Assessing the performance of bike-sharing in Greece

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Bike sharing is a mobility concept which has emerged in various large urban centers in Europe, Asia and North America (Mátrai and Tóth, 2016; Parkes et al., 2013; Shaheen et al., 2010) as part of their urban transport system providing complementary transport services to the major mass transit facilities. Although bike sharing schemes have existed since 1960s, their growth has exploded worldwide in the latest decade (ITDP, 2013). Numerous studies have been carried out regarding the benefits of bike sharing, demonstrating its significant contribution to relieving traffic congestion (Wang and Zhou, 2017), offering improved connectivity with public transport (Bullock et al., 2017) solving the "last mile" problem (Rani and Vyas, 2017), reducing private car use and air pollution (Fishman et al., 2014), as well as offering journey time and cost savings (Bullock et al., 2017).

In Greece, automated public bike sharing schemes have started operating since 2010 in various cities but, to the best of our knowledge, no research has been conducted regarding their characteristics and the assessment of their performance. This paper attempts to cover this gap and contribute to the existing research in bike sharing by: i) identifying the current situation by collecting and analyzing quantitative data regarding the public bike sharing systems operating in Greece, ii) evaluating the system efficiency and market penetration by computing two relevant performance metrics, iii) providing a taxonomy of the different business models operating in Greece and iv) providing recommendations so as to expand the use and encourage the integration of public bike sharing schemes into the transportation system of Greek cities.

For this purpose, a wide dataset regarding the existing bike sharing schemes in Greece and their infrastructure and operational characteristics was created. The data collection process took place from July 2017 to December 2017 and consisted of in-depth interviews with stakeholders such as bike sharing vendors and representatives from bike sharing organizations (municipalities, private firms etc.), while autopsy-based research and extensive research on the bike sharing organizations' websites was conducted to acquire the required data. The in-depth interviews with the stakeholders were conducted face-to-face, by telephone or by email by using a structured questionnaire. The questionnaire was designed on the basis of discussing the following topics: basic system information (organization name, beginning of operation, operator, and business model), system dimensioning (number of bicycles and docking stations), system usage statistics (number of registered users), installed information and communication technology on the bikes (radio frequency identification, global positioning system), system rebalancing and integration and economic issues.

Our analysis indicated that by the end of 2017, there were many independent systems of public bike sharing schemes in Greece. In particular, from 2008 to 2017, a total of 48 bike sharing systems started their operation in Greece, 38 of which were automated. During this 10-year time

frame, 14 automated programs terminated their operation, with an average service life of approximately 16 months. All automated programs included 3rd Generation bike sharing systems features, while no system implemented global positioning systems for tracking its bicycles. With regards to their business model, 90% of the existing schemes were provided and operated by a municipal authority, while the rest were private. The different business models applied in Greece will be presented in the full paper, along with their characteristics.

To evaluate the efficiency of the existing bike sharing schemes, two key performance metrics were calculated. In specific, for each system, the average number of daily uses per public bike and the average daily trips per resident were computed to measure the system efficiency and the market penetration respectively. Our results indicate that nationwide system efficiency corresponds to an average of 2 daily trips per 1000 inhabitants, while for market penetration an average of 0.4 daily uses per bike is computed. A comparison of these values with the benchmark values proposed by ITDP (2013) suggests that, overall, bike sharing systems in Greece are of low performance with low market penetration and low infrastructure usage rates, mainly explained by the fact that the vast majority of bike sharing systems in Greece are not integrated in the urban transport system of the areas they serve. Finally, the performance metrics are computed separately for the different business models and conclusions are drawn with regards to the impact of business-related aspects on the system efficiency and the market penetration.

The above findings could provide significant insight to policy makers, public entities, private companies and other organizations that aim to expand the use and encourage the integration of public bike sharing schemes into the urban transportation system in Greece. One of the most important elements is to properly define the location of the bike sharing stations, since non-optimal locating may compromise their success (Frade and Ribeiro, 2015). In particular, it is recommended to locate stations near central metro stations and other "hot" spots around the center of the city so as to maximize the demand covered. However, currently the majority of stations in Greece are located in low-demand points, since our analysis indicates that in Athens only the 11% of the stations are located in high-demand public transport stations. Other recommendations include improving the image of cycling through promotional activities and campaigns in Greece and promoting the use of bike sharing by providing financial or non-financial rewards to regular users. For example, the offer of reward-based incentives (in the form of monetary rewards or points) are found to contribute to the promotion of sustainable transport services like bike sharing (Polydoropoulou et al., 2018).

This research is currently enhanced by exploring the demand side via conducting questionnaires to the end users so as to account for their views and attitudes towards bike sharing. In this way, advanced travel behavioral models could be developed to model travel demand for bike sharing while accounting for individuals' socio-economic characteristics and their attitudes and perception towards transport modes, the environment, car usage and general lifestyle.

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