Literature Survey

Date	19 September 2022
Team ID	PNT2022TMID32291
Project Name	A new hint to transportation – Analysis of the NYC bike share system.
Maximum Marks	2 Marks

Abstract:

One of the problems in bicycle sharing systems design is the estimation of the potential demand to the service, especially in countries where this type of systems is not yet implemented. The main objective of this methodology is to relate the demand of bike-sharing systems with external characteristics that affects the bicycle usage in order to obtain its territorial distribution.

1.Introduction:

The growing need for changes in mobility patterns turns public transportation, bicycle and pedestrian mode the solution to reduce the externalities related with mobility, in particular the consequences of the mass use of fossil fuels, the growing price of the fossil fuels and the excessive occupation of public space by private cars. Apart from its minimal ecological impact and the reduction of energy dependence, bicycle transportation mode has certain benefits for cyclists, such as improving health and saving money, it provides a significant improvement in the quality of city life and a better experience in the use of urban spaces.

2.Literature review

2.1) Bike sharing systems

It is important to distinguish between three generations of services. According with several authors there are three generations of services of bike-sharing: free bike system, coin-deposit systems and information technology based systems (Shaheen, Guzman, & Zhang, 2010), (Wang, Liu, Zhang, & Duan, 2008) and (DeMaio, 2009). The free bike-sharing system is characterized by a set of bicycles (with unusual colors and/or shapes) that are available without costs to the user. Typically the stations are located near public facilities that have their own staff which are responsible for the users' identification, reducing the needs of human resources of the system. The use of the bicycle is, in the most cases, free to the user. The first bike sharing system was emerged in Amsterdam, the Netherlands in 1965. A set of fifty free bicycles was seen as the solution for traffic problems. However the Witte Fietsen (white bikes) Plan failed after its launch due to the bicycle damages and thefts. In the coin-deposit systems the bicycles are not freely available, once the users have to use a coin to unlock the bicycle from the docking stations. At the same time, some concerns about the location of the stations are introduced to ensure the efficiency of the operation. Although some significant changes on the motorized transportation patterns in some cities the coin-deposit system did not solved the thefts problem. To overcome this problem, the third generation of bike-sharing emerged based on automatic services. This generation uses smart technology (mobile phones, mag-stripe cards, smartcards or codes) to unlock the bicycles from the stations allowing the automatic identification of the users (with a code for instance). The casual users pay a security deposit to ensure the return of the bicycle, and the use of the bicycles is paid depending on the time interval of the usage. Typically the service is free in the first specified time interval and the price gradually increases after the interval depletion. This system is simpler to manage in terms of human resources, but requires a higher investment in technology. Some of the great advantages of the technology introduction are the possibility of 24h service, the easier location of stations in the city and the data collection about the usage of the service. Shaheen, Guzman, & Zhang (2010) identified also the fourth generation of bike-sharing systems. Fourth generation bike-sharing systems are multimodal systems. Their main concern is an improvement of the service to the user needs, in other words it is demand-responsive. It includes an improvement in technological mechanisms in the stations and bicycles that facilitate their use and share, electric bicycles, bicycle relocations and the integration of the several transport services in the same access card (public transportation or car-sharing). In Portugal it was implemented a free bicycle sharing system in Aveiro, called Bugas, that was launched on April 2000. It stated with a stock of 350 bicycles spread over 33 parks all over the city. However, after the pilot period some of the bicycles were vandalized or stolen. Currently the system works as a less ambitious service with only one station and some degraded bicycles. The successful of the bike-sharing programs depends on how the demand is satisfied. However, the definition of bike-sharing demand is not yet a popular subject in the literature. Next section provides a literature review about general bicycle demand models and a focus on existing bike-sharing demand definition strategies.

2.2. Demand studies for cycling and bike-sharing

One of the biggest concerns of the urban transportation planners is to provide the most adequate response to traveller's needs, estimating transportation demand and its variation. Planners are also aware of the strong relation between transportation and land use, and as this relation should be incorporated in demand studies. It is complex and risky to predict the number of bicycle trips, especially in cities where the bicycle is not yet widely used. There are various studies on the prediction of non-motorized travel demand. Turner, Hottenstein, & Shunk (1997) and (Schwartz et al., 1999) present an overview of different approaches to determine the bicycle travel demand. One of the methods more frequently referred is the Latent Demand Score Method (Landis, 1996) and it is specially adapted in cases where bicycles are not yet a popular choice. The methodology provides a coefficient of potential demand for bicycle trips throughout a transportation network (in each arc of the network), based on the influence of generator/attractors points in the city on the number of bicycle trips for all road segments. One of the advantages of this model is that it acts as a geographic information system. However the trips estimated are not directional (the method considers the total number of the trips that were generated and attracted), meaning that the method compromises an Origin-Destiny evaluation. An adaptation of this method was used in a demand study for the city of Tomar (Portugal) where the main difference of this adaptation to the Latent Demand Score Method is that it considers the number of trips in each origin-destination point, and the choice of shortest path between origin and destination (Ribeiro, Frade, & Correia, 2012). The current scientific studies or real world applications use 'revealed' or 'stated' preference surveys as methods for bike sharing systems demand estimation (dell'Olio, Ibeas, & Moura, 2011) (ConBici, 2007) (PROBICI team, 2010). In the cases of bike-sharing systems expansion, the revealed surveys can be very useful; however in some cases the responses to the stated preference surveys can be strategic and may not reflect the real intentions of the interviewee. Surveys results must be used with care, mainly in the cases where similar services were not yet implemented. In order to avoid the constrains caused by the surveys, the demand modelling approach will study different bike-sharing systems around the world defining the profile of the users and potential users, the factors that can influence the demand (as the geographical conditions, the variation of demand during the day or over the seasons, and the travellers characteristics age; sex, and/or job, etc.) and how they affect it. The demand of New York City bike-sharing system was designed using the user group patterns of successful bike-share programs: Velib'in Paris, Velo'v in Lyon and Bicing in Barcelona; from which three typical user groups were identified: commuters, recreational/errand riders and tourists. The authors estimated the number of people in each potential user category in New York and applied to them different uptake rates (3%, 6% and 9%) to quantify the users of bike-share program. The uptake rates are defined based on London and Paris surveys (NYCDCP, 2009). Krykewycz, Puchalsky, Rocks, Bonnette, and Jaskiewicz (2010) use a methodology to estimate the demand for a new bicycle-sharing program in Philadelphia (Pennsylvania). The authors' defined two market areas using raster based geographic information system analysis and applied three bike share trip diversion rates determined through surveys in Lyon, Paris (France) and Barcelona (Spain) in order estimate the modal shift from other modes to bike-sharing, establishing different demand scenarios (low, middle and high). In the Seattle case, the demand study was based in the Philadelphia study. However, the market areas were defined considering a GIS raster dataset of weighted sum indicators that influence bike-share use (population density, non-institutionalized group quarter population density, job density, retail job density, commute trip reduction companies, tourist attractions, parks/recreation areas, topography, regional transit stations, bicycle friendly streets, streets with bicycle lanes and local transit stops). Rates observed in Lyon, Paris and Barcelona, to the defined market areas, were also applied (Gregerson, Hepp-buchanan, Rowe, Sluis, Vander, Wygonik, et al., 2010). Daddio (2012) presents a regression approach to relate the surrounding characteristics with the station demand. The dependent variable is the number of trip departures per station, using the data provided by Capital Bikeshare (bike-sharing system of

Washington Metropolitan Area). The independent variables are measure within 400 meter walk distance from each station. The variables considered are divided in three sets of characteristics: trip generation, trip attraction and transportation network. In the District of Columbia, the variables statically significant are the population between the ages of 20 and 39, the proportion of population that belongs to a race other than "white alone", the number of retail establishments selling alcohol, the number of metro stations and the distance from weighted mean (ridership) from the center of full DC and CA Capital Bikeshare system. The use of public bicycles increases potentially when they are complemented with other transportation modes (intermodality), or when parking problems exists in the origin or destination of the trip. In The Netherlands for instance a growth in bicycle use for non-recurrent trips, besides a reduction in car use and a growth in train trips, was observed after the introduction of a public bicycle sharing service, (Martens, 2007). Krizek & Stonebraker (2010) presented a methodology - developed for Puget Sound Regional Council in Washington in 2002 - that determines the total number of potential users of a bicycle station (in different scenarios) depending of the respective user groups, defined as: bicycle commuters who work within a quarter mile of the bicycle station; bicycle users who park their bicycles at transit stations and bicycle users who travel with their bicycles. The methodology relates the number of the users with the employment data, the number of transit trips, the bicycle share within 3 miles of a proposed bicycle station, and the number of bicycle commuters to within a quarter mile of the bicycle station. The validation of this method was done considering the data of two existing bicycle stations and the methodology was considered reasonably accurate.

Conclusions

This paper sets out a method for estimating the bike-sharing demand and it allows to geo-reference the demand, considering the characteristics of the city and of the trips. This approach was illustrated by an application to the Portuguese town of Coimbra. The main advantages of this approach are that it provides a quick assessment and it can be adapted to other towns and cities according its characteristics. The method can help in decision-making for transportation planners, policymakers and investors. The method is useful in the full design of the system, including the location of bike-sharing stations and in the dimension of the fleet, as well as in the scheduling of the investments. Further studies can include the consideration of other socio-economic characteristics, such as population density, non-institutionalized group quarter population density, job density, retail job density, commute trip reduction companies, tourist attractions, parks/recreation areas, topography, regional transit stations, bicycle friendly streets, streets with bicycle lanes and local transit stops, as in the Gregerson, Hepp-buchanan, Rowe, Sluis, Vander, Wygonik, et al. (2010) mention before. It should be also considered the demand associated to public transport, to understand which public transport mode bike-sharing users chose to complete their trip. Therefore, several information is also being collected in socio-economic variables for each district and each traffic zone that are part of the case study, in order to have a detailed demand determination framework, which is an important part of the formulation in the simulation-optimization model this study aims to reach for.

Bibliography

AASHTO Executive Committee. (1999). Guide for the Development of Bicycle Facilities. Washington, DC: American Association of State Highway and Transportation Officials.

An, M., & Chen, M. (2006). Estimating Non-motorized Travel Demand. Transportation Research Record: Journal of the Transportation Research Board, 07-2410, 18–25.

ConBici, C. en D. de la B. (2007). Guía metodológica para la implantación de sistemas de bicicletas públicas en España. Madrid (Spain). Daddio, D. W. (2012).

MAXIMIZING BICYCLE SHARING : AN EMPIRICAL ANALYSIS OF CAPITAL. dell'Olio, L., Ibeas, A., & Moura, J. L. (2011).

Implementing bike-sharing systems. Municipal Engineer, 000, 1–13. DeMaio, P. (2009). Bike-sharing Its History, Models of Provision, and Future.pdf. Velocity 2009 Conference.

Brussels, Belgium. Dill, J., & Voros, K. (2007). Factors affecting bicycling demand: initial survey findings from the Portland, Oregon, region.

Transportation Research Record: Journal of the Transportation Research Board, 2031, 9–17. Retrieved from http://trb.metapress.com/index/rlq1710417402412.pdf

Turner, S., Hottenstein, A., & Shunk, G. (1997). Bicycle and pedestrian travel demand forecasting: Literature review, 7(2).

Vuchic, V. R. (1999). Transportation for Livable Cities. New Brunswick, N.J.: Center for Urban Policy Research.

Wang, S., Liu, L., Zhang, J., & Duan, Z. (2008). BIKE-SHARING--A NEW PUBLIC TRANSPORTATION MODE : STATE OF THE PRACTICE & PROSPECTS. Traffic Engineering, 222–225