

## **BIKE SHARING SYSTEMS AS A TOOL TO INCREASE SUSTAINABLE COASTAL AND MARITIME TOURISM. THE CASE OF PIRAEUS**

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### **Abstract**

Piraeus is the fourth largest municipality in Greece and a port city. Piraeus port is one of the biggest in the Mediterranean, serving thousands of passengers, who use the city as a transport corridor to reach Athens. On the other hand, the harbor gives a sense of liveliness in the city, further reinforced by the advantageous geographical position, important archaeological sites and a beautiful shoreline. New perspectives are also opening up for the city due to the development of a new cruise terminal. Among the crucial challenges faced by Piraeus city is the strong car-dependency. In order to cope with this issue and related impacts, but also to reinforce traditional economic activities related to the maritime economy, the municipality has decided to re-orient its planning efforts, visioning Piraeus as a sustainable coastal and maritime tourism destination. As part of this planning goal, the promotion of cycling has been decided, by launching a Bike Sharing System (BSS), being perceived as an excellent tourist attraction along with other advantages this can bring. The paper deals with BSS planning as a smart policy that will directly benefit the local economy. It elaborates on those factors that show how and why changes occur in a city due to a BSS, how and why it is successful or not and what are its benefits but also main challenges. It also gathers knowledge from European BSS in order to embed it in Piraeus' BSS planning effort for improving citizens and visitors' sustainable mobility pattern in Piraeus.

**Keywords:** Port city, Bike Sharing Systems, sustainable mobility, sharing economy, Piraeus

**JEL classification:** R42

### **1. Introduction**

Considering the serious threats that affect the city environment such as climate change, accidents, traffic saturation, pollution, noise and the extended takeover of public spaces by cars, the municipality of Piraeus visions to promote sustainable mobility policy choices and solutions, following successful experiences gained by many cities in Europe that have shift towards cycling and walking.

In 2004, OECD, in its report on National Policies to Promote Cycling, stated that "Cycling is increasingly recognized as a clean, sustainable mode of transport and an essential part of an inter-modal plan for sustainable urban travel." Today, almost 15 years later, it is widely recognized that bicycle is the solution to urban problems, such as traffic congestion, high cost of living, land use consumption and also environmental and health issues. Elliot Fishman (2013) indicates that a common response to the contemporary urban policy, seeking to overcome challenges presented by car dependence, is to replace car journeys with bicycles' ones.

Bicycle Sharing Systems (BSS), as part of wider urban mobility management strategies, are critical components of current policies and practices to address these challenges. The key objective of BSS systems is to provide free or low-cost access to bicycles for short distance trips in urban areas as an alternative option to private car use, therefore reducing air pollution, noise levels and traffic congestion. Bike sharing is also linked to motorised public transport either as an alternative transport mode or as a short distance ('last mile') solution, connecting commuters to public transport hubs. In this context, a 'bicycle sharing system', 'bike sharing system' or 'bike sharing scheme', can be defined as any fully automated, self-service network of bicycles that is available to individuals on a short-term basis as a means to short distance transportation in urban areas. Bike Sharing Systems can be classified according to financing models followed (public, private, or public-private partnership), ownership, operator and operational model, scale and range.

Urban transport advisor Midgley (2011) has noted that "bike sharing has experienced the fastest growth of any transport mode in the history of planet." The introduction of a BSS has profound impacts on "creating a larger cycling population, increasing transit use, decreasing greenhouse gases, and improving public health", as reported by DeMaio (2009). Bike sharing gains popularity as it offers both an alternative transportation option and a mean to increase bicycle use by integrating cycling into the transportation system. The main principle of bike sharing is to offer a short-term access to bicycles on an as-needed basis, removing the burden of costs and responsibilities relating to bike ownership. Shaheen et al. (2010) described the benefits of bike sharing, such as flexible mobility, reductions of gas emission, health of population related to physical activity, reduced congestion and fuel use, financial savings at the individual level and support for multimodal transport connections.

Piraeus is a typical Greek city. The main urban characteristics of Piraeus are high density housing and narrow roads, which are disproportionate to the heights of buildings in terms of building height to street width ratio. Building stock counts several decades now, which implies that no underground parking spaces are available, leading to excessive on road parking. Due to this fact, cars can move in a narrower corridor. In fact, car speeds are low, however this does not mean that streets are welcoming and movement of pedestrian and cyclist is safe. In fact, exactly the opposite is the case in the city. Sidewalks are too narrow and full of obstacles, forcing pedestrians to walk on the street. There is absolutely no provision for cyclists. The above-mentioned characteristics and the absence of green elements turn streets into traps for pollution and noise, the well defined in the literature "street canyon effect". The structure and environment of the city as a whole is hardly attractive to walk or even stand on the street. Walking and cycling are not a viable option; hence residents are strongly depended on their car or motorcycle. The effects of this dependency are well known in terms of quality of life and urban operations.

The Municipality of Piraeus participated in the CycleCities project in order to integrate cycling in urban mobility policies. Bike sharing schemes or systems lie at the core of urban mobility management strategies; and the integration of such system in the Piraeus' cycling plan was considered necessary. This research focuses on studying existing BSS case studies in the European context; and using these experiences for planning a new BSS system for the city of Piraeus along the lines of the CycleCities project.

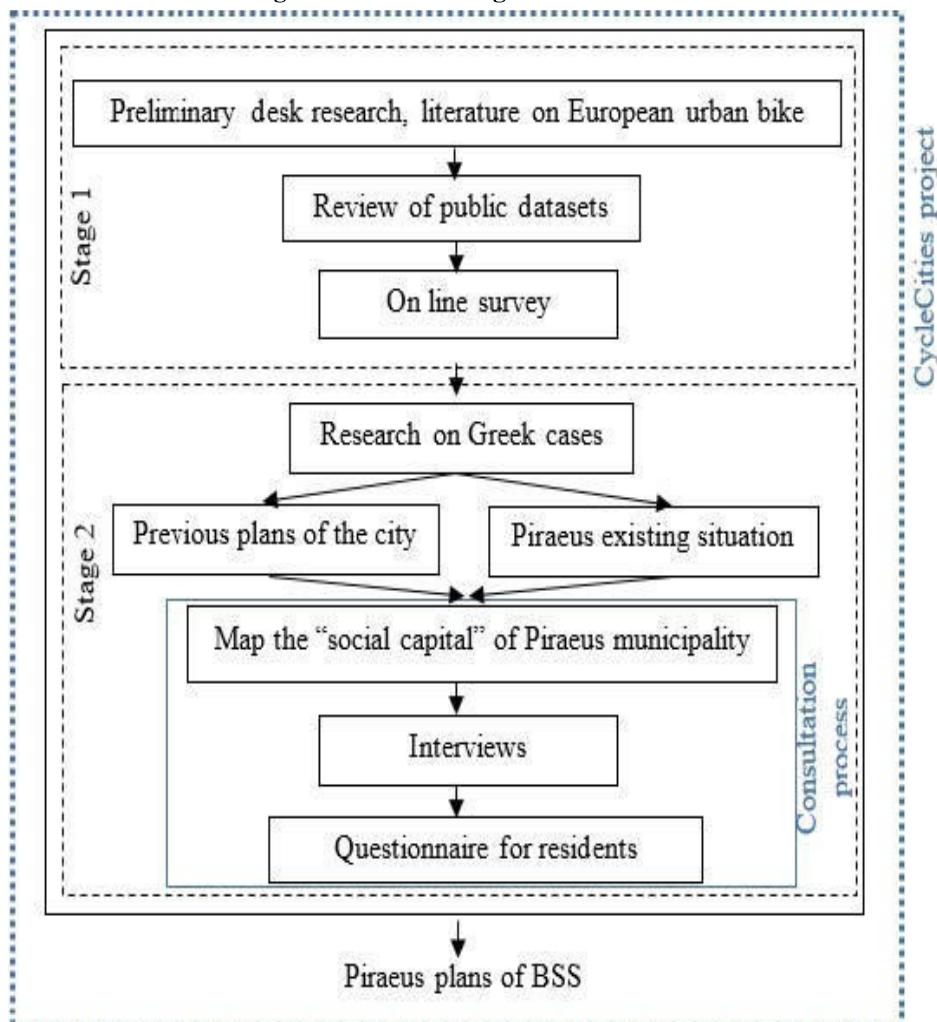
## 2. **Methodology**

This research was accomplished in two distinct stages (Fig. 1). Both stages were carried out under the umbrella of CycleCities Project, an INTERREG IVC funded project. The first stage intended to gather evidence on BSS effectiveness and impact on urban mobility management. The second stage concerned the state of Greek Bike Sharing Systems (BSS) with a special focus on the case of Piraeus municipality.

Stage 1 included 3 steps. The first step was to make a preliminary desk research, literature review and brief analysis of the state of the art of the European urban bike sharing systems. Then a review of several public datasets (e.g. OBIS project, EPOMM database) currently available on bike sharing systems in Europe (types of systems installed, numbers of bicycles and registered users, costs and financing) took place. Based on the previous steps, the BSS cases to be surveyed were identified and comparatively analysed. An online survey questionnaire was developed so as to gather views, opinions and experiences on effectiveness

and user satisfaction in relation to Bike Sharing Systems, using as a basis on the BSS cases identified through review of available data. Finally, the pilot testing and fine-tuning of the questionnaire took place, while accompanying survey material was structured (e.g. guidelines, invitation texts). The survey lasted for 6 weeks. The questionnaire led to the collection of additional, up-to-date evidence and provided more in-depth insights into the effectiveness, value-for-money and overall impact of current bike sharing schemes and systems in European cities, as voiced by those directly involved in planning, deploying and operating BSSs. After the consolidation of related answers, a comparative analysis of the survey data was carried out.

**Figure 1: Methodological Framework**



Source: own elaboration

The sample was analyzed using the SPSS two-step clustering method and the hierarchical cluster analysis in order to identify groups of similar BSS, with high distinction to other groups.

While steps 1 and 2 of the research aimed at establishing an overview of the current situation and the facts and figures of European BSSs, the questionnaire-based survey (step 3) focused on exploring specific aspects of bike sharing schemes, related to their effectiveness, associated costs and value-for-money as well as their overall impact.

*Stage 2* elaborated on bike sharing systems in the context. At first, Greek cities were researched according to CycleCities questionnaire in order results obtained from them to be integrated in the overall European results. Afterwards, a detailed research on Piraeus municipality took place. All previous studies (transport studies, urban planning studies, architectural reform studies, etc.) were gathered in order to understand the previous/existing visions and goals for the city.

A consultation process followed the above step, aimed at gathering the local authorities', stakeholders' and residents' points of view, in order these to be taken into account in the planning procedure. Public involvement in the planning policies for sustainable mobility is a highly demanding task. Surveys have shown that the reaction of citizens in attempts to enhance participation in the planning procedure is quite similar in most countries. It requires honest intention from the planning organization, acting as the initiator; and effective incorporation views gathered in the final planning outcome, in order for the procedure to be meaningful (Stratigea, 2015). To motivate local population and achieve wide participation for consultation purposes implies the provision of certain incentives. Moreover, a comfortable and friendly environment has to be established, within which citizens should feel that they take part in a planning process that aims at improving the quality of their lives.

The preparation of the *consultation process* includes the following actions:

- Recording of the "social stakeholders" of Piraeus. Interviews / meetings with the "social stakeholders" of Piraeus were recorded.
- Making interviews / meetings with the local authority, the Department of Planning and Development of the municipality and citizens. The type of semi-structured interview was selected, which is a flexible, open, minimum standardized approach and allows for in depth conversation. The conversation focused on the issues of mobility in the city of Piraeus. An interview guide was written that included the three following main issues to be addressed: (a) the way residents travel and the means they use both within Piraeus and in their inter-municipal travels; (b) their participation in urban planning decisions or any suggestions on how citizen participation could be enhanced in such decisions; and (c) the problems of the city, how they perceive the development of the city in general and in relation to their trips in particular.
- Exploring views and wishes of the residents of Piraeus via a questionnaire in relation to travelling in the city and the prospect of sustainable mobility policies.

### 3. Findings

#### 3.1. First stage of research

Starting point of the research was an overview of the current situation of BSS by reviewing the literature and previous surveys/ projects like the OBIS project (2011). A lot of researchers have focused on different aspects of bike sharing systems and their work should be noted as highly important. Matrai et al. (2016) and Fishman et al (2013) make a holistic literature review on this subject. Shaheen et al. (2010) highlight the systems' generation and evolution over time. Ricci (2015) dealt with the identification and critical interpretation of the available data on BSS. Fishman et al. (2014 and 2012) focused on the facilitators or the barriers of bike systems. Midgley (2011) and Shaheen et al. (2012) developed datasets about different system characteristics. DeMaio (2009) focused on analysing the business model of public bike sharing systems.

In the next stage of the research, a survey questionnaire was conducted, leading to the collection of additional, up-to-date evidence and providing more in-depth insights into the effectiveness, value-for-money and overall impact of current bike sharing schemes and systems in European cities, as voiced by those directly involved in planning, deploying and operating BSSs. Data were collected through the collaboration networks of the CycleCities project partners. It was focused on specific aspects of BSS, relating to their effectiveness, associated costs, value-for-money and their overall impact.

##### 3.1.1. Responses' overview

The majority of cities (40%), which participated in the survey, were medium-sized cities. Regarding the respondent's involvement in BSS's deployment, this revealed that most participants were involved in the process of planning/designing a BSS, followed by those who worked in systems' daily operation, performance and maintenance.

The analysis regarding the BSSs' user groups revealed that the primary group of BSS users is commuters to work/school, followed by tourists and people on their leisure time.

Concerning the costs and economic results of the BSS, it was revealed that the main source of revenue are primarily the user's fare and advertisements, followed by the income earned from contracts with the local authorities as well as any grants/donations that may occur. Also, the repair/ replacement costs due to damages, vandalism and theft were not as important as some might believe. Compared to the overall operating cost, it was less than 10% for the great majority of the European BSSs. In case of negative economic results, the city administrator or the private operator covers the deficits, depending on who has deployed the system and the type of signed contract in case of private operators.

In the majority of cases, the most important benefits that followed the deployment of BSS systems were the increased bike use ("cycling uptake occurred") and the improvements in citizens' health. The most frequent territorial and other policy measures implemented, in combination with the deployment of the BSS, were cycle routes, awareness raising campaigns and partnerships of BSS with public transport sector.

### 3.1.2. Correlation analysis

The correlation analysis indicated the relationship between variables. It was used to understand whether the relationship is positive or negative, but also identify the strength of this relationship.

There was no relation identified between the proportion of municipality area covered by the BSS and other factors. This lack of correlation appears as it might be beneficial to have a large system that covers the whole municipality, but it is contradictory to the basic design principle, which requires a high density of stations, a fact that is not feasible if the network of stations is expanded in the outskirts of a city.

The average duration of each trip is highly correlated to the relation of revenues and expenses. In all systems with average trip duration up to 30 minutes, expenses exceed revenues. The BSSs that have profits are allocated within the 60-120 min class on trip duration. This is due to the fact that pricing schemes, with a limit of 30 minutes free of charge, are encouraging for short-time use of the public bikes. But this correlation also reveals that users accept to pay if they need a public bike for more than the free time provided.

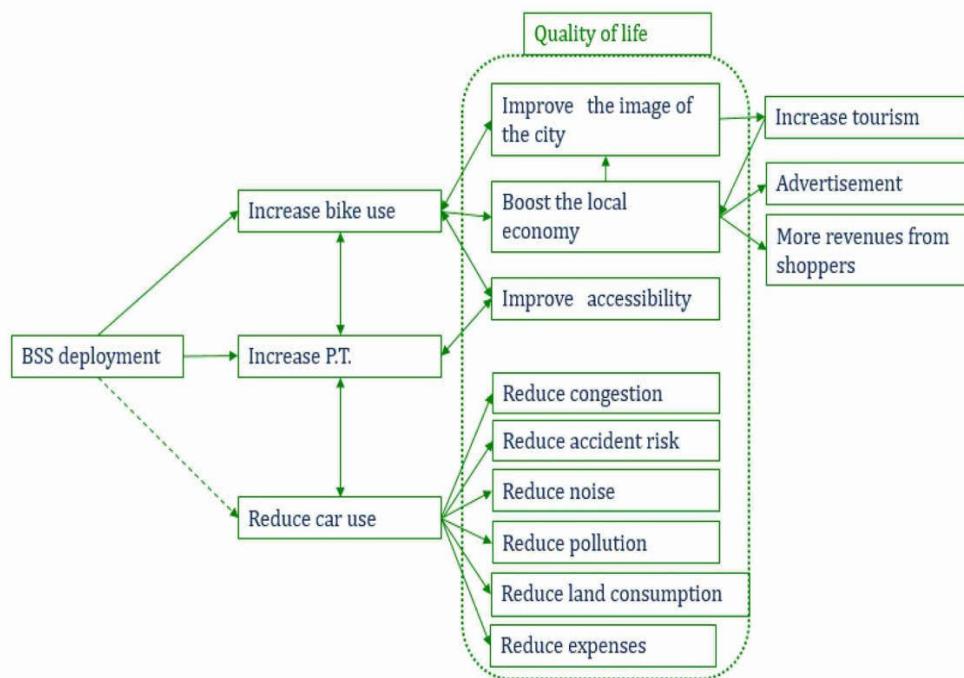
Highly correlated were found to be the primary user group and the level of public consultation through polls and voting. Adequate public consultation of this kind is only found for the commuter-oriented BSS. High correlation is found for different kinds of public consultation as: public meetings, polls and voting and public information centers. If involvement in public consultation is planned, these three participation modes are sufficient when used together. In other cases, all three are considered somewhat insufficient.

An important correlation occurs between the source of the total revenue and the public opinion. Systems registered as totally financed by advertisement are rated with highest score for the public opinion. This might be due to the fact that advertising companies present a professional image of the BSS.

Furthermore, the effect of increasing tourism as major benefit is strongly correlated with the average economic result of the BSS. For systems with a positive revenue-expense ratio, the effect on tourism is assessed very high and vice versa. The major benefits of the increase in bike use are directly correlated to the benefits of reducing traffic congestion, improving citizens' health and reducing CO<sub>2</sub> emissions / improving the urban environment.

High investment costs as a major challenge of the BSS, is significantly correlated to the need for additional funding to improve the system. The importance of additional funding is also correlated to the assessment of public consultation, especially through information centers. Systems that emerge after adequate or sufficient public consultation feature a high importance of additional funding. Lower prices for users, as a critical measure to increase the system's value for the city, is highly correlated to the positive assessment of the impact of BSS on local development as well as to the need for setting up initiatives for engaging local communities in decision-making and combined actions, involving other transport modes.

The overall impact of the systems, based on the results of the survey, is summarized in Figure 2.

**Figure 2: Diagram of the impact of BSS**

Source: Vassi & Vlastos (2014)

### 3.2. Case study: Piraeus

#### 3.2.1. Current situation and existing plans and studies

Piraeus is an historical industrial city. It has very high residential densities and activities and a severe problem of illegal parking that creates traffic jams all day long in various spatial entities. The Piraeus area is characterized by great diversity in its geographical characteristics. It includes areas with steep slopes, but almost flat areas where the bike could move comfortably and serve both residents and visitors from other regions.

Piraeus advantages are the liveliness of the harbor with thousands passages every day as well as the diversity of the shoreline and the landscape in general. It has important archaeological sites and an advantageous geographical position in the center of historic sites, as the islands of the Saronic Gulf, Sounio, ancient Corinth, Epidaurus, Mycenae, etc.

The lack of adequate transport infrastructure and the limited surface resulted in a dramatic increase in density. The classical buildings with one or two stores were sacrificed in order to have block of flats. The existing density is not consistent with the presence of the large number of cars. Piraeus is a lively city and at the same time tends to be paralyzed by congestion on the road network.

The Municipality of Piraeus has become an autonomous commercial and business center. A large part of the population works within the borders of the municipality. There is also an important proportion of the population that works outside the municipality, mainly within the Athens Metropolitan Area (public and private employees, freelancers and entrepreneurs) but also in other areas (industry, etc.). Within the center, but also in the overall municipal territory, there are many supra-regional businesses and services, which increase the traffic congestion, with all the relevant consequences this can cause. The city has a number of important supralocal roads. Thousands of vehicles pass daily throughout the city and determine its functioning and dynamics.

The municipality has implemented traffic regulations (turned two-way roads to one way) due to the expected deployment of the tram and metro. On certain roads were reclamations, aiming at improving conditions for pedestrians or at separating circulation of buses (which move contra flow) from car traffic. While in general, the implementation of one-way roads used to be considered as a good practice in traffic planning for "fine tuning" car flows, a number of problems have arisen in the city of Piraeus.

A severe problem is the increased car speed that now exists on roads without traffic lights, such as the coastal road, which prevent and discourage residents and visitors from crossing it, and therefore degrades the value of the sea front. Also, the illegal parking on central streets constitutes a problem, reducing their capacity and therefore their functionality. Finally, an important problem is the total lack of law enforcement and therefore political support, which could have regulated and prevented situations as the above described.

The lack of parking policies, the emergence of private parking areas that attract more and more cars, combined with the inadequate public transport (at a distance from current needs of the city) create an intolerable situation due to heavy car traffic and on-street parking density that degrades the quality of the urban landscape and quality of life.

Consequence of all the above is the deterioration of the city's image as a coherent urban and social landscape (A4). Additionally, the social inequality is one of the biggest obstacles that Piraeus should overcome in the 21st century.

Previous studies and plans for Piraeus were studied. The aim was to search for those elements that could be used, either in the phase of the analysis or in the phase of the planning process for setting up a strategy for sustainable mobility. The metropolitan plans for the wider area were taken into account, as Piraeus could not remain unaffected by them. Most of the studies and plans were based on the use of car. For example, in 2002, a traffic study was drafted in order to solve traffic problems in the municipality. Proposals emerging from this study aimed at optimizing the flow of cars along the main roads, by increasing the traffic lanes and the green phase of traffic lights in the junctions.

In 2008, the newly elected municipal authority set new objectives for the city, a vision that was targeting to: improve the quality of life, decrease spatial inequalities, improve sustainable accessibility, enhance sustainable mobility, showcase the history-culture and promote the city as a tourist destination. In the light of these objectives, decided crucial aspect was to cope with mobility inefficiencies and make a turn towards more sustainable mobility patterns in the city. The first attempts made were rather inadequate. In 2008, the Municipality of Piraeus, in cooperation with Attiko Metro, has launched 6 projects for the rehabilitation, restructuring and development of urban transport of the greater Piraeus area (extensions of lines, underground lines, parking facilities), in order links to be established to the rest of the Attica Region. In 2012, the project of converting an inactive railway section to bicycle and pedestrian routes was considered highly insufficient by some and totally useless by others. The reconstruction, planting and aesthetic upgrading of the route are of no value, since the pedestrian-bike path will be cut off from the urban environment and disconnected from public spaces and public transport.

In 2011, the municipality joined the CycleCities consortium, inspired by the sustainable mobility targets set: increase the percentage of cycling in the city, improve accessibility in particular land uses, plan for cycling network, attract private investments on cycling, decrease accidents, engage stakeholders in the planning process, raise the citizens' awareness. The opportunity seen via CycleCities was to integrate cycling in urban mobility policies, using the European experience. One of the policy directions serving sustainable mobility concerns in Piraeus municipality, already identified from the beginning of the project, was the deployment of a BSS, as this was proven to be extremely efficient in terms of adopting bicycle as means of transport in cities without any urban cycling culture (case of London and Paris). The results of the first stage of research were absolutely encouraging towards the adoption of such a system within the framework of "Piraeus' Cycling Implementation Plan", which was the main expected outcome of the project. As BSSs directly increase bike use and public transport use, it was proven (by the first stage of the research) that it improves the image of the city, boosts the local economy and improves accessibility. It also indirectly reduces car use, resulting in reduced congestion, noise, pollution, accident risk, land consumption and expenses.

These results were almost identical to the targets set by the municipal authority for the city. In this way, BSS has emerged as the ideal "tool" for achieving these goals.

### 3.2.2. Consultation process

As mentioned above, in the context of the interviews / meetings, the social stakeholders' groups of Piraeus were identified. More specifically the groups that were identified to take part in the meetings or share their views through interview-based one-to-one discussions,

included: municipal social services such as parents' associations in schools, local associations and partnerships which act in Piraeus, other unions or partnerships that engage citizens (churches, orphanages), local media (news websites, newspapers, radio, bloggers) and local political parties.

Based on the type of stakeholders identified, interviews were performed. The involvement of citizens offered valuable information and highlighted critical issues, which were taken into account in the planning process and further explored in the second phase of public participation.

Among others, the main conclusions drawn from the interviews were: a) there was strong support for the creation of cycle routes mainly on one way roads, along the beach and along the harbor; and b) citizens were reluctant to use the bike for safety reasons, practicality or health (due to traffic conditions, inadequate cycling skills, difficulty to find safe parking near the house, knee problem, rise of the crime during night time). There was a preference towards bike, mainly for local traveling and leisure in the coastal roads but not at the metropolitan level. The transportation from / to and within the city center, emanating from the neighborhoods, are done by foot or by car. Piraeus is a dense area, with relatively small distances and the center can be reached by foot from the surrounding neighborhoods. Consequently, there was strong support for measures in favor of the pedestrian; and it was generally desirable to restrict the use of cars in the center. Moreover, the bus service in Piraeus was not adequate due to the lack of reliability and speed of service.

There was strong interest in quality of life issues (security, cleaning, pedestrian traffic, use of open spaces, highlighting of archaeological sites-monuments). Moreover, rise of crime and lack of security in certain areas, made walking and public transport a less attractive option in the evening.

Regarding the planning procedure and public participation, there was contact between the municipality and the citizens, but promises were not realized. Some people believed that the involvement of citizens eventually will make planning worse. It was feared that the involvement of citizens is affected by personal interests and that people were trying to "promote" themselves or their interests through participation and not to improve planning. There was a feeling that the environment of the city was shaped by personal choices of powerful groups and not only by the municipality.

Finally, there is a strong sense that Piraeus must regain its identity, a core element of which is the port. The port should be reorganized in order the cruise industry and tourist services to be developed.

The findings of the interviews were reinforced by a larger sample, using a standardized questionnaire. The views of residents on critical issues related to the desires and intentions as well as their experience of the city were explored. The questionnaire focused on specific interventions and traffic scenarios in the city, which respondents were asked to evaluate, stating their agreement or disagreement with them. Evaluation of the scenarios were used for the design of various interventions in the city. The scenarios included in the questionnaire reflect real dilemmas of planners.

The findings regarding bike attractiveness were very optimistic, but regarding bike sharing systems, the feelings of the residents were mixed. This is justified by the fact that there is no experience of a successful system in the wider metropolitan area of Athens, but also in Greece.

#### **4. Planning for Bike Sharing System**

The creation of a network of BSS stations was divided into four phases. In order to select the location of the stations, the following data were used: population density, strong poles of attractions, Piraeus' public transportation network, the proposed bicycle network, a BSS study made by the municipality of Athens for installing public bicycle system, the European average prices for bicycle numbers/ no., residents & visitors, cover / housing density, distance between stations, bike prices, costs, etc, origin and destination study made by OASA in 2006. According to this study, 24.72% of commuters live in the Municipality, while 20.6% use cars and 29.8% use public transport. This means that some short trips in the Municipality can potentially be replaced by bikes and public transport. It should be noted that for the choice of

location of stations, easily accessible -on foot or by means of transport- public spaces were preferred, provided that they do not disturb the coverage area.

The first phase is a pilot design for a network of bike sharing stations. Residents and visitors of Piraeus prefer the construction of cycling infrastructure on the beach (which meets the highest percentage of the municipality recreational uses). For this reason, the first bike rental stations will be placed along the coastal road. Additionally, an important issue for both residents and visitors of the municipality is to establish links of this the infrastructure with the existing public transport. So, they are placed in Metro and Tram stations. Twelve stations with twenty bikes on each station were proposed, following the European average ratio 'bicycles / residents and visitors' as well as the findings from a similar study in Athens. The proposed stations will be installed in the locations shown in Figure 3a and Figure 3b.

**Figure 3a: Position of the first 12 stations (Phase 1)**



Source: own elaboration

The distance between the stations is small, so a user of the system can easily and quickly go from one station to another, but even if he/she wants to approach them on foot, this is feasible. All stations were chosen to be in proximity with major poles of attraction and in direct contact with the proposed bicycle network of Piraeus.

The *second phase* will complement the first one. Links will be established to and from rail and tram network. There will be placed additional stations to serve the tourists' demand, arriving at the two ports of Piraeus (piers cruise and passenger ships). An attempt is made to exploit the existing infrastructure of Piraeus; and the one to be launched in the near future. In this way, additional areas will be served. Finally, the service of the central region and the coastal cycling network is enhanced. Ten more stations with 20 bikes per station were proposed. The proposed stations will be installed in the locations depicted in Figure 4a and Figure 4b.

**Figure 3b: Bike sharing stations – 1st phase, proposed cycling network, public transport and major poles of attraction in Piraeus Municipality**



Source: own elaboration

The distance between stations (in the first and second phase) is small, and the users can easily switch from one station to another. All new stations were chosen to be nearby and have direct contact with the proposed bicycle network.

**Figure 4a: Bike sharing stations – 1st and 2nd phase, proposed cycling network, public transport (and the new lines) and major poles of attraction in the Municipality.**

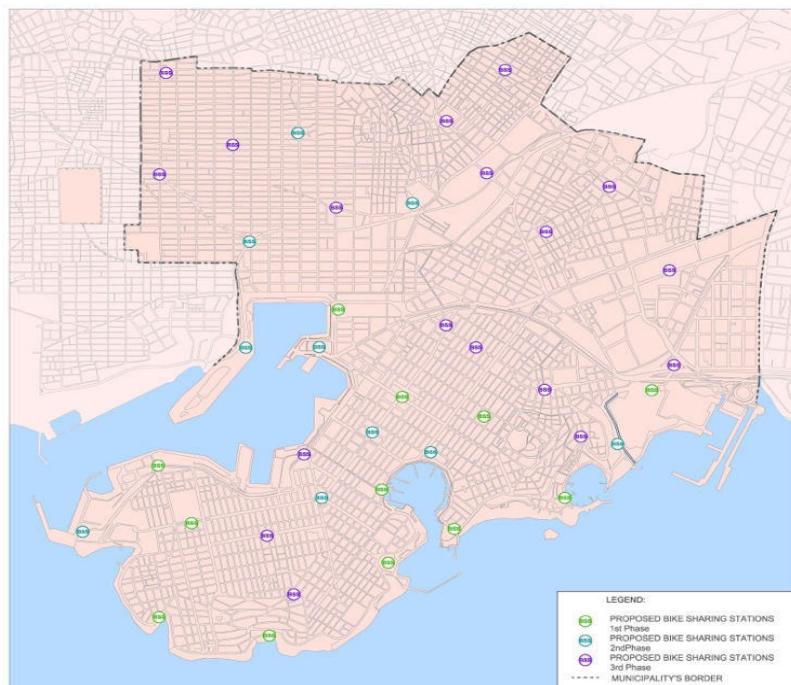


Source: own elaboration

**Figure 4b: Position of the first 22 stations (Phase 1 + Phase 2)**

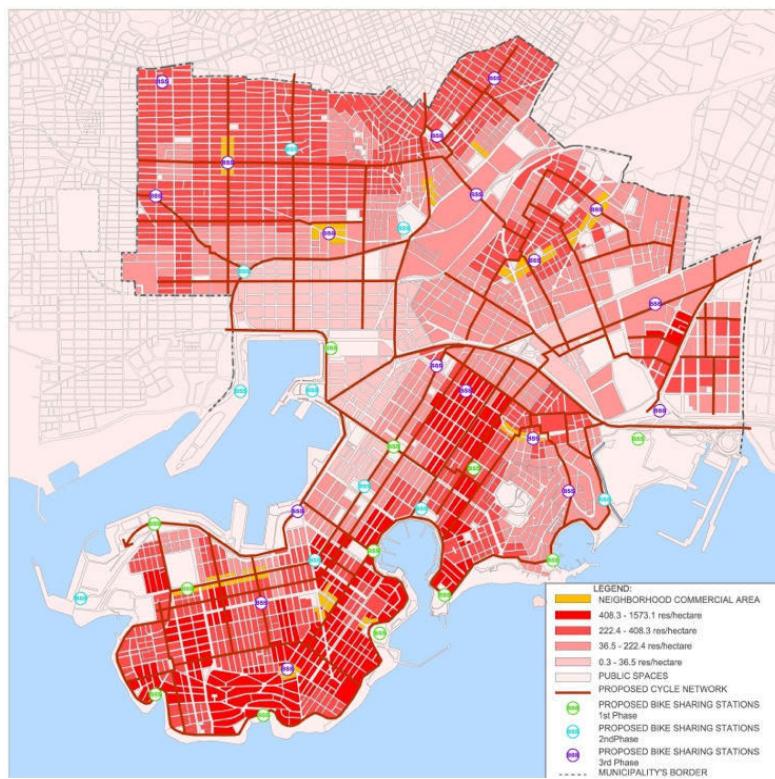
Source: own elaboration

The *third phase* attempts to cover areas, which designate high population density, in order for the inhabitants to gain better access to rail and neighborhoods centers. Furthermore, in order to enhance the trips at the neighborhood scale, areas with commercial activities of a smaller scale than the one in the center of Piraeus were selected to be served. Finally, additional stations were selected, to be established in the central regions and close to powerful poles, as demand is expected to be high. Eighteen stations with 20 bikes in each were proposed. The proposed stations will be installed in the locations shown in Figure 5a and Figure 5b.

**Figure 5a: position of the first 40 stations (Phase 1 + Phase 2 + Phase 3)**

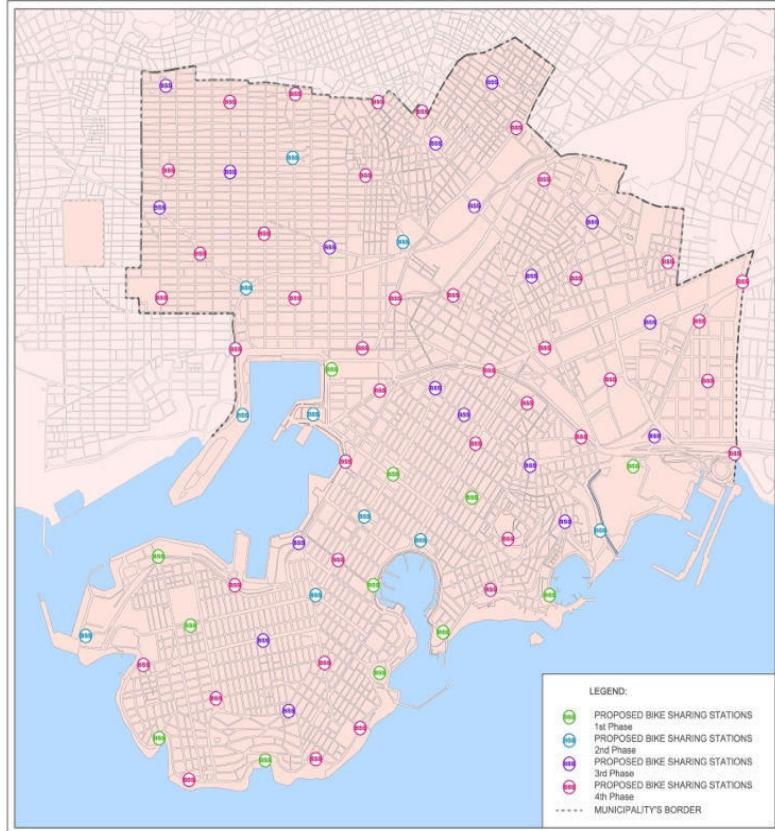
Source: own elaboration

**Figure 5b: Bike sharing stations – 1st, 2nd and 3rd phase, proposed cycling network and population density in the Municipality**



Source: own elaboration

**Figure 6a: Locations of the stations – area of the municipality covered**



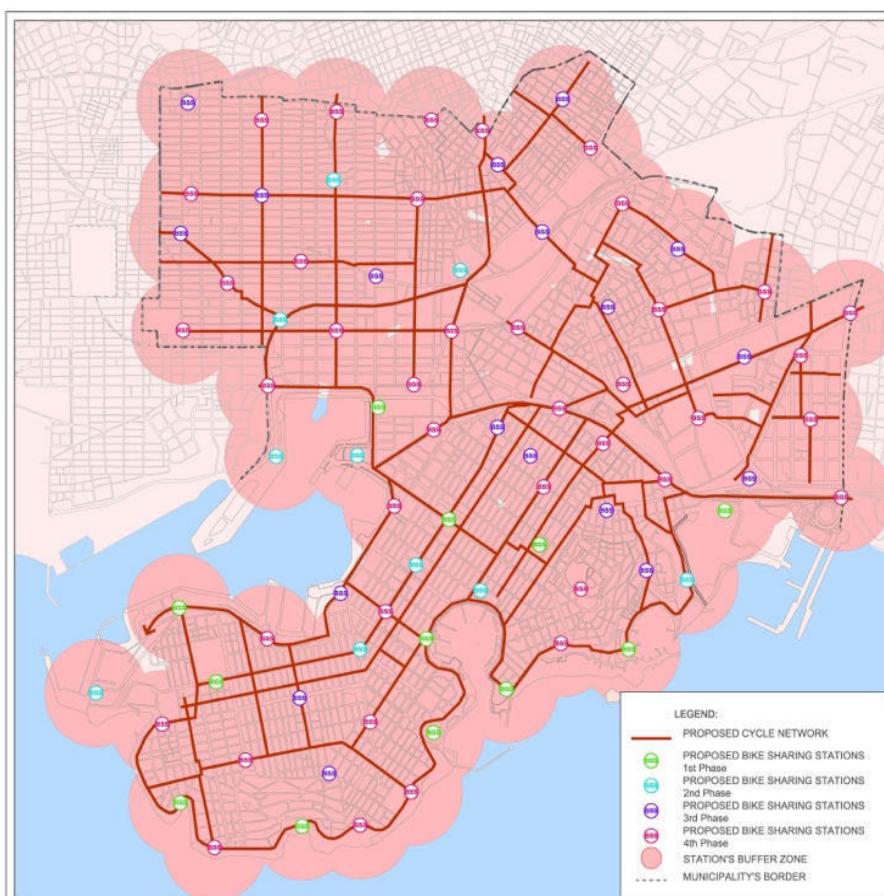
Source: own elaboration

The distances between stations are reduced, so bicycle use can be facilitated by people who are not familiar with it. All stations are located near the proposed bicycle network, and they are selected to be placed in public places (eg squares, parks).

In the *fourth phase*, the stations were selected in a way that the maximum distance between two stations to be 250m (the buffer zone of 250m from each station was selected as it is easy to travel the distance by bike). Therefore, buffer zones, influence zones of 250m around the stations of the previous phases, were created. Those areas not covered by these zones are the locations of 40 new stations of the fourth stage.

The criteria for the establishment of the new stations were: a) the location of the new stations, which have to be near proposed bicycle network; b) the selected locations for the stations should be in proximity to land uses, such as schools, sports facilities and shops; and nearby roads served by public transport (buses) (among the whole network of stations, only three stations are not in direct contact with the proposed bicycle network, but in a range of 250m.); and c) the central area of Piraeus (shopping center, and trade and recreation center) will be enriched with extra stations for shared bicycles, as in this area the demand is expected to be more intense. Forty more stations were proposed (Figure 6a and 6b).

**Figure 6b: Bike sharing stations in the Municipality of Piraeus (1st, 2nd, 3rd, and 4th Phases)**



Source: own elaboration

The final outcome is shown in the map of Figure 6b. The Municipality will have constructed 80 bike sharing rental stations, with 1600 shared bicycles. This image is a proposal for the distant future, in another society, where the bike is fully incorporated into the daily life of residents and visitors of the area.

## 5. Conclusions

Following experiences gained in other European cities, Piraeus BSS is expected to act as a complement to public transport, especially in the light of the new metro and tram lines. It will replace short journeys that are currently made by car. This is expected to improve travel conditions (both for pedestrians and motorized transport) in the central areas but also near the public transport stations. Furthermore, the problem of parking in the center of Piraeus, which today is one of the most important problems throughout the Municipality, will be dealt with.

Although it requires a great deal of funding, the implementation of a bicycle sharing system, will bring immediate benefits not only to the company that will operate it, but also to the Municipality, provided that its implementation is properly done. The city will be more attractive and easy to visit. Thus the visitors, who are now crossing Piraeus and heading to Athens, will remain to the city.

The implementation of the BSS will take place gradually in order to initially attract the visitors of the city and then the residents of Piraeus, so as to use it for their daily journeys. Initially the system is expected to serve city visitors in order to reach the major poles of attractions in this city. In this phase, residents are expected to understand the operation and usefulness of the system. Over time, they will integrate it into their everyday lives, replacing motorized vehicles.

A very important component for the success of the public bicycle system is the maintenance of the infrastructure in order for the system to be reliable. The municipality should pay attention in order to prevent vandalism and also to repair immediately possible damages. In addition to the bicycle infrastructure, bicycle applications should be developed to inform the public for the location of the stations, the number of bicycles available and the cost of using them. Moreover, applications and / or maps can be developed to present the city, attractions and possible "activities to do" so that the visitor can easily explore the city. Different routes within the city can be proposed (routes of archaeological interest or recreation). The difficulties or interest of each route should be stated, as well as alternatives to tackle those difficulties should be mentioned. Concerning the success of the system, there must be continued political support in order to persuade residents to use it. The deployment of such systems should be accompanied by citizen awareness campaigns and motivation for the use of bicycles.

It should be highlighted that in many cities, in Greece and abroad, Municipal Authorities decided to deploy BSSs without implementing other measures or infrastructures for the bike. The deployment of such systems contributes to the modern image of a city. It also helps municipalities to establish links with the younger generation, which is familiar with the use of the internet. Through the internet, availability of bikes in every station can be searched; and potential users can communicate with each other and get informed about interesting sites and preferred routes.

This system is a challenge and a dilemma for Piraeus, since no other measures regarding bicycles are implemented. Piraeus aspires to follow the example of the 1,286 cities worldwide, which have already installed more than 3,420,000 public bicycles. This attempt is undertaken in order for the municipality to strengthen its economy related to cycling tourism, so as to compete with the other southern European cities (Spanish, Italian and French), where the largest number of BSS is deployed (132 cities in Spain, 104 in Italy etc.). The deployment of a bike sharing system can bring direct kind of profits in the city of Piraeus, as it can improve its image, strengthen economic activities, raise the number of visitors', as well as reduce pollution, noise and energy consumption levels. The benefits to the city's social environment are also not negligible: health, safety, socialization, liveliness of public spaces.

All these show that Piraeus' public electronic bicycles are not a luxury but a high-performance investment, which is even more efficient when accompanied by cycle paths, low traffic streets and enhanced public transport.

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