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DOCKLESS BIKE-SHARING SYSTEMS IN FUTURE SUSTAINABLE CITIES – CASE STUDY: BUDAPEST
Dockless Bike-sharing Systems in Future Sustainable Cities – Case Study: Budapest

Abstract

The aim of this research is to identify the hidden possibilities and advantages of dockless bike-sharing systems and multi-operator models. Based on international practices and market liberalization examples in the transport sector, this paper proposes a general policy framework for multi-operator models.

As dockless bike-sharing operators conquered the world, oversupply, vandalism, parking problems occurred in various cities because of low market entry barriers and lack of agreements between cities and bike-sharing operators. After cities realized that they had to take actions to avoid these problems, they started to set up recommendations to regulate the services of private providers. The negative reputation of dockless systems contributed to the degradation of their image and of the applied solution too. However, since proper regulations were implemented and cities and operators started to work together, more and more good examples have shown up worldwide.

This paper aims to provide a clear picture about dockless bike-sharing, therefore, it includes an overview about the technology and about the tools which can help cities maximize the benefits of dockless systems.

To complement the desk research and to apply the findings and results of the research, the bike-sharing services of Budapest are examined. Additionally, there are some recommendations for future development to improve the city’s bike-sharing services, preferably with dockless technology.

Keywords: Sustainable urban mobility, Bike-sharing systems, Dockless, Regulations

1. Introduction

1.1 Problem description

Realizing the negative environmental and socio-economic effects of mass motorization, rapid urbanization and sedentary lifestyle, various international organizations suggested and requested the implementation of policies which foster developments for active mobility. Encouraging people to walk, cycle and use public transport more has become a widely applied solution in various cities worldwide.

Bike-sharing plays a great role in promoting urban cycling and sustainable mobility. It provides the possibility to use a bicycle whenever it is the most convenient way to get from A to B. As it has a wide range of benefits, bike-sharing has become popular all around the world and many cities have developed their own systems. In the early 2000s only a few bike-sharing schemes operated, while by June 2018 the number of cities with bike-sharing was over 1500. Originally, most of these schemes were station-based; allowing people to pick up and drop off the bikes at automated stations throughout the city.
In recent years, dockless bikes and private operators hit the Chinese and later the worldwide markets. Bike-sharing does not require stations anymore, smart phone operated dockless bicycles can be left wherever the users want to leave them within the service area. These systems provide great flexibility for users and operators alike. It is estimated that by June 2018 there were approx. 23 million dockless shared bicycles in more than 250 cities worldwide.

However, dockless bicycles brought new challenges too as the business and operating model of dockless bike-sharing differs from earlier common practices. Various examples show that these systems should be treated and regulated in a partly different way to avoid the possible drawbacks of the technology and the consequences of unregulated market competition and improper user behaviour.

1.2 Methodology and limitations

This paper summarizes my master thesis that I wrote at the Technical University of Valencia (Universitat Politècnica de València). Further details and explanations can be found in the thesis.
To collect information about bike-sharing systems and the spread of dockless bikes, I carried out a comprehensive literature review including scientific researches and articles, planning guidelines and manuals as well as non-scientific articles and journals. To complement the desk research, I carried out stakeholder interviews to get to know the opinions of professionals on dockless bike-sharing. I interviewed representatives of bike-sharing operators, NGOs and planners. Additionally, I did fieldwork to examine the bike-sharing services and cycling infrastructure of Budapest.

As the dockless bike-sharing boom is a recent phenomenon, limited data sources and published researches are available. Consequently, it was difficult to carry out quantitative analysis about dockless bike-sharing services. However, the media and daily news have been focused on the spread and performance of dockless bike-sharing systems since the beginnings. Moreover, the debate on dockless bike-sharing systems is broadening among professionals and decision makers as well.

2. Literature review and related work

Scientific articles about dockless bike-sharing systems are hardly available. However, various journal articles, professional statements and other informal, non-scientific documents can be found on the topic. Several organizations published planning manuals and guidelines for cities about dockless bike-sharing recently.

Most of the scientific papers focus on station-based technology. However, a recent study summarizes the business model innovation of bike-sharing services. (Waes, et al., 2018)

The most common topics which are discussed are the benefits of cycling and bike-sharing systems, rebalancing problems, user satisfaction aspects and planning guides. Some articles provide a general overview about bike-sharing related literature and systems’ performance. A review encompasses studies published between 2013 and 2015, and another one the most important papers published before 2013. (Fishman, 2015) (Fishman, et al., 2013)

- **Benefits of cycling and bike-sharing systems**

  It is widely accepted that regular cycling and bike-sharing, as active mobility modes, have great positive effects on personal well-being, health and productivity, while cycling network development and higher modal share of cycling reduce the transport sector’s negative environmental impacts and contribute to economic development. (I. Otero, 2018) (Zhang, et al., 2018) Moreover, bike-sharing popularizes cycling, improves its reputation and encourages cycling as it breaks the subcultural image of cycling. (Goodman, et al., 2014)

  Bike-sharing systems can make a change towards more sustainable urban mobility and influence travel patterns by providing easy access for cycling and fostering multimodal trips. It could function as a first and last-mile connector and could increase public transport use. (Martin, et al., 2014) (Pucher, et al., 2009) (Mátrai, et al., 2016)

- **Rebalancing problem**

  Dockless shared bicycles with real-time GPS tracking provide the possibility of smart management and rebalancing. The optimization problem of rebalancing bikes in the case of station-based bike-sharing schemes has a broad literature. The main objectives of the re-
balancing are minimizing unsatisfied user demand and minimizing the total distance, time and effort of rebalancing. (Alvarez-Valdes, et al., 2016) Free-floating bike-sharing takes a further step and increases the scale of the rebalancing problem. (Pal, et al., 2015) Incentivizing user-based redistribution and influencing travel patterns by offering discounts for those who contribute to rebalancing the bike-sharing system is becoming a common practice in the case of dockless systems.

- **Planning guides and manuals**
  There are several planning guides and manuals available, which give an insight to understand the principles and key determinants of successful bike-sharing systems and user satisfaction. (OBIS, 2011) (ITDP, 2013) (ITDP, 2018a) Although most of them focus on station-based systems, the main principles are valid for dockless systems too. Various feasibility studies are available online as well.

- **Emerging topics in bike-sharing**
  The emerging trends that shape the future of bike-sharing services include the spread of electric pedal-assisted bicycles; social benefits and social equity; developing data analysis methods and their gaining importance in the bike-sharing sector; integration with public transport services and with other mobility options like the concept of MaaS; and expanding privately funded dockless technology and new business models. (Munkácsy, 2017) (Dave Milne, 2018) (Glász, et al., 2017) (Pettit, 2016)

### 3. Bike-sharing systems – overview

Bike-sharing services vary considerably, including the utilized technology and the applied solutions. In general, bike-sharing programs offer bikes which can be picked up and dropped off at different locations throughout the service area. In urban areas, it is mostly a self-service mobility option which is used for one-way trips. (Mátrai, et al., 2016)

#### 3.1 Evolution of bike-sharing systems

Researchers identify four generations of bike-sharing systems: (Munkácsy, 2017) (Mátrai, et al., 2016)

1. **1st generation free-bike systems** (1965, White Bikes, Amsterdam)
2. **2nd generation coin-deposit systems** (1995, Bycyklen, Copenhagen)
3. **3rd generation information technology based systems** (1998, Vélos à la Carte, Rennes)
4. **4th generation demand responsive multimodal systems** (2009, BIXI, Montreal)

Although the characteristics of fourth generation systems are not exactly defined, some articles state that dockless bike-sharing systems potentially fit into this generation. (Fishman, 2015) At the same time, others argue that dockless bikes represent a new generation as they rely on new technologies. (Brink, 2017) (Assunçao-Denis, 2017) In the era of big data, bike-sharing is becoming data-driven. New dockless bike-sharing operators brought not only a new technology but a new business model as their services lay on private funding. These systems have unique characteristics which may define a new, fifth generation of bike-sharing systems. The table below summarizes the characteristics of the two generations.
Table 1: The main characteristics of fourth generation and potential fifth generation of bike-sharing

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>• E.g.: MOL Bubi – Budapest, Hungary</td>
<td>• E.g.: Mobike, Urbo, LimeBike etc. in various cities</td>
</tr>
<tr>
<td>• Custom bikes with special, durable components</td>
<td>• Dockless bicycles without dedicated stations (there are some exceptions)</td>
</tr>
<tr>
<td>• Properly located stations which enhance intermodal trips</td>
<td>• Privately funded start-ups and companies</td>
</tr>
<tr>
<td>• Optimized distribution</td>
<td>• Access with smartphone (all functions covered by an application)</td>
</tr>
<tr>
<td>• Access with mobile technology and kiosks</td>
<td>• Multi-operator model</td>
</tr>
<tr>
<td>• Access to real time information (e.g. bike availability)</td>
<td>• May include pedal-assisted bicycles</td>
</tr>
<tr>
<td>• May include pedal assisted bicycles</td>
<td>• Deposit and usage fee (pay per use)</td>
</tr>
<tr>
<td>• Large scale integration</td>
<td></td>
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<tr>
<td>• Registration and usage fee (most cases the first 30 minutes are included in the subscription)</td>
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</tbody>
</table>

Although Chinese companies induced the rapid expansion of dockless technology which has conquered the world markets and later other actors joined in, it is worth to mention that dockless bikes had existed in other forms before. For example, Call a Bike, a dockless bike-sharing system operated by Deutsche Bahn, a German railway company, was put into operation in 2000.

3.2 System types and business models

Considering the purpose of this research, there are two main aspects of system design which should be discussed here, station design and deployment type. As market and technology develop quickly, I focused on identifying only the main types of systems. However, there could be some existing solutions which are not covered by the proposed classification. (Based on (Carplus Bikeplus, 2018a) and (On Bike Share, 2018).)

3.2.1 Station design

Pragmatically, there are two main design methods: docked (or station-based) and dockless. However, there are schemes which have hubs with operating staff who give and take back the bikes from users (e.g. at railway stations). Moreover, there are bike share lockers and even peer-to-peer bike-sharing exists.

• **Station-based or docked** (also known as fixed):

  There are (usually on-street) docking stations to secure the bikes at specific locations. The stations are placed around key locations and in most cases they come with a terminal which makes registration and hiring possible. The bikes are attached to the stations with a special mechanism (slot) which can work through several different mechanisms (see the figures below).

• **Dockless** (also known as station-less or flexible):

  In the case of dockless technology bikes operate without heavy docking stations. A locking mechanism (smart lock) is attached to the bike, generally it locks and blocks the rear wheel. In general, the lock can be controlled with a smartphone application but it can work other ways as well (e.g. the users are required to call the operator to get the code of the lock). In the case of large-scale systems smart, GPS-tracked bikes are used.
There are two main types of dockless bike-sharing systems:

- **Dockless** (also known as station-less)
  Within the geo-fenced service area, the users can leave the bikes wherever they want to leave them - ideally following the local regulations.

- **Semi-dockless** (also known as hub-centric or lock-to)
  It is a kind of hybrid system of dockless and station-based. Within the service area there are geo-fenced virtual stations (even marked parking areas) where the bikes should be parked. The stations could be designated only for dockless bikes or can be shared with other bikes too. In some cases, these stations are marked with painting and signs. Regular bike stands could be used as well. In that case the bikes are equipped with bike locks and the users should lock the bikes to the stand (lock-to technology, e.g. Donkey Republic). The semi-dockless model is expanding because it could eliminate the parking problems related to recently emerging dockless bikes.

![Fig. 2: Examples for docking mechanisms and for smart lock of dockless bicycles (right)](image)

![Fig. 3: From the left: docking station in Budapest, dockless bicycles left next to a bus stop and semi-dockless bicycles in a marked parking zone (Source: Michal Naka - Twitter)](image)

### 3.2.2 Deployment types

The following deployment types exist:

- **Point to point (A to B trips)**
  Point to point systems allow users to pick up the bikes from a station and leave them at another one (or at the same). This type is the most frequently used one in cities. This solution provides flexibility to users to make one-way trips by bike-sharing.

- **Ride and return (A to A round trips)**
  Ride and return systems require the users to return the bikes to the same station where they picked them up. This deployment is common where most of the trips are round trips, in most cases used for touristic purposes.
• Free-floating (A to B without specific stations)

In the case of free-floating systems, the bikes can be left anywhere within a specified area (respecting the local regulations and specific conditions for parking). It provides users with great flexibility to lock the bikes as close as possible to their destination.

### 3.2.3 Possible combinations of station design and deployment

**Table 2: Operation models**

<table>
<thead>
<tr>
<th>Deployment \ Station design</th>
<th>Station-based</th>
<th>Semi-dockless</th>
<th>Dockless</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point to point</td>
<td>The operating model of most station-based, 4th generation bike-sharing systems. The bikes are parked orderly at the docking stations.</td>
<td>More and more common model to avoid parking problems of dockless bikes. A cheaper and easier to implement alternative for station-based systems.</td>
<td>-</td>
</tr>
<tr>
<td>Ride and return</td>
<td>In most cases the stations are placed around public transport stops, touristic sights, hotels or university campuses.</td>
<td>Same as the station-based version of ride and return, but it does not require heavy, expensive docking infrastructure.</td>
<td>-</td>
</tr>
<tr>
<td>Free-floating</td>
<td>-</td>
<td>Penalized behavior or charged service as the bikes should be parked at the marked zones.</td>
<td>Most dockless bike-sharing systems follow this operating model.</td>
</tr>
</tbody>
</table>

Besides these models there could be other combinations, one of them is called hybrid system which is a combination of a point to point docked or semi-dockless system and a free-floating dockless system. Hybrid systems have dedicated stations (they can be docking stations or semi-dockless hubs) and the bikes can be left out of the stations as well, either for a special fare or included in the general membership fee (e.g. SocialBicycles).

**Note on terminology**

Although in the classification dockless and semi-dockless bikes are separated into two subcategories, for the sake of simplicity I call both dockless in this paper, unless it is necessary to distinguish them.

### 3.2.4 Financial and business models

Over the past few years, as shared economy and shared mobility have emerged, new business models have appeared. There are several business models to implement and operate public bike-sharing regarding public and private involvement and ownership.

Station-based systems in most cases are operated in a kind of public-private partnership. Cities have official agreements with the operators and providers and the systems are tendered by the cities. The revenues are based on subscription fees and user charges, advertisements or sponsorship, and the revenues are complemented by public subsidies.
The business model of dockless bike-sharing systems differs from previous practices. Private companies own, plan, fund, implement and operate the systems and the profit is based on pay per use fares and deposits. Usage data and its further applications might play a great role as well.

Most of the dockless bike-sharing operators are newcomers in the bike-sharing sector or even in the mobility sector. These new actors mostly have IT backgrounds. Even though some of these companies offer ride-hailing or on-demand mobility services, the great majority of them have experiences in e-commerce, social media, mobile or on-line payments. Dockless bike-sharing providers are often backed by venture capital investors which make them independent from public subsidies to implement and operate their systems. (Waes, et al., 2018) (Hillhouse Capital, 2018)

4. Dockless bike-sharing systems

As dockless bike-sharing systems do not need heavy infrastructure, it provides a “loophool” to operate the bikes without taking responsibility for them. There are several arguments against dockless technology, which frequently pop up in the media or at professional forums, especially since the technology has become applied worldwide. Some arguments are only valid about rapidly spreading venture capitalist companies, such as the ones that are based on the several problems caused by low entry barriers like lack of regulations and formal agreements between operators and cities. The most frequent arguments are as follows:

- Haphazardly parked dockless bicycles flood cities, occupy street space and pavements
- Dockless bicycles are often stolen and vandalized
- Insufficient maintenance or rebalancing
- The long-term sustainability of the new private actors is not clear and certain
- The rapid expansion of dockless technology is not the future of bike-sharing, it is only about data collection
- Negative effects on local economy (bike rentals, repair shops and manufacturers)

4.1 Analysis of dockless bike-sharing technology

A simplified SWOT analysis was carried out to identify the characteristics of dockless bike-sharing systems in a systematic way. The analysis covers the most important aspects such as user experience, funding, planning, implementation and operation.

Since the analysis focuses on the technology and on the operating model themselves rather than on actual providers and their services, the assessment was carried out from a theoretical point of view. However, there are some exceptions. In some cases, the analysis reflects on recent events and existing market actors to make the analysis up to date and more realistic.

As a result of limited data sources and published researches, there are some aspects which are only partly or not mentioned in this analysis. To have a more comprehensive picture, further research and quantitative analysis are needed to examine system performance and the discussed topics. Besides that, the research should be extended concerning other aspects as follows:
• Financial and economic long-term sustainability (in the case of new startups and market actors)
• The effects of rapidly expanding dockless bike-sharing on local economy and bicycle industry
• Effects on public interest and dockless bicycles as a reliable public service

The following table summarizes the key findings of the SWOT analysis.

Table 3: SWOT analysis of dockless bike-sharing

<table>
<thead>
<tr>
<th>Strengths:</th>
<th>Weaknesses:</th>
</tr>
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<tbody>
<tr>
<td>• Lower capital and implementation costs</td>
<td>• Parking problems</td>
</tr>
<tr>
<td>• Less time-consuming planning and implementation procedure</td>
<td>• Dockless bikes are more exposed to vandalism</td>
</tr>
<tr>
<td>• No or less need for public funding</td>
<td>• Limitations of electric-assist mode</td>
</tr>
<tr>
<td>• Geo-fencing provides great flexibility</td>
<td>• Limited access</td>
</tr>
<tr>
<td>• All functions are available within an application</td>
<td>• Docking stations have their advantages</td>
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<table>
<thead>
<tr>
<th>Opportunities:</th>
<th>Threats:</th>
</tr>
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<tbody>
<tr>
<td>• Private companies with strong financial background and enormous fleets</td>
<td>• Low market entry barriers and rat race among providers</td>
</tr>
<tr>
<td>• Globalization, digitalization and their effects on mobility habits and services</td>
<td>• Data security and privacy</td>
</tr>
<tr>
<td>• Market competition</td>
<td>• Economics “Free Rider” problem</td>
</tr>
<tr>
<td></td>
<td>• Bike-sharing as a public service</td>
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</table>

**Strengths:**

• **Lower capital and implementation costs**

Capital and implementation costs are lower than in the case of station-based systems as docking stations are not required. It is estimated that the costs related to docking stations could reach 70% of the capital costs. Stations of semi-dockless systems are less costly as well.

Operation costs might be lower as the costs of station maintenance could be reduced and incentivized user-generated rebalancing is more common. (ITDP, 2018a) (OBIS, 2011)

• **Less time-consuming planning and implementation procedure**

Less time-consuming legal approval procedure compared to station-based systems as there is no need for docking station infrastructure which requires a longer planning and authorization procedure. Implementation could be carried out in a shorter time frame as well as the construction of stations, if necessary, is less complex.

• **No or less need for public funding (private companies with private funding)**

In most cases the implementation and operating costs of bike-sharing systems have been covered by public subsidize. Private dockless bike-sharing providers cover both capital and operating costs. Market liberalization and competition could reduce both operation and implementation costs as well as usage fees. Thus, the need for public subsidize could be reduced or could be even unnecessary. Private financing would make bike-sharing system expansion possible in cities where otherwise it would not be an option.
• **Geo-fencing provides great flexibility**

Dockless technology and geo-fencing provide great flexibility for users, operators, cities and for future development as well:

- Users can leave the bicycles directly at or close to their destinations where it is the most convenient for them (considering physical limitations of available space for bikes and reallocation).
- Operators can easily adjust their services to the actual user needs as the geo-fenced service area or the virtual stations can be easily modified. In the case of physically marked semi-dockless systems it is easier and legally less complicated to relocate “light” stations compared to the relocation of docking stations and kiosks.
- Geo-fencing provides the possibility for cities and public authorities to have control on the use of public spaces and public bikes. Cities can monitor the location of the bicycles and enforce local regulations.
- Geo-fencing makes future development and expansion more flexible as well as the service area could be enlarged easily.

Besides that, GPS-tracking provides accurate, detailed and robust travel data for further data analysis to improve and optimize mobility and bike-sharing services. The potential uses of travel data analysis are endless as data mining and big data analytics are evolving rapidly.

• **All functions are available within an application (hiring, payment etc.)**

An app covers all the necessary functions from registration through hiring to on-line payment methods or customer services. This makes the use of the system easy and attractive. The integration of different bike-sharing and other mobility services could be carried out easier too. However, integration and one-way access have drawbacks as well (see Weaknesses / Limited access).

*Weaknesses:*

• **Parking problems**

Since the bicycles are not necessarily locked to fixed objects and users can leave the bicycles wherever they want to within the service area, some of them might not respect the relevant regulations (if there is any). Although semi-dockless systems have marked, designated parking areas, non-compliant behaviour can cause problems in this case as well. As a solution there are some semi-dockless systems which require the users to lock the bikes to bike stands, but it limits system flexibility.

• **Dockless bikes are more exposed to vandalism**

As the bicycles are not attached to a fix object they can be moved and be stolen easier. While all bike-sharing systems face theft and vandalism, the easier access to dockless bikes could make it worse. More attention and new solutions should be adapted to prevent theft and vandalism.

• **Limitations of electric-assist mode**

Electric-assist bike share has the potential to provide more accessible and convenient services. Charging or changing the batteries of dockless bicycles is a more complicated and resource-intensive task than in the case of docked ones that can be easily wired and connected to the electrical grid. Despite this limitation, there are some initiatives to operate
dockless e-bikes (such as Jump Bikes or LimeBike). These companies have their own service teams who take care of the batteries. There is another noteworthy solution for e-bikes which is called BYOB or Bring Your Own Battery. This solution requires users to bring their own battery which they can use during their journeys. The bikes without batteries function as regular, pedal powered bikes and with batteries the electric assist mode can be used (JCDecaux or CycleHop).

- **Limited access**

In the case of recently emerged dockless bike-sharing systems, using a smartphone application is the only way to access the services. Although smartphone applications and integration provide plenty of possibilities and easy access for a great majority of users, this approach has also certain drawbacks. Those who do not use smartphones cannot access the services as it is the only way to hire a bike. Discharged phone or missing internet connection could be also a problem.

- **Docking stations have their advantages**

Station-based systems offer several important advantages and not all of them are valid for dockless bike-sharing systems. Docking stations and the mass of bicycles make the system visible and attract user interest, especially if all the shared bikes have the same design. Fixed stations also offer reliable services as users can find the bicycles always at the same spot. They do not have to search for a bike in an application (in the case of sufficient rebalancing) and the locations of fixed stations easily fit into the daily travel routines. (OBIS, 2011)

**Opportunities:**

- **Private companies with strong financial background and enormous fleets**

Many investors see great opportunities in the growing market of dockless bike-sharing services. There are several market actors who provide reliable, large-scale services. These market conditions provide good opportunities to expand shared bicycles, especially where financial issues obstruct development.

- **Globalization, digitalization and their effects on mobility habits and services**

As the number of smartphone users is significantly growing, smart bike accessibility is increasing as well. Smartphone application based on-demand mobility services are emerging worldwide. These new solutions have great effects on people’s mobility habits. New technologies could also develop the existing dockless schemes, broaden their expansion and eliminate their weaknesses. (Hillhouse Capital, 2018) (Dalos, 2017)

- **Market competition**

In the past, in most cities there was only one system available which was funded and subsidized by public money. Recently, as private start-ups have developed, new market actors and business models hit the market. Market competition (with proper regulations) has positive effects. Companies that want to survive the fierce business competition, may adopt new technologies and reduce prices, conduct education and training programs. There is a negative side of market competition as well as it is shown in the table below. However, in this analysis market competition is regarded as an opportunity because properly regulated market competition could offer new possibilities for innovation and scheme expansion. Services (EC, 2012) (Stucke, 2013) (ITDP, 2018b)
Table 4: Highlighted potential positive and negative effects of market competition in the bike-sharing sector

<table>
<thead>
<tr>
<th>Positive effects</th>
<th>Negative effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Lower fares and costs</td>
<td>• Unfair methods of competition</td>
</tr>
<tr>
<td>• Better service quality</td>
<td>• Ignoring social inclusion and equity</td>
</tr>
<tr>
<td>• More choices and variety</td>
<td>• Ignoring regulations, more likely violate the law</td>
</tr>
<tr>
<td>• More flexibility for operators and users</td>
<td>• Oversupply</td>
</tr>
<tr>
<td>• More innovation</td>
<td>• Less emphasis on safety and user protection</td>
</tr>
</tbody>
</table>

**Threats:**

- **Low market entry barriers and rat race among providers**
  Lack of agreements between cities and bike-sharing providers, insufficient preparatory works and unregulated market competition could cause and has caused various problems. In the same respect, rat race among dockless bike-sharing providers and low entry barriers caused parking problems, public space occupation and oversupply in various cities. The biggest Chinese market actors flooded cities with their smart bikes without public licenses or official agreements. The rat race was mainly about catching as many users as possible by reducing the prices to destroy competitors. This led to chaos, lack of maintenance, rebalancing and bankrupt start-ups. (UITP, 2017)

- **Data security and privacy**
  The financial background and long-term sustainability of dockless bike-sharing start-ups is not always clear. Some experts argue that the main driver of the rapid expansion is travel data which might threaten data security and privacy. Data collection is criticized by several articles as the main investors could benefit most of the collected data.

- **Economics’ “Free Rider” problem**
  Private bike-sharing operators use public spaces and generate profit, even though in most cases they do not pay for public resources. Socializing private costs should be avoided, and a sustainable and equitable use of public resources and public spaces should be fostered - by considering the social benefits of the system. (ECF, 2017a)

- **Bike-sharing as a public service**
  Although long-term reliability of bike-sharing services should be ensured, some operators left the market after several month of operation. In the case of unregulated market actors lack of rebalancing and maintenance was also a problem in several cities. Private bike-sharing providers interest in profitability might be in contrast with public and local needs. However, it is recommended that bike-sharing services should be treated as a reliable public service and the services should be prioritized by the needs of the cities, rather than by profitability.

**4.2 Regulations for dockless bike-sharing**
Taking responsibility and regulating dockless bike-sharing is becoming an increasingly hot topic in a lot of cities worldwide. Media and citizens claim for the avoidance of nuisance and vandalism caused by unregulated dockless bikes, therefore legal actors started to work on the topic. By April 2018 more than 30 cities worldwide have drafted or adapted regulations for dockless bike-sharing. (ITDP, 2018b)
Chapter No. 4.2.1 and 4.2.2 briefly summarizes the actions taken by cities and the recommendations of organizations on the topic of dockless bike-sharing. Based on the introduced examples, chapter No. 4.2.3 proposes a general regulatory framework for dockless bike-sharing and for a multi-operator model.

4.2.1 City action examples

Similar problems occur worldwide but cities react in different ways. There are examples for do nothing approach and strict regulations as well. Some cities even banned dockless bike-sharing operators. However, after a while, as valuable experiences have been gained, it seems that more and more cities decide to act progressively and cooperate with the operators and regulate the market.

Cities’ approaches can be divided to the following categories:

- There are Chinese cities like Shanghai and Beijing which banned additional dockless bikes to avoid massive oversupply that had previously occurred.
- There are cities where dockless bikes operate and a wait-and-see approach is followed, which means that these cities have not established any formalized regulations, agreements or have not done any other comprehensive actions supporting or against dockless bike-sharing operators. E.g.: Budapest
- There are cities where dockless bike-sharing is temporarily banned until proper legal regulatory environment and a pilot period will be established. E.g.: Amsterdam
- There are cities which allow dockless bike-sharing services while started to establish regulations with a comprehensive approach covering all modes of shared mobility. E.g.: Barcelona
- There are cities which are open for dockless bike-sharing providers and have initiated a pilot program to examine whether dockless bike-sharing is suitable option and what kind of regulations and additional interventions would be needed for successful operations. E.g.: Auckland, Los Angeles, Milan, New York, Seattle
- There are cities which already implemented a kind of regulatory framework or requirements for dockless bike-sharing services or already concluded agreements with the operators (the covered and regulated topics are similar in most cases, but the details vary widely). E.g.: Various Chinese cities, Dublin, London, Manchester, Sydney.

4.2.2 Recommendations by professionals

As the professional discourse on dockless bike-sharing emerged, various organizations started to focus on the technology and on its policy aspects. Some key actors presented common position papers to urge cities to develop frameworks which ensure that dockless systems contribute to a successful urban mobility strategy. Others presented detailed guidelines about the optimization of dockless bike-sharing systems. To provide an overview, the most comprehensive documents are as follows:

- The Institute for Transportation and Development Policy published a recommendation and a periodic evaluation framework for cities about how to regulate and optimize dockless bike-sharing systems. (ITDP, 2018c)
- Bikeplus created an accreditation scheme providing a set of standards for bike-sharing operators. (Carplus Bikeplus, 2018b)
The European Cyclists' Federation launched Platform for European Bicycle Sharing & Systems (PEBBS) with the involvement of service providers, cities and other relevant stakeholders. In order to help cities, PEBBS created two supporting strategic policy documents in collaboration with other professional institutions and organizations. (ECF, 2017a) (ECF, 2017b)

Two North American organizations, the North American Bikeshare Association and Alta Planning + Design also published their recommendations. (NABSA, 2018) (Alta, 2017)

### 4.2.3 Findings on regulations - Multi-operator model for bike-sharing

The new business model brought by the dockless bike-sharing boom changes the way of how bike-sharing systems operate in cities. The formerly common single-operator model is changing and the number of cities with more than one provider is increasing.

Bike-sharing systems of cities can be completely private or the combination of public and private. Cities could also combine station-based and dockless technology. Even two or more operators could provide dockless bike-sharing services in the same city. In some cases, operators might share the same service area, in other cases different service areas could be defined for each operator.

As it was discussed, a multi-operator model enhances competition which might have both positive and negative effects. Cities should ensure that private companies provide reliable bike-sharing services which serve the needs of users and the desires of cities. Proper regulations should be adapted for fair and beneficial competition. Collaborations between operators and cities ensure reliable services for users and create a predictable operating environment for businesses at the same time. (ITDP, 2018a) (ECF, 2017a)

Some general recommendations for cities are as follows:

- It is important to mention that the multi-operator model for bike-sharing systems is not a solution which fits to every city. Cities should examine, whether multi-operator model is a good option for them and they should tailor it to the local conditions and desires in all cases.

- Bike-sharing should fit into the vision of future mobility system and urban structure. Cities should treat bike-sharing as a public service and as an integrated, reliable part of the city’s mobility system. Even if the bike-sharing system is privately-funded, economic interests and profitability cannot be allowed to take precedence over public interest.

- Cities and providers should work together from the beginnings for successful operation. Moreover, citizen involvement should be also an integral part of the preparatory work and during the operation as well. Monitoring of user feedback should be enhanced, and the services must meet user needs.

- The launch of a bike-sharing service requires proper, safe and attractive cycling conditions. Therefore, this issue should be emphasized as a crucial momentum for success. Marketing, promotion and education should play important roles as well.

- Cities should launch a system which has a sufficient size in terms of density of bikes and covered service area. A too small service area or less dense system might not
attract enough users which does not necessarily mean that bike-sharing as a service could not be successful with other parameters and more extensive preparatory works.

- It is worth mentioning that improperly parked bikes might cause public nuisance but the main cause of public space occupation is not the bikes themselves but private cars and on-street parking. An integrated and more complex approach would be more beneficial; thus cities should regulate bike-sharing, other vehicle-sharing services and mobility options at the same time. The focus should be on equity of public spaces and space should be dedicated by considering the desired future of the city and in accordance with the defined future modal share and mobility trends (for example in line with the SUMP or such document of the city). In simple terms, if cities want to encourage the use of bicycles, they should dedicate more space for cycling.

### 4.3 Regulations for multi-operator models

Regulations should be outcome-oriented. The main requirements of the desired services should be defined ensuring flexibility and favorable conditions for market competition and innovation. Operator and user feedback should be analyzed on a regular basis and, if necessary, regulations and developments should be adapted to them.

A pilot program could be suitable in all cases and after a several months long test phase cities could decide whether a multi-operator model or even dockless technology is a suitable solution for them and they could decide what kind of regulations and operations fit their needs best.

Cities should coordinate the accreditation of operators and should monitor their performance. Only those operators could be allowed to provide services who fulfil the requirements. (Accreditation could take place on higher level too, such as national standards for bike-sharing.)

The topics which should be covered by the regulations are as follows:

- **Fair and beneficial competition**
  The optimal and maximum number of bicycles and operators should be defined to avoid oversupply and optimize the bike-sharing supply in line with demand. Too much competition can be a problem while the other end, a small system and insufficient density could lead to failure as well.

- **General service requirements**
  The minimum service requirements should be defined such as bicycle availability, required minimum and optimal number of bicycles in each pre-defined area (redistribution and rebalancing); required standards for bicycles and equipment (safe, comfortable or pedal-assisted bicycles which meet local standards, GPS tracking and geo-fencing etc.); maintenance; fare structure; insurance; helpdesk and customer service etc.

- **Public space management**
  The main driver of this topic is to ensure orderly parked bicycles and avoid public space occupation. Incentives and penalties should be established to avoid vandalism and improper parking. The task of removing the abandoned bicycles should be organized as well. User education and marketing are also crucial which encourage positive attitudes towards bike-sharing and proper user behaviour.
• **Integration**
Bike-sharing services should be integral parts of the mobility system of cities regarding both physical and administrative integration. Common or integrated fare structure is desired in the case of a multi-operator model as well. Customers should not be confused by multiple operators, therefore a common platform should be developed which provides access to all services (e.g. an application which involves all operators and all of their bicycles are shown on one single map).

• **Equitable access to bike-sharing**
Bike-sharing should be accessible for all. The aim is to increase the equity of bike-sharing and to provide accessible services regardless age, gender, income etc. More than one payment and access methods should be offered to make the bike-sharing services more attractive and accessible for those who do not use a smartphone. Favorable and flexible fares and membership options are crucial.

• **Increase the (social) responsibility of operators**
Operators should focus on customer awareness and education in a holistic way. Besides promoting or incentivizing proper user behaviour and traffic safety, cycling and sustainable mobility habits should be promoted as well.

• **Data sharing and data protection**
Operators should provide real-time data which makes control and monitoring possible. It is also essential for future planning and for other applications such as real-time route planners or for common platforms. The protection of user data and privacy should be ensured as well.

5. **Comparative assessment of dockless and station-based bike-sharing**
Both dockless and station-based bike-sharing technology have their own advantages and disadvantages. It is necessary to examine the opportunities of the two technologies to find out under what kind of circumstances they could perform best. I carried out a simplified assessment to conclude and compare these two types of bike-sharing systems regarding implementation and operational aspects and user needs. I compared state-of-the-art 4th generation station-based systems with dockless ones. (ITDP, 2018a) (Waes, et al., 2018)

As a first step, we should examine the needs of operators, cities and users who consider different aspects and factors of bike-sharing services as important ones. (Mátrai, 2016) Some of the aspects are not under direct influence of system design and there are others which significantly differ depending on whether the system is station-based or dockless. The comparative assessment focuses on the latter characteristics which are summarized in the tables below.
### Table 5: Comparison of station-based and dockless bike-sharing systems regarding implementation and operation

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Station-based bike-sharing</th>
<th>Dockless bike-sharing</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>• Orderly parked bikes and managed public spaces&lt;br&gt;Docking stations define the places where the bikes should be parked while slots secure the bicycles and keep them in order.</td>
<td>• Scalability and flexibility&lt;br&gt;Lower capital and implementation costs as dockless systems do not depend on special infrastructure and might not require large space in one place for docking stations. These characteristics make large-scale development easier.</td>
</tr>
<tr>
<td></td>
<td>• Long-lasting infrastructure&lt;br&gt;Heavy infrastructure is less exposed to vandalism and implies permanence and stability.</td>
<td>• Quick implementation&lt;br&gt;Requires less preparatory work and planning, while geo-fencing provides great flexibility to adopt the services to user needs continuously.</td>
</tr>
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<td></td>
<td>• Stations and system image promote cycling&lt;br&gt;The mass of bicycles at docking stations attract people’s interest.</td>
<td>• Dockless bikes could serve less dense areas economically&lt;br&gt;Due to lower implementation and operating costs, and flexible deployment.</td>
</tr>
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<table>
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<tr>
<th>Weaknesses</th>
<th>Station-based bike-sharing</th>
<th>Dockless bike-sharing</th>
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<tbody>
<tr>
<td></td>
<td>• Spatial and financial challenges of implementation&lt;br&gt;Docking stations and special infrastructure have their higher costs and they might require more space in one place.</td>
<td>• Dockless bikes are more exposed to vandalism&lt;br&gt;As the bicycles are not secured to a fixed object (except lock-to technology).</td>
</tr>
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<td></td>
<td>• Time-consuming implementation&lt;br&gt;Docking station placement, planning, authorization and implementation are more time-consuming.</td>
<td>• Improperly parked bikes&lt;br&gt;Without proper regulations and incentives bikes are not always parked orderly and it might disrupt others.</td>
</tr>
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<td></td>
<td>• High operating and maintenance costs&lt;br&gt;Station-based bike-sharing systems might have higher operating costs.</td>
<td>• High operating costs of dockless e-bikes&lt;br&gt;As parked dockless bicycles are not connected to the power grid, charging the batteries is a more resource-intensive task.</td>
</tr>
</tbody>
</table>
Table 6: Comparison of station-based and dockless bike-sharing systems from a user point of view

<table>
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<tr>
<th></th>
<th>Station-based bike-sharing</th>
<th>Dockless bike-sharing</th>
</tr>
</thead>
</table>
| **Strengths** | • Fixed stations provide comfort and reliability  
Users can find the stations always at the same locations and do not have to look for a bike. That makes the services reliable in all cases and fixed locations fit into daily routines easily.  
• Fixed stations can be accessed without smartphones  
Station-based systems are accessible if the user does not have internet connection or a smartphone. | • Flexibility  
Users can leave the bikes where it is the most convenient for them within the service area (semi-dockless systems might limit this advantage).  
• Convenience for smart phone users  
All functions are available within an application which provides convenient services for those who use a smart phone. |
| **Weaknesses** | • Inflexible services  
Users should leave the bicycles at the dedicated docking stations which might limit accessibility and flexibility, especially in less-dense parts of the city. | • Limited access  
Accessing the system requires internet connection and a smartphone which might be a limitation in some cases. |

**Complementation or competition? – Hybrid systems**

Hybrid systems, the mix of the two models, could strengthen the benefits of both while reducing their drawback effects. Expanding the bike-sharing system is easier, faster and cheaper with dockless technology and it can complement docked systems. There are two possible applications for a hybrid system.

The first and simpler solution is the semi-dockless model as it was discussed earlier in chapter No. 3.2.1. In that case, dockless bikes should be parked in a designated parking area or should be locked to a defined object without the need for special docking infrastructure.

In another model for hybrid system, docking stations keep public spaces in dense areas, while dockless bikes serve less dense parts of the city where the implementation of docking stations would not be efficient. In that case, the bikes could be used as dockless bikes in the outskirts and they must be parked at designated stations or parking areas in denser parts of the city. (DeMaio, 2018) (Waes, et al., 2018)

**6. Case study - Budapest**

Budapest is the capital of Hungary and it functions as a political, cultural, economic and educational centre of the country. 1.7 million people live in the city, while 2.5 million live within the borders of the metropolitan area. Budapest has a territory of 525 km² while the metropolitan area is around 2500 km².
The topographical and climatic conditions of Budapest are mostly favorable for cycling. The city is basically flat, only the centre-western part of the city is hilly which makes cycling less attractive there. However, to electric assisted bicycles these hills do not pose a major obstacle.

The share of cycling in Budapest has significantly grown since the 2000s because of infrastructure development and the emerging and popularizing cycling movement. Compared to the 1990s the share of cycling has grown more than ten folds by 2014. (Bencze-Kovács, et al., 2015)

Cycling network development went through a boom in the 2000s and especially in the 2010s, when the bike-sharing system was introduced as well with other infrastructural developments. On one hand, there are various good practices, on the other hand, the cycling network of Budapest is not complete and key elements are still missing or major road rehabilitations are needed.

Although Budapest has ambitious goals and development plans to increase the share of cycling, there is no clear and strong political will which encourages the use of cycling in an exemplary manner. The SUMP of Budapest set the target, the share of cycling from 2% in 2014 must be increased to 10% by 2030 (see figure below).

![Fig. 4: Modal split of Budapest in 2014 and the desired share for 2030 defined by the SUMP of the city](image)

**6.1 MOL Bubi – the bike-sharing system of Budapest**

MOL Bubi was launched on 8 September 2014 after several years of planning and preparatory work. The scheme started its operation with 1100 bikes and 76 stations. Since then, the system was enlarged and developed, almost 1500 bikes and 124 stations can be used now.

MOL Bubi is a 4th generation public bike system. It has modular, portable stations with solar-powered touchscreen computer terminals. The scheme has several special features. For example, if the docking station is full and all the slots are occupied, the bikes can be locked to an extra bike stand with a built-in lock. The bikes are equipped with an on-board computer and a GPS tracker. There are several ways to access the bicycles, which provides flexibility for users (via the smart phone application, on-board computer or computer kiosk).

Usage data show that the number of trips has significantly decreased. There are some known factors which might contribute to the reduction of trips (for more details see the SWOT analysis below). As the exact causes are not known, Centre for Budapest Transport initiated a user survey to analyze the situation and understand the influencing factors better. The study is under preparation, the results will be available in the near future.
SWOT analysis of MOL Bubi

To analyze the services of MOL BUBI a simplified, qualitative SWOT analysis was carried out.

**Strengths:**

- MOL Bubi has progressive features and modular technology which provide high level of flexibility in terms of hiring, returning, implementation and registration for short-term tickets. Smart bikes, GPS-tracking and geo-fencing enables real-time monitoring and provides data for efficient reallocation.

- MOL Bubi is an integral part of the transport system of Budapest. The management is part of Centre for Budapest Transport and bike-sharing services are treated as a complementary option for the city’s transport offers. This approach enables integration on all levels and fosters multimodality: infrastructure development, station placement, common fare structure, signages, maps, real-time route planning and service information, customer service etc.

- The additional lock and the extra stand provide flexibility for users and for operation and rebalancing.

- MOL Bubi has become a well-known brand in Hungary and even on the international level. It is the biggest and most successful bike-sharing system in the country representing sustainable mobility which has become an integral part of the everyday life of Budapest.

**Weaknesses:**

- Relatively small service area which covers only the inner parts of Budapest. In some parts of the service area the low-density of docking stations is also a problem which should be improved.

- After almost four years of operation some of the teething problems of MOL Bubi are not solved. These problems include the solid tyres which slow down the bikes; some IT problems; and the registration procedure still requires long paper work. In some cases, bureaucracy and inflexible legal environment work against the change.
Opportunities:

- Huge potential in further enlargement of the service area to cover currently not served parts of Budapest (optional financial framework is available).
- New docking stations could be funded by private investment. There are plans for implementing new stations by private funding and there are already three stations which were implemented following this funding model.
- The busiest metro line (M3) is under reconstructions for several years while cycling, especially bike-sharing could play a great supplementary role. Two new docking stations, B+R facilities and further developments were established to improve cycling conditions.
- Various students and researchers examined the operations of MOL Bubi and proposed actions on how to develop the system and increase its efficiency.

Threats:

- Without strong, supportive political will and financial support the enlargement and the development of the system will not happen. Although MOL Bubi has a modular, flexible station design, the implementation still requires planning and authorization procedure. Even if the funding for the expansion of the system is available, some of the districts of Budapest hinder the development. The lack of free public spaces limits the expansion but converting parking spots to docking stations could be an efficient and win-win solution. However, some local governments, the owners of the public spaces, do not want to provide parking spots for the docking stations for made-up reasons. Although the SUMP of Budapest clearly defines that the modal share of cycling should be increased while car use should be decreased, banning on-street parking and providing more space for cycling remain a taboo and decision makers still insist on the parking spots.
- Bicycle-friendly urban environment is an important basic condition which is partly missing. The conditions are not citywide favorable for users, especially for those who are not experienced cyclists. Infrastructural developments are needed which also require political and financial support.
- After the initial growth the number of users and journeys do not meet the previous expectations.

6.2 Dockless bike-sharing services in Budapest

There is one dockless bike-sharing operator in Budapest. Donkey Republic originally offered ride and return services for tourists. Besides that, since the autumn of 2017, they offer a special membership plan for frequent users as well (one-way trips are allowed). Moreover, Donkey Republic has special offers for those who use their bikes during the reconstructions of M3 metro line. Unfortunately, usage data is not available.

In addition, Budapest received various proposals from dockless bike-sharing operators and conducted a cooperation agreement with one of the largest market actors as well. Although the dockless bike-sharing boom already reached Budapest, a comprehensive professional discourse has not started yet.
6.3 Recommendations

Developing scenarios is a common practice in strategic planning. These development alternatives are great tools for planners and decision makers to understand better the effects of the proposed measures. Moreover, scenarios allow discussion about the opportunities and support decision-making while recommendations can be presented in a systematic way through them.

1. Business-as-usual scenario

This scenario assumes that MOL Bubi and its technology will remain the same and the already decided improvements will be done. The planned expansion of the service area will be completed as an optional financial framework is available to enlarge the system and improve the density in the existing service area up to 225 docking stations in total. The system and its elements will be improved to address their weaknesses.

The agreement between the operator and the city is valid until November 2019 and it will likely be extended for one more year. It means that the technology, the operating model will not change until November 2020 and Budapest has more than two years to prepare for the change.

It is expected that the system accessibility will increase as the density of the stations will be improved. However, teething problems of the system should be eliminated as well to change the decreasing trend of usage.

![Fig. 6: The map shows the approximate service area of MOL Bubi (black) and the zones where the density of the stations should be improved (grey) (Based on KTE, 2017)](image)

2. Developing and enlarging the bike-sharing scheme without the involvement of further market actors

This scenario assumes that besides the already decided and planned developments MOL Bubi will be further developed and enlarged. The bike-sharing system will operate with the same technology and operating model without the (official) involvement of any other actors or dockless bike-sharing providers. Nevertheless, it cannot be excluded that dockless bike-sharing operators will hit the streets of Budapest, even if the city will not initiate official agreements with the operators.

Budapest 2030 strategy defines the desired urban structure of Budapest and proposes a hierarchy for urban centers and intermodal hubs (see the figure below). (Budapest, 2013)
Around these sub-centers smaller bike-sharing sub-systems could operate to encourage intermodality and cycling on local level.

A major difficulty in this scenario is that at these sub-centers and intermodal hubs most people travel in one direction in the morning and in the other direction in the afternoon, so rebalancing the system could be challenging. Further studies are needed on user demand and travel patterns analysis. The conclusions could be drawn by estimating the number of needed bicycles and the needed amount of space for the docking stations. MOL Bubi stations should be implemented around those sub-centers where a bike-sharing system could be a feasible and suitable option regarding user demand and operation aspects.

Besides station development, additional measures are necessary to improve the weaknesses of MOL Bubi and attract new users. To identify these additional measures, the mentioned user satisfactory survey, which is under preparation, could solve as a base for further planning.

After the involvement of new parts of Budapest, it could be estimated that more people will tend to use the bike-sharing system which could encourage cycling for local trips or as part of an intermodal mobility chain.

Fig. 7: Map of Budapest and the urban sub-centers defined by the Budapest 2030 strategy

3. Complementing MOL Bubi by new dockless bike-sharing operators

This scenario assumes that further dockless bike-sharing provider(s) will offer large-scale services in Budapest. It is assumed that dockless bikes could complement the existing bike-sharing services regarding density and enlarging the service area while the technology and operation of MOL Bubi remain the same.

Dockless bikes could increase the accessibility of bike-sharing services by complementing MOL Bubi where the density of the stations is lower. The hubs of dockless bikes, as semidockless station design is recommended, could be smaller than the current docking stations, therefore the implementation could be more flexible in those parts of the city where decision makers and the reallocation of public space do not prioritize cycling. Although the dockless bicycles might not occupy less space in total, the hubs could be smaller by accommodating less bikes in one place than a general docking station.
Dockless bikes could be a suitable option out of the present service area of MOL Bubi as well. In less dense parts of Budapest dockless bikes could enlarge the service area of bike-sharing in a more efficient way. Dockless bikes could be a suitable solution in that case, especially around the sub-centers which were described in the previous scenario.

As dockless bikes could increase the accessibility of bike-sharing services, it is estimated that the number of users would grow as well. Dockless bikes could strengthen the weaknesses of MOL Bubi, which might attract new users, especially in the new parts of the service area.

Further planning and a thorough assessment are necessary to estimate the exact impacts of the proposed measures as well as the investment and operating costs. The previously discussed regulations and recommendations should be adapted in the case of Budapest too. Additionally, as Budapest has ambitious goals to increase the share of cycling and other sustainable modes by decreasing the share of car use, public space occupation by different modes of transport should be reviewed. Street space and parking lanes occupied by cars should be reclaimed to provide more space and more favorable conditions for cycling and for people. Therefore, to avoid the inequalities of public spaces, recommendations or regulations should be implemented to provide a standard for public space distribution. This step is strongly recommended as some of the districts of Budapest have already started to ban new forms of mobility and refuse to provide public space for bike-sharing.

7. Conclusions

This paper highlighted the fact that bike-sharing services could play a great role in mitigating the consequences of mass motorization and the mobility problems of our cities. Bike-sharing has become a standard tool in cities and has revolutionized urban cycling in various cities around the world when new generation dockless, free-floating bike-sharing services hit the market. Although these systems have some disadvantages compared to station-based technology, they provide great flexibility for users and for large-scale development. Dockless systems have some teething problems, but their benefits might outweigh the drawbacks which can be avoided by proper regulations and other actions. A framework for a multi-operator model was introduced and to combine the strengths of station-based and dockless systems, a hybrid system was also discussed.

It is important to mention that dockless bike-sharing is not a solution which fits all cities. Dockless bikes can complement the existing station-based services, especially in those areas where the stations are less densely located. However, there could be several conditions which limit the application of dockless bicycles such as already existing, dense network of stations and political or administrative barriers.

It can be concluded that new generation dockless bike-sharing services pose new challenges for cities but there are several tools which help decision makers and professionals to implement a beneficial dockless bike-sharing scheme. The technology and the key market actors of bike-sharing systems are changing now. One thing is clear, bike-sharing provides plenty of possibilities to tackle urban and transport problems. It is now up to us to make use of the new opportunities.
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