SUSTAINABLE URBAN MOBILITY IN EUROPEAN CITIES

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Overview

Through fuel combustion, the transport sector contributed about 23.2% to greenhouse gas emissions in 2014. To cope with climate change, the international community has set the limit below 2 ° C of the average global temperature increase in comparison with pre-industrial levels. To this end, the European Union has established a progressive reduction of greenhouse gas emissions over the years until it reaches 80% by 2050 (Eurostat). Strong dependence on oil and coal, major contributors to climate change, makes it increasingly inevitable to find sustainable alternative sources. In order to meet energy needs, the transport sector needs an average of 94% of oil, representing a major challenge in order to achieve the desired objectives (European Commission). In order to deal with these challenges and to meet the established targets it is essential to take into account the need for changes in transport systems and attitudes towards the type of mobility chosen. Cities face major challenges in terms of accessibility, congestion, air pollution and sustainability. To allow for intramodality between the diverse types of transport with infrastructure improvements and to publicize public transport and other sustainable modes of mobility such as cycling and walking. In this way it is necessary to perceive the social, economic and environmental performance to better understand the failures and to create policies that are more focused and efficient.

Methodological approach

A cluster analysis was carried out for the year 2015 for 16 European cities. The criteria for the selected cities was data availability. In the first phase, three composite indicators were created, namely economic, social and environmental. The aggregation of the three composite indicators form the indicator of sustainability. All these indicators, composite or not, were standardized. After that, several tests were performed aiming to assess the property of normality for the four indicators (Alonso et al, 2015). Pearson's correlation with city specifications, GDP per capita, urban density, population and percentage of mobility type with indicators were also performed.

In order to determine the number of existing clusters, one performed the hierarchical method in which it was necessary to standardize again the z-scores required for this type of study (Hair et al, 2014). The determination can be made through the dendrogram or of a graph obtained with the coefficients of agglomeration schedule. Through the R squared criterion resorting to the one-way ANOVA the results were confirmed. For the cluster analysis we resorted to SPSS Statistics version 25.

To support the results, the k-means of the non-hierarchical method was also performed. With this method it is possible to reorganize the cities in different clusters in comparison with the initial method in which the inclusion is definitive. This feature allows to reduce the probability of misclassification of a particular city increasing the chances of putting it in the correct cluster. With the results of the non-hierarchical method it is possible to perceive which were the indicators that contributed the most to the formation of the clusters through an ANOVA.

Results

The Kolmogorov-Smirnov (K-S), Shapiro-Wilk (S-W), and the Skewness and Kurtosis tests were used to test the normality. Regarding to the first test, the environmental indicator does not fulfill the requirement of normality which can be explained by the small number of observations under study. Sample size has a significant importance in these tests. Minor samples, especially those below 30, may have a substantial impact on results, that is less advantageous. The greater the sample, the better it is the sensitivity and, consequently, better results (Hair et al, 2014).

Regarding the indicators, Budapest, London and Cadiz stand out economically, socially and environmentally. In terms of sustainability, stand out London, Madrid and Paris positively and by the

negative Turin, Warsaw and Frankfurt. Pearson's correlation results show that the economic indicator has a negative correlation with GDP per capita and positive with public transport share. The social indicator has a negative correlation with GDP per capita and positive with population. The environmental indicator has a positive relationship with sustainable modes share and negative with the rest of motorized modes share. The sustainable indicators have positive relationship with GDP per capita and with the population.

Regarding cluster formation, it is shown the possibility of existing 2 or 3 clusters. With the decision of performing 3 clusters one was able to form a lower, an intermedium and an upper group. Previously, when testing these two alternatives at the non-hierarchical level, in the inclusion of another cluster, the number of interactions was reduced. In the same method with k = 3, the ANOVA table by means of F values tells us the contribution of the indicators to the classification of the groups, highlighting the environmental and sustainability indicators. In this way, cluster 1, environmentally efficient, is formed by five cities, Paris, Frankfurt, Barcelona, Prague and Cádiz, cluster 2, social friendly, by eight, London, Madrid, Berlin, Wien, Copenhagen, Stuttgart, Stockholm and Helsinki, and cluster 3, economically competitive, by three cities, Warsaw, Budapest and Turin.

Discussion and conclusions

In the economically competitive cluster, since there is a strong economic performance, the social, environmental and sustainability indicators are below what would be expected. Social friendly cluster stands out at the social and sustainable level and environmentally efficient cluster with best performance on the environmental level of the three clusters. Interestingly, economically competitive cluster presents a higher percentage of public transport use but, in contrast, a low percentage in the level of sustainable modes compared to environmentally efficient cluster. Cities with the highest urban density are more likely to receive investment (Naganathan, H., & Chong, W. K., 2017). The economically competitive cluster shows a higher urban density, but at the level of GDP per capita is much smaller, which leads to not having as much investment and income allocated to the improvement of urban mobility.

Being an emerging area, data collection and available information are scarce and difficult to access. Indeed, the few data is mainly based on reports. Understanding how cities have evolved over the years to the level of sustainability and environmental problems combined with the policies already implemented would be a good tool to help the policymakers on how to proceed to go towards a more sustainable and efficient cities.

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