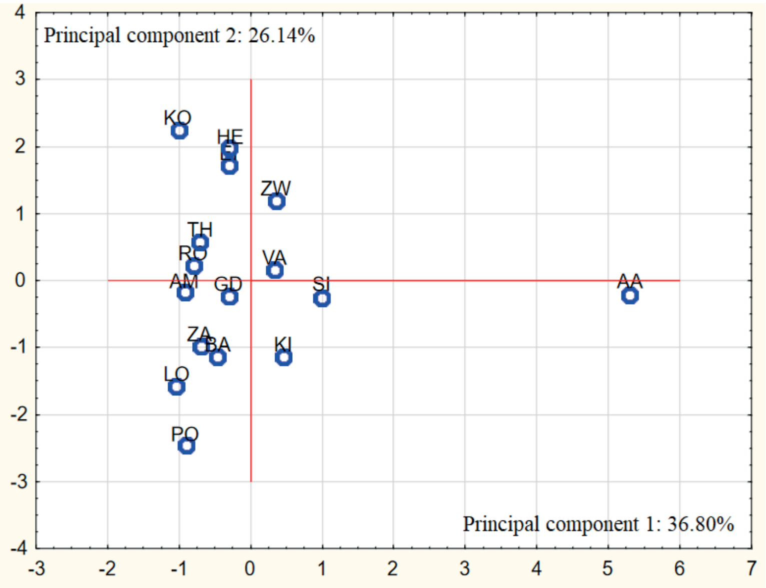
was carried by the principal components. Proximity to two variables informs of a strong correlation. Perpendicular vectors indicate a lack of correlation. Variables positioned on opposite sides are negatively correlated.

The last step of the study involved the identification of outliers based on the configuration of objects in the space of principal components. Fig. 3 presents the graphical location of cities in the space pf two principal components.

4. Discussion

The analysis correlation of dependencies in the group of six highlighted indicators describing the transport system for a selected group of European cities revealed a three-factor structure of this set of indicators, which allowed the reduction of the space of their analysis to three dimensions. The basis for this assessment was the eigenvalues of the correlation matrix of the considered indicators and the degree of variability reproduction using the first three principal components. The variances of the three principal components significantly exceeded the value of 1, indicating a large variation. The three principal components reproduced 86.85% of the total volatility of all analysed transport system indicators. These results can be considered to be satisfactory. The first principal component transferred 36.8% of information about the emissions contained in input variables. The second principal component explains 27.14% of the variability of input data and the last — 22.9%.

Most information resources on the three principal components convert the length of a high capacity public transport system (HC_PT), but only some —



Legend: AA — Aalter, AM — Amsterdam, BA — Barcelona, EI — Eindhoven, GD — Gdynia, HE — Heerlen, KI — Kielce, KO — Koprivnica, LO — London, PO — Porto, RO — Rotterdam, SI — Sintra, TH — The Hague, VA — Valencia, ZA — Zagreb, ZW — Zwolle.

Fig. 3. Configuration of objects in the space of two principal components

the number of personal automobiles per capita (PA). It is respectively 96.5% and 77.13%.

The values of weights indicate that the first principal component is the most positively related to two features, i.e., the length of a high capacity public transport system (HC_PT) and transportation fatalities (TF). On the other hand, the second principal component consists of a positively correlated variable length of bicycle paths and lanes (BP) as well as one that is negatively correlated annual number of public transport trips per capita (PT_T) while the third principal component is most positively related to two features, i.e., the length of light passenger public transport system (LC_PT) and the number of personal automobiles per capita (PA).

The analysis proved that the Aalter transport system was the outlier because there were no bicycle paths and lanes (BP), nor the length of high capacity public transport system (HC_PT) was the highest. Additionally, Koprivnica and Porto transport systems were different.

CONCLUSIONS

This paper proposed an assessment for characterising the urban transport of selected European smart cities, which could be used to study this domain from many approached and at different levels. The main contribution of this study is the identification of dependencies between characteristics of urban transport on the basis ISO 37120 norm indicators.

The investigation shows large disparities in the urban transport of selected European cities. The impact of specific analysed factors of sustainable transport in selected European cities can be described by means of three principal components. The first principal component transforms about 37% of the information contained in the input variables. It is responsible for the length of a high capacity public transport system (HC_PT) and transportation fatalities (TF). The second principal component is positively correlated with the length of bicycle paths (BP) and negatively — the number of public transport trips (PT_T). The above correlation testifies the connection of high values of HC_PT with low TF values and, accordingly, the increase of a given variable causes the decrease of the other. Thus, it can be concluded that the principal component analysis is useful in the context of the reduction of variable dimensionality in the description of the problem. The authors would like to note that almost half of the cities come from the Netherlands, which has an impact on the final result of the conducted research.

City leaders should pay more attention to safety when planning public transport in urban areas. All transport users should be provided with access to transport infrastructure and diversified transport modes, with emphasis on low carbon emissions. Integrated planning for transport systems and land use should advance sustainable transport. Developed sustainable urban mobility plans should ensure seamless and door-to-door mobility. They should promote the dialogue on sustainability underpinning the movement of people and goods.

The analysis of the European transport system shows that environmental issues are considered in planning urban mobility. Overall, sustainable transport is still unsystematic in terms of urban activities. The results may provide a valuable tool for decision-makers to identify areas more or less accessible to other zones.

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Attachment 1. Profit of selected European cities

CITY	COUNTRY	TOTAL CITY POPULATION	CITY LAND AREA	POPULATION DENSITY	CITY GROSS OPERATING BUDGET	CITY'S UNEMPLOYMENT RATE
	Units	persons	km^2	persons /km^2	million USD	%
AM	Netherlands	834 713	164.66	5 065.0	11 372.8	7.6
EI	Netherlands	224 788	88.84	2 530.3	85 334.8	8.3
HE	Netherlands	87 406	45.53	1 944.0	439.8	8.6
RO	Netherlands	618 357	208.88	2 959.0	4 467.5	12.6
TH	Netherlands	519 988	98.13	5 299.0	-	8.8
ZW	Netherlands	124 896	119.3	1 046.0	543.8	7.0
LO	United Kingdom	8 538 700	1 572.00	5 341.7	18 571.3	7.2
KO	Croatia	30 872	90.94	339.0	15.6	10.4
ZA	Croatia	790 017	641.32	1 232.5	1 112.3	9.6
AA	Belgium	20 218	81.92	247.0	-	3.3
GD	Poland	247 478	135.00	1 831.0	-	4.9
KI	Poland	197 704	110.00	1 797.3	242.1	7.7
BA	Spain	1 611 822	102 16	15 777.4	3 217.5	17.0
VA	Spain	787 266	137.48	5 849.2	896.2	21.7
PO	Portugal	214 329	41.42	5 180.5	351.1	17.6
SI	Portugal	382 521	319.23	1 198.3	127.1	6.3

Note: elaborated by the authors based on WCCD ISO37120.

Attachment 2. Analysed variables for European cities

	HC_PT	LC_PT	PT_T	PA	BP	TF
AM	14.42	26.26	265.04	0.28	76.31	1.48
EI	0.89	52.1	190.01	0.62	204.64	3.14
HE	11.51	114.41	64.88	0.49	222	2.29
RO	13.4	16.05	248	0.34	102.19	1.62
TH	3.63	22.84	111	0.35	85.24	1.55
ZW	46.5	1.5	56	0.41	129	2
LO	14.31	45.1	490.17	0.3	5.86	1.57
KO	0	25.91	0.01	0.38	226.74	0
ZA	3.29	200.12	343.08	0.37	31.64	2.53
AA	121.08	133	27.55	0.53	0	29.61
GD	4.44	97.83	240	0.54	22.61	0.4
KI	11.63	670.9	177.23	0.48	25.8	3.03
BA	15.89	58.16	441.86	0.48	6.51	1.36
VA	14.43	58.72	158.45	0.59	21.09	2.27
PO	18.85	289.12	636.5	0.33	6.95	1.85
SI	8.1	502.17	43.66	0.68	1.23	2.09

Note: elaborated by the authors based on WCCD ISO37120.