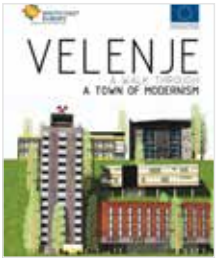

VELOCITY

Imagining a Public Bike Scheme in Kilkenny

December 2018

PRESCIENCE
KNOWLEDGE FORETOLD

This plan was commissioned by Kilkenny LEADER Partnership CLG. It was authored by Ian Dempsey, Prescience in collaboration with Willie Miller Urban Design (Glasgow) and Jacob Dibble (Helsinki) between June and December 2018.

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VELO-CITY:
IMAGINING A PUBLIC BIKE SCHEME IN KILKENNY

December 2018

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EXECUTIVE SUMMARY

Cycling contributes substantial added value to a wide array of EU and national policy goals. These goals are influenced and shaped in part by commitments to supranational obligations including the United Nations Sustainable Development Goals, the Paris Agreement and the New Urban Agenda. In practical terms cycling supports low emission mobility; stimulates economic, leisure and social development; facilitates multimodality in and integration of public transport; enhances urban mobility; promotes physical activity, health and wellbeing as well as liveability and quality of place.

In 2017 the EU Cycling Strategy quantified the economic benefits of cycling across a broad spectrum of disciplines to be €513bn. It asserts that where pro-cycling development policies and incentives are in place and where cycling is promoted as an equal partner in the mobility system, economic benefits of €760bn by 2030 can be achieved.

From its earliest iteration in the 1960's Bike Share Schemes have evolved rapidly, with over 1600 schemes now in operation globally; its evolution aided by significant social, cultural and technological change as well as by locally-led initiatives. Now in its fourth generation, Bike Share Schemes have become a prominent feature of the urban mobility system and are now regarded as essential elements in *placemaking, Smart City* and competitive positioning strategies.

Bike Share Schemes can differ substantially in nature, network and scale but in essence they enable the short term rental of a bicycle generally for a small fee, whether subscription or usage based. Rentals have traditionally been from a pre-ordained location such as a docking point with the bicycle later returned to the scheme at this or some other location within the network. Recent developments in Bike Share Schemes however have seen the emergence of dockless or *free floating schemes* which obviate the need for docking stations and offer greater flexibility in access, usage and network range.

Successful Bike Share Schemes in urban locations are characterised by widespread user acceptance, low cost, ease of access, reliability, consistency, and convenience. Scheme size and reach is generally a function of population and population density in the urban environment with bicycle provision focused on central, densely populated and highly trafficked routes. A continual requirement to rebalance bicycle stocks to meet demand at peak times militates against the location of docking points in isolated or peripheral locations. Demand characteristics differ considerably depending on the scheme objectives and goals, target groups, user demographics, the quality of the cycling infrastructure as well as the compatibility with and/or integration with other modes, most notably public transport.

Operating and financing models differ widely; the specifics of which will generally be a matter of defined scheme objectives, most generally linked to seamless integrated urban mobility, congestion easing or the facilitation of modal shift. Higher costs associated with the development and operation of conventional docked schemes generally require a significant subvention of public funds from National or local authorities. In contrast the lower costs associated with dockless schemes require that they operate on a commercial basis; success primarily determined by operational efficiency, commercial revenue and user acceptance. Aside from the need for a public subvention and Irrespective of configuration, revenues accrue from subscription fees, usage charges and commercial sponsorship.

Extensive research conducted on Bike Share Schemes throughout the World demonstrates that convenience and value for money are central to user acceptance and scheme success. The

Bicing in Barcelona

former demands consistent ease of access to a bicycle and proximity to user residence and place of employment; the latter requires cost savings over other modes, including public transport. Most notably from a sustainable transport and modal shift perspective, the majority of scheme users globally migrate to bike share from other sustainable forms of transport rather than from the private car. Occasional leisure and recreation usage predominates over regular commuting usage.

A Bike Share Scheme was first introduced to Ireland in 2009. The initial success of the Dublin scheme – often regarded as one of the most successful in the World – saw it introduced to Cork, Limerick and Galway by 2014. These schemes are conventional city-scale docked schemes with a dense urban network aligned and integrated with the public transport network. The operation of each of the schemes as well as their continued development is dependent on policy initiatives and financial support from Department of Transport, Tourism and Sport, the National Transport Authority as well as from the Local Authorities. More recently, the scheme scope and network in Dublin has been extended by the introduction of a dockless scheme by private operators as a complement to the densely clustered docked network.

Kilkenny City, its scale, personality, demographics and economy offer many of the characteristics necessary for the introduction of a Bike Share Scheme. However the success of any such scheme in the City is unlikely until clear scheme objectives and goals are determined, thus allowing the accompanying developmental and operational resources to be identified, sourced and/or redeployed from stakeholders as necessary. Survey findings suggest a disposition locally towards occasional bike share usage on *a pay as you go* basis rather than for a regular commute. This is in line with experiences observed elsewhere in Ireland and overseas whereby scheme usage is an adjunct to primary and secondary transport modes.

This study determines that a modestly-scaled, conventional docked scheme for the City would cost a minimum of €150,000 to develop and require a minimum public subvention or commercial sponsorship of a similar magnitude to sustain operations on an annual basis. Such an investment could be justified on the basis of a strong contribution by a Bike Scheme to *placemaking,* urban liveability, citizen wellbeing, quality of life and quality of place in Kilkenny. The rationale for the use of such resources to promote modal shift, to serve as *first/last* mile solutions, to ease vehicular congestion or to facilitate increased leisure and tourist usage in the City is much less certain. The development and operational costs of Bike Share Scheme can be mitigated by the licensing of a Bike Share Scheme and the transfer of financial risk from the Local Authority to a commercial operator; the success and sustainability of which would be wholly dependent on attracting sufficient commercial revenue. However, where this occurs, the solidity, permanence and network effect of a scheme is considerably diminished.

This study identifies a *critical path* through which stakeholders can define scheme goals and objectives, pool resources and delineate responsibilities. It also identifies critical enablers for scheme success to include a Cycling Master Plan and associated infrastructure enhancements that can create and foster a pro-cycling culture and environment, appropriate to and safe for all. It is within this context that a Bike Share Scheme can make a notable contribution to the social, economic and environmental development of Kilkenny City.

Taking account of the enablers and success factors observed elsewhere the study concludes by envisioning a scheme for Kilkenny. This proposal, which is scalable and can be developed incrementally over successive phases, seeks to place the development and sustainability of a Bike Share Scheme within a progressive *placemaking* strategy appropriate to the city's scale and context. It is based upon the existing cycle infrastructure for which the study makes site specific recommendations to enhance its network value. The key principles of *Network, Centrality and Place* are used to inform the optimal location of bicycle availability, irrespective of whether a docked or dockless scheme is favoured. This seeks to ensure that maximum coverage and reach is afforded to all locations and users in the City, factors central to scheme success.

Alvedon City Bikes, Stockholm

1.0 INTRODUCTION

Through desk research, stakeholder consultation, survey, analysis and observation, this study seeks to evaluate the feasibility, scale and scope of a Bike Share Scheme for Kilkenny City. The study has been informed by the evolution and development of bike share schemes globally as well as more recently in Ireland. Conclusions drawn and recommendations made in the report, while fully aligned with national and regional initiatives and replicable to other locations, are unique to Kilkenny City and its context.

The agreed terms of reference for the study include:

- An exploration and analysis of the most appropriate options among different working (or proposed) models of city bicycle schemes across Europe, with particular focus on similar sized cities to Kilkenny city.
- An examination of how these options interact with their environs - with a view to how any proposed Kilkenny City Bike Scheme might engage with the towns and villages of rural Co. Kilkenny.
- Research and analysis of the potential financial models and business plans to both initiate and sustain the operation of a Kilkenny City Bike Scheme and make a recommendation on the optimum model, including consideration of maintenance and marketing costs.
- An exploration of the development/ operational models adopted by the other city models, levels of subvention and the motivations of funders therein.
- Appropriate consideration of potential business model options to include existing cycling operations and bike hire providers in the City and, if available, how this accommodation was addressed successfully elsewhere.
- Specific recommendations on the City and environs infrastructure (cycle lanes, bike racks, etc.) to facilitate the development of the optimum Bikes Scheme model.
- Consideration of Kilkenny's particular streetscape and public realm.
- Provision of maps and graphics at the appropriate level as to demonstrate issues of placement and generic design of features, etc.
- Relevant recommendations on strategies and funding models both public and private to promote cycling and the adoption of a cycling culture among the residents and visitors of the City and environs to support the scheme.
- Recommendation on a potential '*critical path*' to the successful development of a Bike Share Scheme.

Vélo'v station 5002 - Place des Compagnons de la Chanson, Lyon

2.0 CYCLING: POLICY CONTEXT

The development of cycling infrastructure and the promotion of a pro-cycling culture is supported through policies and incentives determined at European, national and local level. These will generally be linked to transport planning, health, recreational and environmental measures, and infrastructure development as well as to quality of life measures. Of some relevance to the planning, development and viability of a Bike Share Scheme (BSS) in Kilkenny are the following agencies their policies and development framework.

EUROPE

The European Commission (EC) aligns diverse but mutually supportive priorities, policies and enabling supports through its *2020 – A European Strategy for Smart, Sustainable and Inclusive Growth Strategy.* This strategy comprises seven flagship initiatives that promote smart, sustainable and inclusive growth and guide policymaking in the member states in the period to 2020. Policy measures and funding instruments for investment in infrastructure, innovation, new technologies and low carbon economies as well as for the development of skills and human capacity are aligned and configured to support the Europe 2020 Strategy. A successor strategy to be implemented in the period 2021-2027 is expected to be framed around these themes.

Within its overall development framework the EU supports cycling with specific policies and measures. *The EU Cycling Strategy: Recommendations for Delivering Green Growth and an Effective Mobility in 2030* is the result of a systematic review of all EU policies related to cycling and notes that the development of cycling is of substantial added value to EU policy goals particularly in relation to low emission mobility; multimodality and integration of modes; a focus on urban mobility; improved infrastructure and road safety; the promotion of physical activity and health as well as economic activity in a thriving bicycle manufacturing and cycling tourism industry. Specific objectives articulated by the strategy are that:

- Cycling should be an equal partner in the mobility system.
- Cycle use in the EU should grow by 50% on average in the period 2019-2030.
- Death and serious injury rates are reduced by 50% (per km cycled) in the period 2019-2030.
- EU investment in cycling is increased to €3bn in 2021-2027 and to €6bn in 2028-2034.

The concept of a BSS is identified in the EU Cycling Strategy as an essential component of any multimodal transport system and as an enabler of innovation at the city level. To incentivise and support these developments a broad framework and set of policy recommendations exist. These include:

- The integration of cycling and public bike sharing into multi-modal journey planners, ticketing schemes and *Mobility as a Service* (MaaS) applications.
- The physical optimisation of access for cyclists at and around public transport facilities.
- Digital and physical integration to make bike sharing accessible with the same card or account used by other public transport systems.
- The inclusion of cycling and public bike sharing data and services within the standardisation and harmonisation of multi-modal and real-time transport data.
- The consolidation of the data collected from public bike sharing schemes for better and seamless inter-modal trips.
- Data collection from cyclists to be used to improve urban cycling and to allow access data for individual cyclists.

In October 2018, EU Transport and Environment Ministers adopted the *Graz Declaration "Starting a new era: clean, safe and affordable mobility for Europe"* with a clear commitment to modal shift towards sustainable modes of transport and support for cycling. After the *"Declaration of Luxembourg on Cycling as a Climate Friendly Transport Mode"* adopted by EU Transport Ministers in October 2015, Environment Ministers have now joined in a further decisive step for the promotion of cycling at EU level. The declaration contains a clear commitment to modal shift towards sustainable modes of transport, including cycling. This commitment is further strengthened by the prominent role given to active modes like cycling acknowledged as an equal mode of transport and as an integral part of an intermodal mobility chain.

IRELAND

The Irish Government and the National Planning Framework, *Project Ireland 2040* sets out a framework for developing the infrastructure that will underpin the social, economic and environmental fabric of Ireland over the next quarter of a century. It is a long-term integrated plan to deliver the necessary spatial planning, infrastructure development and public services to support an increased Irish population of 5.8m. Transport, mobility and modal shift feature prominently within its goals and commitments. Development priorities and support measures delivered by Government Departments are aligned to the Ireland 2040 Plan.

At national level, the Department of Transport, Tourism and Sport (DTTAS) has responsibility for the planning and development of transport infrastructure and services. The functions and activities of the National Transport Authority, Transport Infrastructure Ireland, Bus Eireann, Iarnrod Eireann and the Commission for Rail Regulation come under its auspices. Its key strategy is *Investing in our Transport Future: Strategic Investment Framework for Land Transport (2015);*

The Government's transport policy for the period 2009 – 2020, *Smarter Travel – A Sustainable Transport Future,* focusses on the development and promotion of sustainable means of transport – walking, cycling and public transport – through the provision of funding for infrastructure as well as funding for behavioural change programmes to encourage the use of more sustainable transport modes. It stipulates that Local Authorities prepare *Local Transport Plans* including targets for modal change to more sustainable means of travel and an accompanying programme of measures to achieve these targets. The programme was allocated €100m funding under the *Capital Plan Building on Recovery: Infrastructure and Capital Investment 2016-2021.* Ireland's first *National Cycle Policy*

Framework, which sets out specific commitments on infrastructure and policy development, is linked to the *Smarter Travel* initiative

The Department of Communications, Climate Action & Environment (DCCAE) has responsibility for the delivery of policies and programmes, including communications, energy, climate change, air quality and environmental policy. Key strategies include the *National Adaptation Framework: Planning for a Climate Resilient Ireland and Our Sustainable Future: A Framework for Sustainable Development in Ireland*. In 2014, the Irish Government adopted the *National Policy Position on Climate Action and Low Carbon Development*. This establishes the fundamental national objective of achieving transition to a competitive, low carbon, climate-resilient and environmentally sustainable economy by 2050.

The National Transport Authority (NTA), a statutory non-commercial body operating under the aegis of DTASS, it is responsible for the development of an integrated and accessible public transport network; procurement; the licensing of public transport services; the provision of bus infrastructure and fleet and for cycling facilities and schemes. It also supports the implementation of *Workplace Travel Plans* to encourage modal shift amongst commuters.

Transport Infrastructure Ireland (TII) a statutory non-commercial body operating under the aegis of the DTTAS. Its primary function is to provide an integrated approach to the future development and operation of the national roads network and light rail infrastructure. It operates, maintains and improves the National Primary and National Secondary road network. Its key strategy is *Investing in our Transport Future: Strategic Investment Framework for Land Transport.*

Kilkenny County Council (KCC) is responsible for delivering a range of services including roads, traffic, planning, housing, as well as economic and community development, environment, recreation and amenity services. Through its planning and development functions it has a key role to play in regional development and in directly facilitating and supporting residential and commercial development. KCC is obliged to set out its strategic priorities for economic, environmental and social development in a *Development Plan*, compiled at six-year intervals. The current plan spans the period 2014 -2020. Though not having autonomy in transport provision at local level, KCC supports sustainable mobility practices through delivery of national policy and through investment in and the management of the enabling infrastructure and public realm; much of which is supported by objectives, policies and measures set out in *Land Use and Transportation Studies* (LUTS), *Mobility Management Plan* (MMP) and *Traffic Impact Assessments* (TIA).

KCC also has an important function in promoting and supporting community development throughout the City and County. The Kilkenny Local Community Development Committee (LCDC) in its *Local Economic and Community Plan* (LECP) for the County in the period 2015 -2021 has set as a high level objective the encouragement of an *"integrated transport systems through the use of existing and new infrastructure innovations, and increase the use of communications technologies through enhanced infrastructure and skilled communities".*

Kilkenny LEADER Partnership (KLP), a community-led local development initiative of longstanding, supports local economic and community development activities in the City and County. It plans, animates and implements a range of EU and national development programmes such as the LEADER programme, recreation, employment activation and social inclusion supports. Its *Local Development Strategy* (LDS) sets out an enabling framework and provides resources for economic and community development.

The Kilkenny Recreation and Sports Partnership (KRSP) is one of the network of Local Sports Partnerships developed through the Irish Sports Council (ISC). Its' primary focus is the creation and implementation of plans for long term local sports development; the development of structures, networks and events. Amongst its many initiatives, it supports the Smarter Travel initiative through the Community Cycling Programme; the Balance Bike and Active Schools Challenge; National Bike Week. It also offers guidance to local employers on the implementation of workplace travel plans.

KILKENNY

dublinbikes scheme

3.0 QUANTIFYING THE BENEFITS OF CYCLING

The development and promotion of cycling yields significant economic benefits. In 2016, the *European Cycling Federation* quantified the economic benefits of cycling within the 28 EU member states as being €513bn or more than €1,000 per inhabitant; its methodology clearly defining benefits across a broad spectrum of disciplines to include transport and environmental policy as well as industrial, employment, health and social policy.

In order of magnitude the total of €513bn is comprised of:

Health - €191.27bn (accounted for by longer lives - reduced mortality, healthier lives – reduced morbidity, mental health benefits, health benefits for children, road safety benefits avoided car accidents, reduced absenteeism from work)

Time and Space - €131.0bn (accounted for by quality of time spent cycling, shopping by bike, child welfare – time saving for parents, quality of public space)

above: High Street, Kilkenny below: the River Nore and Kilkenny Castle

Social Affairs - €50.0bn (accounted for by social equality, gender equality, child welfare, social safety)

Mobility - €20.69bn (accounted for by congestion easing, construction and maintenance of road infrastructure, public transport subsidies, connectivity – inter and multimodality, transport taxes and tax subsidies)

Technology and Design - €20.0bn (accounted for by urban design – benefits of integrated urban planning and infrastructure, new technologies and smart city development)

Environment and Climate - €15.43bn (accounted for by CO2 emissions savings, related benefits to reduced CO2 emissions, reduction of air pollution, reduction of noise pollution and environmental asset development)

Diversity – 10.0bn (accounted for by resilience and robustness, connectivity between people, accessibility)

Energy and Resources - €2.8bn (accounted for by fuel savings, active mobility hybrid contributions to e-mobility, resource savings in vehicle production and infrastructure building

above: High Street, Kilkenny below: Kilkenny Castle

4.0 THE EVOLUTION OF BIKE SHARE

Bike sharing has grown rapidly in the past decade. Although the concept has been around since the 1960s, the number of cities offering a BSS has increased from just a handful in the late 1990s to over 1600 schemes globally at present.

ITERATIONS AND GROWTH

The evolution of BSS's is often classified within four '*generations*'; the catalyst for the *first generation* being *Witte Fietsen* (White Bikes) in Amsterdam. This was launched in 1965 by anarchist activists and consisted of white painted bicycles free for people to use. Bikes could be taken anywhere, left anywhere, and used by anyone. The total absence of security mechanisms led to theft and vandalism and its subsequent rapid demise. Similar first generation experiments in other locations were also short-lived.

There was little general interest in the concept and it experienced little growth until technological advancements emerged designed to reduce the threat of vandalism and theft. *Second-generation systems* involved a coin deposit system, with the first large-scale second-generation programme launched in Copenhagen as recently as 1995. The problems experienced by these first two generations of BSS including theft and damage led to the development of third-generation systems.

Third generation systems are characterised by dedicated docking stations in which bicycles are picked up and returned. They are supported by digital payment systems and other technologies to allow the tracking of the bicycles. These can be operated by smartphones, radio frequency identification tags (RFID), travel cards, personal PINs, or some combination thereof. Docking stations are generally permanent fixtures but can also be modular or temporary, powered by renewable energy sources. It is these elements, in combination with growing public policy interest in cycling, that have enabled the rapid growth of BSS's globally.

Fourth-generation systems signalled the appearance of flexible, clean docking stations, modularity, touchscreen kiosks, additional bike re-balancing technologies, as well as the smart card integration allowing a user to ride both bikes and public transportation. The fourth generation also gave rise to dockless systems and a more expansive micro-mobility landscape to include electric power assistance; e-bikes and e-scooters.

Already widely used in some urban locations, these will become established elements of a BSS, extending scheme scope and reach by allowing riders to cover longer distances. It is expected that they may sway users not currently attracted to conventional BSS, potentially as a substitute for private car use in more sustainable and *smarter* cities. Range extension will also allow BSS to reach more users and connect more locations, further broadening appeal and viability.

TIMELINE

1965 – The introduction of Witte Fietsen "White Bikes"

1995 - Copenhagen Bycyklen (Copenhagen City Bike) programme commenced.

1996 - The Bikeabout system, a small bike-share service limited to University of Portsmouth students required users to swipe an individualised card to access bikes allowing users could be tracked if bikes went missing.

1998 - Vélo à la Carte, the first city-scale bike-share programme using magnetic-stripe cards and RFID technology is introduced in Rennes, France. Bikes were offered free of charge.

2007 - The first modern municipal BSS 'Velib' was launched in Paris.

2009 – The first BSS in Ireland, *dublinbikes,* was launched.

2010 - The first modern bike share systems in the United States were launched with 1,600 bikes across the country.

2013 – BSS becomes widespread and has already been implemented in small and large cities across the world. By this time there are now 700,000 BSS bikes globally.

2014 – 885 cities worldwide have introduced schemes

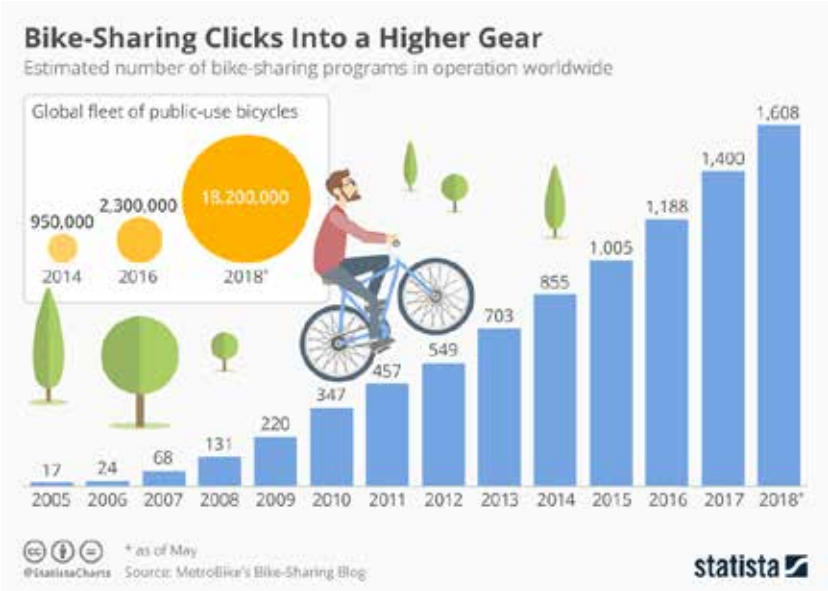
2015 - An estimated 1,000,000 BSS bikes are in circulation around the world with 75% of these in China.

2017 – Dockless equipment schemes primarily manufactured, distributed, and operated by Chinese companies were introduced to U.S. markets

2018 - There are approximately 1,600 bike-share systems in the world today, using a variety of technologies, systems, electric bikes, and operational procedures.

The number of cities operating a BSS has increased from 17 in 2005 to 1,608 as of 2018.

Figure 1: The global growth of Bike Share
Source: Statista, 2018



The global bike share fleet is now estimated at 18.2m bicycles, the majority of which are in China. By 2016, China had more than double the number of bike share systems as the next closest country; 430 compared to 147 in Italy and 113 in Spain. The USA, a relative latecomer, had 109 cities offering a BSS. Worldwide, Spain and Italy are often recognised as the first places where bike sharing caught on and permeated the countries at a large scale, across both large and small cities.

Since 2016, China has experienced explosive growth in the roll out of free floating or dockless

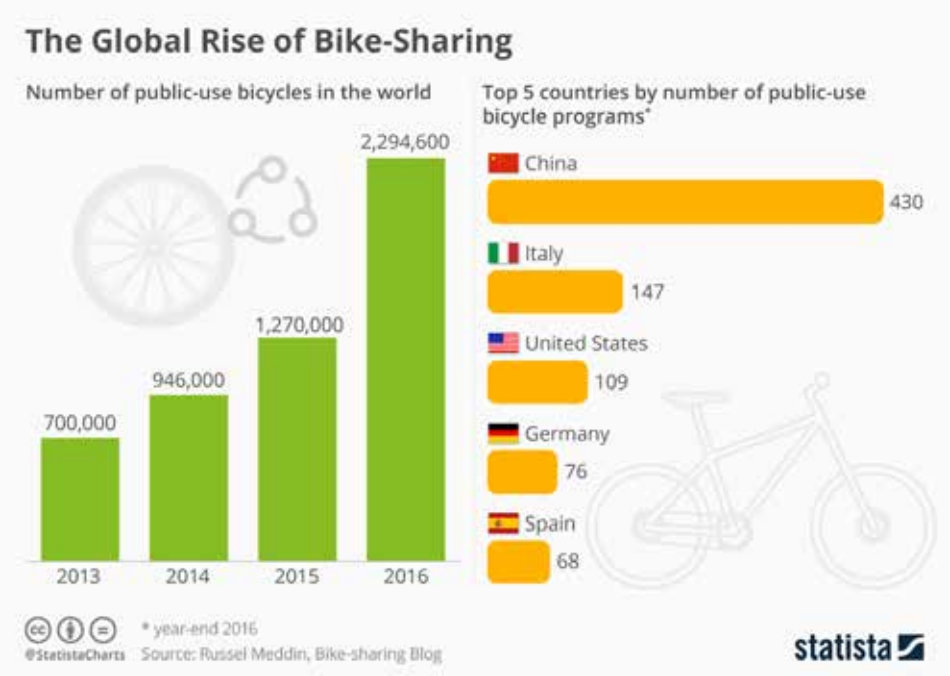


Figure 2: Bike Share by Number of Bicycles/Top 5 countries
Source: Statista, 2018

schemes with more than 80 domestic companies aggressively competing for market share and growth. Fuelled by investment from local technology behemoths such as *Alibaba, Baidu* and *Tencent* along with venture capital from *Panda, Hillhouse* and *Sequoia*, a peak was reached in 2017 with over 16m dockless bikes and 130m subscribers. In an effort to address growing abandonment and associated nuisance concerns, the first national guidelines to regulate dockless schemes were introduced in August 2017.

Since then a fierce price war, increased regulation, inadequate and uncertain business models as well as a scarcity of capital has led to a rapid consolidation, withdrawal or bankruptcy of some major operators. A notable consequence of the flux in the Chinese market was the internationalisation of its main operators, most particularly the entry by *Ofo* and *Mobike* to overseas markets. By the end of 2017, *Ofo* operated over eight million shared bikes in more than 200 cities in 12 countries, including China, Singapore, the United Kingdom, Italy, Japan, the U.S. and Thailand.

BSS have grown substantially across the US, with 123m trips taken since 2010. According to *Bike Share in the U.S.: 2017 Report by Nacto*, the number of bikes more than doubled in the USA from 42,500 in 2016 to around 100,000 by the end of 2017. In total, 35m trips were taken in 2017; a 25% increase on 2016. This growth is attributable to increasing ridership in existing systems as well as greater spread and availability of bikes arising from the launch of several major new schemes across the country. It is noteworthy that dockless schemes account for the greater proportion of this increase with dockless bike share companies introducing around 44,000 bikes alone in the second half of 2017. By contrast docked systems added approximately 14,000 bikes to their fleets, bringing the 2017 total to 54,000 docked bikes. As of the close of 2017, dockless bike share bikes accounted for about 44% of all bike share bicycles in the U.S.

Despite some high-profile failures and painful lessons for operators and municipalities alike, it is generally expected that the BSS model will adapt and endure. Economic sustainability will require the diversification of business models and the exploitation of additional revenue streams beyond subscription and user fees. Most likely sustainability will be achieved as a consequence of the consolidation and merging of operators; a refinement of operating models and practices; greater exploitation of direct and indirect revenue streams; zealous regulation and public realm management and the continued integration of bike-sharing into bigger shared mobility and service platforms.

MOBILITY AS A SERVICE

Technological, demographic and cultural changes suggest that micro-mobility and BSS will be one of the foundations for the *Mobility as a Service* (MaaS) concept in an urban environment. *MaaS* seeks to integrate various forms of transport services into a single mobility solution combining a range of modes and services to offer a tailor-made transport solution that connects travellers door-to-door. A well-functioning BSS can support the move away from personally owned vehicles to other modes of transportation that are as effective and cost-efficient whilst better connecting to existing transportation options and to address *first mile/last mile* issues. Furthermore, a BSS operator is particularly attractive to a MaaS operator as they value its large user base and data insights. In 2018, the integration of micro-mobility and *MaaS* has been demonstrated by *Uber's* $200m acquisition of the dockless electric bike share start-up *Jump;* by micro-mobility operator *Lyft's* $250m acquisition of *Motivate* and by Google parent company *Alphabet's* involvement in a $300 million funding round in scooter-share operator *Lime Bike.* It is expected that *Uber* will seek to deepen its investments in micro-mobility through further acquisitions most particularly focussing on the *electric scooter share* market in the United States; its goal being the capacity to offer a full suite of mobility solutions and to serve as a one-stop shop for consumer transportation .

4.0 DEFINING A BIKE SHARE SCHEME

Traditionally a BSS in its most recognisable form is a short-term urban bicycle rental scheme that enables bicycles to be picked up at any self-serve bicycle station and returned to a similar point, either at the point of origin or elsewhere in a network. More recent developments and iterations centre on flexible, free-floating schemes or dockless schemes. Regardless of form or scale, a BSS offers a low cost, flexible transport option for an urban environment.

Typically the trips taken are short, generally being of less than 30 minutes duration. The bicycles usually contain technologies such a global positioning system (GPS) that allow the BSS operator to track the location of the bike. Payments are usually subscription based with additional costs for extended use and are usually made by credit card or alternative electronic payment. This also acts as a form of security and eliminates the anonymity that led to the demise of earlier, less technologically advanced BSS's. Aside from the subscriber model there are also free or peer to peer schemes in existence. These generally operate on a municipal, community funded or informal basis and most likely will focus on leisure or tourist use.

In most systems, after paying a daily, weekly, monthly or annual membership fee, users can pick up a bicycle locked to an identifiable or designated bike rack or electronic docking station and return it to any available station within the system. Many schemes offer the first 30 minutes for free and operate 7 days a week, 24 hours a day, all year round. However, some schemes opt to close for periods overnight for safety reasons or as a means to mitigate theft, damage and accident risk. Schemes may also choose to close due to climate factors or where adverse weather conditions dictate.

There are many variants to the conventional BSS. They can be conventional docked schemes integrated within the urban transport system or, as has been increasingly the case, dockless schemes allowing users greater flexibility and range. In some instances a BSS can be limited to a specific site such as a workplace or university campus; to a designated target group such as commuters or leisure users; to specific demographics such as students or others; or for a particular usage such as cargo bike sharing schemes.

A BSS has an important role to play as part of an urban sustainable and smart transport network. It provides a complementary transport offer to buses and trains being particularly useful as a personalised form of transport that can serve as a *first/last* mile solution. It is an alternative to private car use within an urban environment facilitating modal shift which in turn helps to reduce congestion and transport-related air pollution and CO2 emissions. By contributing to lower car use, a BSS benefits the remaining car users as well as the wider urban population at large through the minimisation of road congestion, making the city more attractive to tourists and improving urban accessibility across all social groups.

In order to achieve these goals, a BSS should ideally be integrated into the public transport system and available to the widest number of people by being as user-friendly, available and convenient as possible. This can best be achieved through the promotion of a cycling culture; a safe cycling infrastructure; a well-planned and resourced scheme with the ready availability of

The Parade, Kilkenny

well-maintained bicycles; the wider availability of digital networks and Wi-Fi and an increasing technological sophistication in bikes (including electric power assist) and operating systems.

Within an urban context it is evident that a well-planned, appropriately resourced BSS that meets user needs can offer a range of social, economic and environmental benefits. These include transport flexibility, reductions to vehicle emissions, health benefits, reduced congestion and fuel consumption, and financial savings for individuals. By sharing with others through a publicly available scheme, individuals can use bicycles on an *as-needed* basis, without the costs and responsibilities associated with ownership. In doing so, these schemes allow people who may not otherwise use bicycles, to enjoy the benefits of cycling; be they residents or tourists alike. A BSS can also serve as the catalyst for the development of a cycling culture, increased bicycle use and greater investment in cycling infrastructure thus delivering a strong visual statement that bicycles belong in an urban environment.

In addition to its role as part of the urban transport infrastructure, a BSS supports wider societal goals such as improving residents' quality of life and health, enhancing the appeal and attractiveness of the public realm and urban centres; improving urban liveability and economic conditions. The features and benefits of a BSS are generally accepted as being:

- *A cleaner transport option allowing urban areas to tackle climate change, reduce emissions and deliver a better environment for citizens.* When full account is taken of the of the complete life cycle, the carbon emissions for a bicycle and an electric-assist bicycle are approximately *21g and 22g CO2/passenger/km travelled*. This compares to emissions of 101g CO2/passenger/km travelled for a bus and 271g CO2/passenger/km travelled for a car.

- *A contributor to carbon reduction targets.* Ireland is not considered to be on a pathway to achieve its binding 2020 targets or its longer-term objective to decarbonise the economy by 2050. *Ireland's National Policy Framework* notes that where a car journey is replaced by a bicycle trip, approximately 150 grams per km is saved on average. Replacing 2,000 km of car journeys with bicycle trips saves 300 kg of CO2. The scale of Ireland's task in meeting its climate change obligations is starkly illustrated by its ranking in 49th place (from 56) of selected global economies in the *2018 Climate Change index;* a rating as the worst performing country in Europe for action on climate change and the producer of the highest volume of emissions per person in Europe.

- *Healthier and happier cyclists, with cycle commuting associated with a lower risk of cardiovascular disease, cancer and all-cause mortality. Analysis* also shows that walking and cycling have population-level health benefits even after adjustment for other physical activity with public health approaches having the biggest impact if they are able to increase walking and cycling levels in the groups that have the lowest levels of these activities. Cycling has also been determined as having a positive effect on *emotional health* – improving levels of well-being, self-confidence and tolerance to stress while reducing tiredness, difficulties with sleep and a range of medical symptoms.

- An effective *first/last mile solution* that enhances inter-modality and connectivity between other locally available transport choices.

- A rebalancing of transport options and availability and a means to manage transport demand.

- An efficient return on capital investment for the built environment and urban infrastructure.

- An efficient and economical use in the allocation of limited and contested urban road space.

- A greater capital investment in soft transportation modes and infrastructure to create a safer, attractive and more human and liveable urban environment.

- Recent research into Gothenburg's *Styr & Stall* scheme, suggests that if bike sharing is properly promoted, the general population of the city feels that such schemes offer a pro-environmental, inexpensive and healthy mode of transport. In particular, they were seen to complement the city's public transport services, and give the city a more human-friendly feel.

- The promotion of a brand image and competitive positioning for an urban location most particularly as an enabler or component of a *smart city* initiative.

- An expansion of the tourism product offering with direct economic benefits to tourism and ancillary businesses.

- A healthy and efficient means of commuting, navigating and increasing *dwell time* in an urban environment.

- *Numerous studies* suggest that urban retailer's perceptions of shopper travel behaviour are often skewed towards high-carbon transport modes both in terms of trip frequency and value of sales. However there is much evidence that low-carbon transport modes, including cycling, walking and public transport comprise a higher share of trips than perceived by business-owners. Evidence suggests that while value-per-trip may be lower for cyclists and pedestrians, the number of trips is higher, thereby pushing up the net modal value per shopper.

- Replacing on-street parking with a bike lane exerts little to no impact on local business, and in some cases can increase business. While cyclists tend to spend less per shopping trip than drivers, they also tend to make more trips, pumping more total money into the local economy over time. Indeed, retailers can directly appeal to cyclists and facilitate their custom by providing or accommodating cycling infrastructure and parking adjacent to their premises.

6.0 ESSENTIAL CHARACTERISTICS OF A BIKE SHARE SCHEME

The experiences of bike-sharing schemes in ten European countries have been collected in the OBIS *Optimising Bike Sharing in European Cities* Handbook, with the aim of helping other cities to implement and optimise their bike share initiatives. Written in 2011, before the introduction of dockless systems, the handbook can be used by a range of stakeholders including transport decision-makers, practitioners, operators and cycling enthusiasts to assist in the planning and development of a docked bike-sharing scheme.

The OBIS handbook notes that *"In general, mobility demand is higher in big cities, because of the higher population and employment density. Therefore, schemes in large cities often offer higher station density, easy-to-use, high-tech schemes, and a higher density of destinations, which influences the number of rentals in a positive way. Additionally, bigger cities often have more problems with congestion and limited parking space, which makes cycling more competitive with the car in terms of speed and flexibility on distances up to 5-7km and therefore attractive for daily usage. In some cities, where public transport is crowded, a BSS provides an alternative mode of transport.'*

The OBIS Handbook takes care to distinguish between the requirements of a BSS depending on its core or principal objective. It determines that commuting usage for work or education requires a dense station network, optimally sited between place of work, public transport stops and commuting origin. Users will favour subscriptions and usage will generally be at morning and evening peak with some inter-site movement between times. By contrast leisure, recreational or tourist usage will favour pay as you go options, ease of registration, will use the system for longer durations in the day and over weekends as well as favouring a far wider network range.

In its analysis of 41 schemes in 48 European cities, OBIS takes particular care to note the differences in city scale and the importance of population to the success of a BSS. Characterising large cities as having population in excess of 500,000 people; medium sized cities as having a population between 100,000 and 500,000 and small cities as having a population between 20,000 and 100,000, it recommends different median values for bikes, docking stations and points depending on city scale.

Table 1: BSS scale relative to population

Criteria	Value	Large	Medium	Small
Bikes per 10,000 inhabitants	Median	6.2	6.8	12.7
Stations per 10,000 inhabitants	Median	0.5	0.8	1.4
Docking points per bike	Median	1.7	2.0	1.2
Bikes per station	Median	10.2	8.7	6.2

Source: Optimising Bike Sharing in European Cities, a Handbook

Thus, it can be seen that schemes in large and medium sized cities offer more slots and bikes per docking station for automated schemes than small cities. This eases the redistribution of bikes which is necessary in most schemes due to uneven demand. In all the cities featured in the OBIS research with populations up to 150,000, the median ratio of scheme bikes to population size was 1:500. Therefore, in a city with 50,000 people, 100 bikes would be recommended (with an increase or decrease according to the localised demand factors). The median ratio of scheme members to population in smaller city schemes was 1:67. A city with 67,000 people might therefore expect to have 1,000 members. The ratio of docking points to bikes is generally between 1.2 and 1.7. Given the uncertain nature of bike-sharing schemes in small cities, 1.7 spaces per bike is recommended to increase the chances of there being sufficient capacity for users to park bikes at their first choice of docking station.

Irrespective of location or scale, it is accepted that a docked BSS will have the following fundamental elements, grouped as follows:

SERVICE DESIGN

A docked BSS must offer a consistent and reliable rider experience, ensuring ease of use, affordability, convenience, certainty and enjoyment. Fundamentally the user needs to know if a bicycle is available as, where and when needed and crucially that it can be docked or safely secured convenient to the chosen end destination. BSS use is optimised and inter-modality is achieved where bicycles are physically integrated with, readily accessed from or are adjacent to public transport hubs, stations and bus stops.

The scheme size and density is determined by the size of the urban area served or in some cases by the needs of defined target groups or the financial strength and goals of the BSS itself. In larger cities, a key aim is to ensure a high density of docking stations across the deployment area. The amount of docking stations in a scheme's deployment area can be expressed as a figure per km^2 or as the average linear spacing between each station. The *Transport for London* (TfL) feasibility study recommended a density of 8 docking stations per km^2 based on the Parisian scheme. Large-scale systems such as the ones in Barcelona, London and Paris offer stations which are usually not more than 300m apart – a relatively comfortable walking distance.

For the most part schemes in urban locations will generally focus on central, densely populated or trafficked areas, generally providing a docking station every 300-400m or so, providing the user with enough opportunities throughout the system network to key locations and destinations. An issue that arises where there is a low density of docking stations is that, if a user arrives on a bike and the docking station is full, they will seek the next available alternative. Where such an alternative is inconveniently located, confidence in the integrity of the system can be diminished or

eroded entirely. Moreover penalty fines levied may deter the user from using the system in the future.

The service hours and service seasons differ widely amongst locations. Many larger cities will offer a 24/7 service. However, some close overnight or at low demand periods or choose to restrict night-time use to allow for system maintenance, redistribution and rebalancing. Climate can also be a factor with some schemes only operating on a seasonal basis

Feasibility research for the London BSS concluded that the ideal distance for a bike-sharing scheme trip was between 1 and 8kms: 1km being the minimum realistic distance for a bike-share trip. Anything less than this could usually be walked more easily taking into account the time required to access and deposit a bike, and to walk between the docking station and the actual destination or starting point. Distances outside this range will typically lend themselves to private car or public transport. In practice, 8kms would be considered a long journey on a typical 23kg scheme bike - most trips tend to fall in the 13-17 minute range (around 4kms). Thus, a range of 1-5kms is probably more appropriate. Cities with key attractions that are between 1-5kms apart are, therefore, more likely to attract higher levels of bike-sharing use.

Consumer usage and acceptance of a BSS can be expressed in a number of ways. The most useful measure is the number of trips per day. The number of rents per bike is another way of assessing use although this can often simply reflect the accuracy of the pre-scheme demand predictions. In schemes which underestimate demand and provide relatively few bikes (e.g. Barcelona) rents per bike are typically very high (9 to 15 per day). In schemes which overestimate the demand (e.g. London) rents per bike are lower, approximately 3 or 4 per day.

As would be expected, rentals per bike are usually higher in urban areas with high population densities. The reasons for this are diverse: in general mobility demand is higher in big cities, because of the higher population and employment density. Therefore, schemes in large cities often offer higher station density, easy-to-use high-tech schemes and higher density of destinations, which influences the number of rentals in a positive way. Additionally, bigger cities often have greater problems with congestion and limited parking space which makes cycling more competitive than the car in terms of speed and flexibility on distances up to 5-7km. Furthermore in cities where public transport is inefficient, irregular, unreliable or inappropriate to user needs, a BSS provides an alternative mode of transport. It has been noted that a BSS is likely to have greater appeal where car parking is relatively expensive and in short supply or difficult to access. Similarly, if car and cycle ownership is high in the urban environment, this will also detract from the appeal of a BSS. High car ownership, low levels of congestion and cheap car parking would give residents little incentive to use a BSS.

Demand characteristics typically result in an uneven distribution of bicycles in any scheme. The imbalance is location specific and can be influenced by time of day or factors such as commuter demand, topography or one-off events. Irrespective of whether a system is docked or dockless, a fleet needs to be continuously monitored and managed. Bicycles can be redistributed in one of three ways. Natural redistribution (where users leave bikes at their first-choice docking station), forced redistribution (where a user has to go to a different station to find a space), or motor-vehicle assisted redistribution (where the scheme operator moves bikes between stations in a van). Bicycles are fitted with GPS or RFID technology to enable operators to track their location, monitor the status of the bikes, and address any imbalance in distribution. Rebalancing and redistribution of stock to meet user demand and expectation represents a significant proportion of the scheme operational costs.

Most BSS's will require registration, membership or subscription which may vary in magnitude but will generally be pitched at a level to encourage usage. User registration is designed to deter theft and prevent damage but is also the means by which billing and payments are enabled. Subscriptions will be provided on an annual basis to encourage frequency and regularity of use particularly for commuting purposes but will also facilitate shorter use through one, three day or weekly passes, allowing for tourism, leisure or occasional use. Increasingly, there is a trend towards interoperability between different schemes, operators and locations.

Fees and charges are designed to support the sustainability of a BSS. Most schemes encourage daily short-term use allowing free usage for defined periods with charges rising exponentially after the free period, or charges from the first minute of use with a linear charge per time unit reaching a lower daily maximum. A BSS will also include fines and penalties for abandonment, damage or theft. In many cases mitigations are sought by the requirement to provide a security deposit at registration.

Booking and information platforms in larger scale urban BSS's are almost exclusively accessed by apps or online platforms enabled by smartphones and Wi-Fi connectivity. In more advanced schemes or in locations with high quality public transport this is integrated with public transport information allowing common payment platforms, intermodal routing and connectivity.

It is widely accepted that a BSS is likely to be more successful where there is a comprehensive network of cycle-friendly routes. This is not restricted to designated cycle routes but relates to how attractive/safe/navigable etc the whole of the deployment area is for cycling. In addition to the provision of cycling networks – cycle tracks and cycle-lanes - the urban cycle network must consist of a broad variety of measures including traffic-reduced areas and public squares, cycle-friendly junctions and cycle traffic lights, traffic-calmed streets; cycle-lanes with visual segregation, physically separated cycle tracks, cycleways; street lighting, road signs etc. Moreover, the network of cycle-friendly routes must connect and facilitate safe access to the locations and destinations that people wish or need to visit. Route development should form part of a comprehensive cycling strategy. This might include measures such as infrastructure (such as cycle paths, safe cycle parking stands), choices on infrastructure use, (like bike access to one-way streets, car-parking policy), support for initiatives that encourage cycling (led by user-groups, schools or employers) and communication measures that encourage cycling and other sustainable mobility options.

In its planning, design and implementation, a BSS will necessarily consider the infrastructural needs and preferences of under-represented groups, including older people, women, children and those cycling with children or making decisions about child cycling. Younger people, men, and those travelling without children also generally prefer separation from motor traffic, so building for under-represented groups should, if done well, suit others. Inclusive infrastructure is particularly important given evidence that some other barriers to cycling may be stronger for under-represented groups *(van Bekkum, 2011; Bergström & Magnusson, 2003; Daley, Rissel, & Lloyd, 2007; Damant-Sirois & El-Geneidy, 2015; Finch et al., 1985; Steinbach et al., 2011)*. For example, women may have stronger concerns than men about safety from crime, while older people may struggle to cycle longer distances.

A focus on the needs and preferences of under-represented groups should account for these issues when planning the location of infrastructure, routes and wayfinding strategies. It is increasingly the norm in the US that the needs of specific demographics and age groups as well as the needs of the socially excluded or of specific ethnic minorities are considered and that equity goals and accompanying performance metrics are introduced in the planning, implementation and scheme monitoring.

OPERATORS AND CONTRACTS

The operating models of a BSS can differ substantially depending on context, scale, objectives and resources; however, the operation of an urban BSS will generally fall within one of five main categories:

1. A public-private partnership where typically advertising companies, street furniture providers or other public services (JC Decaux, Clear Channel, Cemusa, etc) provide and operate a system in exchange for advertising rights or placement.

2. Publicly or privately owned businesses such as transport companies and retailers (Callabike, DB Rent, EFFIA, Veolia, Lidl, Bixi, OV Fiets, Jaunes La Rochelle, etc) provide and operate a system to enhance linkages with public transport or promote direct access to specific locations.

3. Bike sharing businesses (Bleeperbike, nextbike, Bicincittà, C'entro in bici, Ecotravel, etc) that operate commercially with no public funding.

4. Municipal operators which contract a provider or which alternatively design, own and operate distinct local systems.

5. Associations, cooperatives and non-profits who operate with small-scale public funding.

It is generally considered categories **1** and **2** are more pertinent to large-scale systems. Categories **3** and **4** are typical of medium or small cities, while category **5** is characteristic of a localised small-scale system often primarily with a tourism or leisure focus.

A Municipal Authority will play an essential role in the planning and implementation of a BSS. It may opt to procure a scheme or simply license one and shape its use in line with stated municipal objectives. Municipal Authorities tend to be involved throughout all stages of the project: consulting with stakeholders and individuals; commissioning feasibility studies from consultants to evaluate costs and technical requirements; contracting an operator or procuring the bikes and stations themselves, depending on the business model chosen. They determine the conditions under which an operator implements the system often stipulating adherence to bye-laws or specifying public realm constraints. To ease the planning and scheme design process, operators should be involved as early as possible in order to make use of their technical and operational know-how. In many instances, the Municipal Authority may subsidise the scheme either directly from its own resources or serve as a conduit for national exchequer funds. Irrespective of approach taken, Municipal Authorities are also likely to bear additional costs for infrastructural development and ongoing public realm management.

HARDWARE AND TECHNOLOGY

The access technologies of BSS vary considerably and depend on the size of the system, available financing and the technology used. Options include cards such as smartcards, magnet cards, chip cards or credit cards; RFID**;** apps**;** code-based rental where an access code is transmitted by SMS; smart-code app; QR codes; key; or from a person in charge.

The bicycles used in a BSS also vary considerably in design and quality. Nevertheless they will generally be *robust* in order to minimise damage and vandalism; *unique* in order to enhance scheme visibility as well as to deter theft; *of one size* but adaptable to different users; *adaptable* for advertising and promotions and *lockable* to prevent theft. Stock should be of sufficient quality to withstand the rigours of constant public use and exposure to the elements. A typical acceptable time frame would be a physical quality/robustness to tolerate 4-5 years of standard use. Moreover, the bicycle used should meet rider safety, comfort standards and conform to current bicycle standards. Currently the ISO 4210 framework for city bicycles is the standard required across the EU.

While there has been a rapid growth in the development of dockless schemes worldwide, docking stations remain a feature of many BSS's. They differ in scale and permanence as well as through the technology used; being either *low-tech* with the bicycle locked to the docking point mechanically either with a lock on the docking point or a lock on the bike itself or *high-tech* with an electronically controlled docking point connected to a rental terminal.

Software is needed to operate the system at the back-end - all IT-systems running on the operator's side, invisible to the customer - and at the front-end - all IT-systems with interaction and usage opportunities for customers and potential users.

COSTS AND FINANCING

The issue of costs and financing are fundamental to the planning, development and operation of a BSS with implementation costs varying depending on the scheme size and design. Due consideration must be given to capital costs and to the operational costs necessary to sustain and further develop a scheme. Furthermore, given the likelihood that costs and finances will be provided from different funding sources for different purposes (i.e., upfront capital costs, labour, ICT integration, promotions, maintenance, etc) the sustainability of each operating or delivery model needs to be carefully considered and evaluated. Defining the respective roles and obligations between project partners as well as the resource demands from each is also critical.

The capital cost in a large-scale system is generally of the order of €2,500 - €3,000 per bike, depending on the system configuration apportioned as follows:

Table 2: Capital costs for docked BSS

Capital Costs	% share of Total Costs
Station implementation, terminals docking points and locking technology, station planning, ground work and cabling	70%
Bicycles	17%
Set-up operation, workshop and logistics	6%
Communication	5%
Administration	2%

Source: Optimising Bike Sharing in European Cities, a Handbook

There can be significant variations depending on the technical features of the model used (technologies, network size, logistics, and city-specific characteristics). Modular or mobile schemes requiring minimal groundwork or utility connectivity (e.g. solar or battery powered stations) can be implemented at a lower cost while dockless schemes can be delivered at a fraction of the costs of conventional station-based schemes. Implementation costs are usually depreciated over the duration of the contract. Capital investment to set up the scheme may require grants from national or local authorities, be funded by the operating partners or by a public private partnership of some description. The Velib experience in Paris also showed that there can be unexpectedly high costs linked to theft and vandalism.

Operational costs are generally in the order of €1,500 - €2,500 per bike per year in most large schemes. A reliable apportionment of BSS operational costs is believed to be:

dublinbikes scheme

Table 3: Operational costs for a docked BSS.

Operational Costs	% share of Total Costs
Redistribution of bicycles	30%
Bicycle maintenance	22%
Station maintenance	20%
Back-end system	14%
Administration	13%
Replacement equipment	1%

Source: Optimising Bike Sharing in European Cities, a Handbook

Cost structures will differ depending on the size of the scheme and the number of rentals. Since investment and personnel costs are mainly fixed costs, the average costs per rental decrease as the number of rentals increases. Other operational costs are, to a large extent, variable costs. The higher the number of rentals per bike, the higher the number of maintenance, customer service and redistribution processes. Thus the costs per bike increase. Conversely, this results in lower costs per bike in many smaller schemes with few rentals per bike.

In order to cover the costs of implementing BSS, there is a range of financing and funding models. The main financing sources from an operational point of view are subscription and usage charges paid by the customer. Charges differ substantially between the city sizes in the OBIS research with the smaller (75%) and medium-sized cities (82%) more likely to have schemes that are free of charge than large city schemes (60%). While registration charges, subscriptions and usage charges represent the income raised by users, it should be noted that given the standard 30-minute-period free of charge use period and the short duration for each ride, registration charges are most likely to comprise the bulk of user income generated. Depending on the type of contract with the operators, a BSS can be co-financed with income from scheme naming rights, site location sponsorship or from

individual bicycle sponsorship, station advertising or as some cities have opted to do, fees accruing from ring fenced car parking charges. However individually or collectively, these revenues are rarely of the quantum required to offset the need for a significant public subvention from national or local authorities. Whether such a subvention – and for what duration - is available remains a central consideration in BSS planning.

BSS USAGE

While usage in a BSS can vary dramatically between different countries and different urban locations, docked systems generally exhibit a similar daily usage profile. When comparing system usage between different locations and bike-sharing systems, the standard metric used is *trips per day per bike.* Generally speaking, a BSS will generally be busier during the warmer months, which generally confirms the relationship between weather and the propensity to cycle. Weekday usage peaks between 7am – 9am and 4pm– 6pm, while weekend usage is strongest in the middle of the day. As dockless schemes tend to operate on a fully commercial basis, data gleaned from usage tends to be proprietary. There is little available information to indicate therefore whether usage differs dramatically between docked or dockless systems.

Research carried out during the planning for the London BSS found that, among all resident and visitor groups, students were most likely to use the scheme. This could be due to any number of reasons including the appeal of a virtually free mode of transport, the difficulty of storing a private bike in student accommodation, and concerns about bike theft. The take-up rate by students will obviously be determined by how well the distribution of docking stations links up with journey origin and destinations.

More recent IT-enabled BSS's allow access to large-scale user and ridership data. This is enabled by a GPS embedded in the system hardware which records geospatial and temporal usage patterns. This offers exceptional insights into route choice and other usage characteristics and is regarded as a valuable commodity by operators. In contrast to private bicycle riding, it is relatively easy to determine the trip duration of a BSS journey, as each trip is recorded at the point a bicycle is removed from a docking station or otherwise accessed and later again when it is returned. A study on bike-share trip duration, (*Fishman, Washington, & Haworth, 2014)* using data from Melbourne, Brisbane, Washington, D.C., Minnesota and London found that trips fell within a tight band of between 16-22 min. Other researchers (*Buck et al, 2013; Zaltz Austwick, O'Brien, Strano, & Viana, 2013*) have found casual or occasional users typically take longer trips than annual members with trip duration shown to vary seasonably; longer trips typically occurring during warmer months.

THE IMPORTANCE AND VALUE OF DATA

The technologies used in the operation of a BSS allows a wide of variety of data, both historically and in real-time, to deliver valuable actionable insights for operators and other interests. Indeed, this aspect is likely to account for the explosive growth in BSS globally and in particular for the extraordinary levels of investment from technology platforms and venture capitalists in operators worldwide.

Urban environments provide an entire eco-system of valuable and relevant data. Operators will generally use data to focus on user dynamics, routes taken, and time used. They will use this data to refine adapt or grow the scheme; both in terms of absolute volume as well as range and location. Ostensibly, this allows the operators better meet the dynamic needs of the user. However, as can be evidenced from the development of *MaaS* and the integration of micro-mobility to create total mobility platforms,

"SYSTEM BICY" - example of bike sharing in Velenje. Slovenia

data will also be used for other purposes. These may include seamless multi-modal integration or the alignment of development platforms and payment technologies. Opportunities also exist to monetise the data, information and insights through its sale for commercial purposes.

In general a docked system will have data sharing protocols in place between Municipal Authorities and operators. In contrast, operators of dockless systems – given their privately funded nature – are likely to view the data obtained as proprietary and confidential. Where data is shared Municipal Authorities are likely to place a value on the data and information to better assess and understand the dynamics and patterns of movement through the urban environment. Understanding how areas are being used at different times of day, by different types of people, and in response to different events through real-time data, can be highly beneficial.

Introduced by the EU in May 2018, the General Data Protection Regulation (GDPR) considers how organisations collect, use, store and manage personal data of EU citizens. Data collectors will be required to process personal data lawfully, transparently and for a specific purpose. Given that the BSS business model is dependent on the collection and use of personal data (names, addresses and credit card details), this is likely to have a significant impact on the BSS operations across Europe. It should be noted that the GDPR:

- Applies to all organisations that operate in the EU or handle personal data of EU citizens no matter where the organisation operates. It applies to data processors as well as the data controllers when handling personal data
- It has a broader scope of the definition of personal data and now includes data such as IP addresses, behavioural data, location data, and financial information.
- Individuals have new rights under the GDPR including the right to access the data, right to rectify incorrect information, right to restrict processing, right to portability and right to object certain uses of data.
- It is important to obtain explicit consent from individuals for distinct purposes with a proof of record stating when and how consent was given. GDPR does allow for 'soft' opt-in which enables organisation send marketing messages for similar products or services as long as individuals are given the opportunity to opt-out at any time.
- Individuals can request how their information is processed. Operators will need to clarify the purpose in which the data was collected and should ensure that the purpose is limited and the data collected is as minimised as possible.

Deutsche Bahn bike pool in Berlin

7.0 BIKE SHARE: A REVIEW OF RECENT LITERATURE

A comprehensive review and analysis undertaken in 2016 *Bike share: A Review of Recent Literature (Elliot Fishman)* synthesised 80 studies of BSS's developed in urban locations throughout the world. Concentrating in the main on studies conducted in the period 2011-2015 and coinciding at that time with the phenomenal global growth in docked system BSS's, it represents a useful evaluation of the current state of global bike share research in order to better understand, and maximize the effectiveness of current and planned future initiatives.

Several consistent themes have emerged within the growing body of research on the motivation, demographics and usage of BSS. Firstly, the importance members place on convenience and value for money appears paramount in their motivation to sign up and use. Secondly and perhaps surprisingly, scheme members are more likely to own and use private bicycles than non-members. Thirdly, users demonstrate a greater reluctance to wear helmets than private bicycle riders and helmets have acted as a deterrent in jurisdictions in which helmets are mandatory.

Finally, and perhaps most importantly from a sustainable transport perspective, the majority of scheme users are substituting from sustainable modes of transport rather than the private car. This review and analysis further provided a number of interesting insights and observations:

- Convenience is the major motivator for BSS use. In particular, the ease of access to and proximity of a docking stations to residence and place of employment.
- Financial savings arising from BSS membership and use when compared with public and private transport options is a powerful motivator and is notable for those on lower incomes.
- The distance one lives from/or proximity to a docking station is an important predictor for BSS membership.
- In a range of countries, it has been found that just under 50% of BSS members use the system less than once a month suggesting that subscribers may view BSS as an occasional adjunct to their primary and secondary transport modes. A survey of Kilkenny residents regarding a potential BSS demonstrated that those users who would consider using the scheme also envisioned predominantly *'occasional'* usage as opposed to regular usage.
- A BSS can provide modal shift and substitution however it will predominantly replace trips formerly made by public transport and walking as has previously been evidenced in Dublin *Examining user behaviour on a shared bike scheme: the case of Dublin Bikes (O'Neill and Caulfield, 2012).*
- Males use a BSS more than females and are more likely to use a BSS for commuting purposes, but the imbalance is not as dramatic as private bike riding, at least in low cycling countries.
- Commuting is the most common trip purpose for annual members with casual users more likely to use BSS for social, leisure or tourism purposes.
- BSS's in countries with low cycling usage have lower levels of female participation. However it has been noted that female participation rises substantially for trips that start or finish in a park, suggesting a recreational rather than commuting trip purpose as well as a desire to avoid vehicular traffic.
- BSS users tend to be of higher average income and in employment.
- Health benefits differ by gender and age, with men's major benefit coming from reductions in ischaemic heart disease, whereas women were more likely to benefit in terms of reductions in depression.
- The greatest health benefit would accrue from an increase in middle-aged and older people using BSS.
- BSS users are less likely than private cyclists to wear helmets, but in countries with mandatory helmet legislation, BSS usage levels have suffered.
- When compared to the level of risk for general cycling, locations where BSS exists tend to have better safety records
- BSS users appear less likely to be injured than private bike riders.
- Future directions for BSS development include integration with electric power assist, dockless systems and improved public transport integration.
- Technological advances in GPS, smartphones, real-time information and Wi-Fi hotspot functionality have reduced the need for physical docking stations and represent an affordable development option.
- Greater research is required to quantify the impacts of BSS in terms of mode choice, emissions, congestion and health.

The research offers valuable insights into barriers and inhibitors to BSS success, user adoption, participation and use. The issues most regularly cited as negatives for a BSS included:

- Convenience of driving.
- Location of docking stations.
- Poor cycling infrastructure and facilities.
- Safety concerns.
- Cycling in vehicular traffic.
- Contested and congested road space.
- Lack of immediacy in registration and access to a bicycle.

KEY ENABLERS

The *Bike share: A Review of Recent Literature* research echoes and further reinforces the OBIS

research findings in identifying a number of key factors deemed crucial to enabling a BSS. These are:

- ***Scheme size and density.*** A successful scheme requires a well-developed network of docking stations. The location and density of these stations needs to be carefully considered in order to ensure that they are easily accessible; integrated with other transport modes; available at all strategic locations with high footfall such as commercial areas, transport hubs, social and cultural venues, public services such as post office, hospitals, banks, etc.

- ***Provision of safe cycling infrastructure*** including a network of cycle lanes or paths, direction signs for longer cycle routes, cyclist priority with different safety measures where cyclists and vehicular traffic interact (junctions, pedestrian crossings, traffic lights, bus stops, etc) safe and secure cycle parking places.

- ***User accessibility*** to include all measures taken to make the system easy to access, the ease of the registration process; payment options, the density of stations and bikes; the rapid repair of malfunctioning stations and bikes; and the hourly and yearly opening times.

- ***Bike and station design*** which must be visible but unobtrusive, be of high quality and appropriate to context and scale, resilient to weather, wear and tear and resistant to theft.

- ***Reliability and the ability to deliver to user demand and expectations*** with the redistribution of bikes and management of traffic flow actively managed in order to ensure a constant supply of bikes, as when and where needed by subscribers and users.

- A BSS should be ***integrated with a wider transport policy*** and combined with other transport measures in order to be part of an efficient and sustainable transport system. This includes in particular the need for integration with public transport, in terms of information, physical infrastructure and location, access and charges ideally with integrated tariffs and payment systems.

RISKS AND BARRIERS

Similarly the research identifies a number of risk factors that will inhibit success. These are:

- ***Financial viability***. A BSS generally relies on a mix of funding sources for capital development and operational expenditure. Careful consideration is required to ensure that costs incurred in the planning, development, promotion and operation are realistic and appropriate to the likely levels of user demand. Due consideration needs to be given to costs likely to be incurred for maintenance of docking stations, wear and tear as well as theft or damage to the bicycles.

- Given the need for circularity in the use of bicycles, ***topography and landscape*** can limit or inhibit use in hilly locations, with these locations generally having greater demands for redistribution and rebalancing of stock.

- ***Climate and weather conditions*** can limit the uptake of cycling and the consistency and regularity of user demand over a 12 month period. The local climate is an important influencing factor for cycle usage in different seasons. During the cold season, the demand will be influenced by weather but also by cycling infrastructure conditions (snow, ice, etc). Some locations opt to completely suspend operations during winter.

- An existing ***high level of bike ownership*** and use tends to result in a low participation in BSS.

- Notwithstanding the obvious safety merit, ***compulsory helmet use*** can significantly hinder the success of the scheme, most particularly for casual or occasional users.

- The ***planning process and space limitations*** in an urban environment can limit site availability, desirability, scale and density thus affecting user demand.

STAKEHOLDER MANAGEMENT

Stakeholder management is a critical element in the planning and development of a successful and sustainable BSS. This requires a clear understanding of the stakeholders, knowledge of their interests and motivations and most crucially, whether these can be accommodated, aligned or mitigated as necessary. In any given urban setting the stakeholders and their interests are shown in Table 4.

Table 4: Potential Stakeholders and their interests

Stakeholder	Interests
Policy makers	Planning and implementation of public policy; Delivery of european and national policy and targets; Provision of finance and other enabling resources; Sustainable Development Goals; Management of public good; Mitigation measures; Efficiency of investment
Public representatives and *"City Fathers"*	Town planning and infrastructure development; Spatial planning; Improving liveability; development of commercial activity; management of public realm; implementation of public policy; sustainability and environmental development; quality of life and quality of place; public image and competitive positioning
Transport Authorities and Providers	Transport planning and provision; Demand management; Scheduling; Management of user experience; Integration of modes; Connectivity and inter-modality; Safety; Management of contractual obli0gations and targets; Viability and Subsidies; Visibility of service; Management of administration and operational costs
End User	Liveability; Environmental good; Safety, Accessibility; Efficiency; Availability and ease of use, Comfort & speed; Health and well-being benefits
Business & Services	Ease of access to retail and services: Reduce congestion and delay; Quality of public ream; Environmental quality; Promotion of Tourism; Employee needs: Expenditure of commercial rates & levies; Infrastructural enhancement
Citizens	Liveability, Safety, Dedicated cycle infrastructure; Management of public good, Attractiveness of public realm, Value for expenditure of public money, Privacy and data concerns, Nuisance and blight. Environmental enhancement; Social equity; Expenditure of scarce resources.

SUCCESS FACTORS

Taking account of the enabling factors to be nurtured and the inhibitors whose risk and impact must be mitigated, it is possible to identify a number of critical determinants in the success of a BSS. These include:

- Population and Population density.
- The existence and implementation of a cycling infrastructure plan for the city or region.
- An existing basic culture of urban cycling.
- The construction and maintenance of cycle lanes or paths.
- Safe cycle parking places, especially at public transport stops.
- The scale and extent of the urban area.
- Availability of and proximity to local employment.
- Third-level student population.
- The rate of bicycle ownership.
- External conditions that could make cycling difficult such as topography, pedestrian priority, climate etc.
- Integration with other shared modes of transport such as public transport, park and ride, parking, car-pooling, etc.
- The identification of the principal target group (commuters, tourists, leisure, etc) and consideration of their needs.
- The presence of signature tourism attractions and points of interest.
- The availability of alternative modes of transport to access and move between places and points of interest.
- Distance to public transport stops, hubs and interchanges.
- The ready availability of information on all available transport options and modes.
- A sustainable financing model to address capital and operational costs over the schemes duration.

Rekola bikes in Prague, Czech Republic

8.0 BIKE SHARING SCHEMES IN IRELAND

DUBLIN

JC Decaux, the largest outdoor advertising corporation in the world, has been operating the *dublinbikes* contract on behalf of Dublin City Council (DCC) since its launch in 2009. The scheme resulted from a tender by DCC for the provision of public amenities in return for concession over strategically located DCC owned advertising sites in the city. This was based on broadly similar arrangements in Paris, Lyon and elsewhere operated by Decaux.

The scheme launched with 40 stations, 450 bikes and a longer term goal of increasing to 300 docking stations and 5,000 bikes over 14 phases at a cost of €100m. By December 2010 *dublinbikes* had over 30,000 annual subscribers - greatly in excess of the 5,000-10,000 envisaged at the launch of the scheme. The scheme currently has 116 docking stations with 1600 bikes densely clustered in the urban core within the canal cordon of the City. Each docking station accommodates 15 bikes. Stations operate between 5am and 12.30am and bikes can be returned at any time. The scheme is open to all users over 14 years of age.

All docking stations are equipped for Annual Card (€25) and 3 Day Ticket (€5) users. A number of credit card enabled terminals also allow the purchase a 3 Day Ticket. All users must sanction a pre-authorisation for a flat rate penalty fee of €150, should the bike not be returned within 24 hours. Applicable rental charges are debited monthly by credit card or direct debit. The first half-hour of each journey is free; after that the service charge varies depending on how long the bike is used. In 2016, the *Transport for Ireland Leap Card scheme* was extended to the *dublinbikes* scheme allowing integration with other public transport modes in the city. Usage fees inclusive of the applicable VAT are charged as follows:

Table 5: Usage charges for the Dublin BSS

1st half hour	Up to 1 hour	Up to 2 hours	Up to 3 hours	Up to 4 hours	Every extra half hour
Free	€0.50	€1.50	€3.50	€6.50	€2.00

Source: *www.dublinbikes.ie/Subscription/Pricing-Structure/Pricing-structure*

JC Decaux funded all scheme costs including at initial set up, ongoing operations and maintenance. However subsequent expansions of the scheme have been part funded by the NTA with matched funding required from the DCC capital budget. Subscription and usage fees accrue to DCC.

In April 2016, when considering the planned expansion of the scheme, DCC noted in its *Report on Revenue Generation Options to Facilitate Expansion* that *"The scheme expansion incurs an annual Operations and Maintenance cost of €1.92m that is a responsibility of Dublin City Council to meet each year. This cost is offset by membership and usage fees that accrue to the Council as well as €312,000 per annum from sponsorship as 'Coca-Cola Zero dublinbikes'. Any remaining deficit is met by Dublin City Council. The 2015 deficit was €376,211".* It was further recorded that total income for 2015 was €1.55m, of which €1.24 came from subscription and usage fees. DCC viewed this as a very successful return on investment when considered in the context of the wider economic, public health, liveability and sustainability benefits to the city and its population.

The scheme is often cited as one of the most successful schemes in the world accounting for an increase in mode share for cyclists in the Dublin city centre area from 2.3% in 2006 to 6.0% in 2016. However in recent times, DCC has struck a discordant note, with financing concerns casting significant doubt as to whether the *dublinbikes* scheme can be fully realised as originally planned. DCC states *"such subvention is not sustainable in the long term. Notwithstanding the obvious benefits the scheme delivers to the city as a sustainable and efficient transport choice, it is important that the gap in operational funding is reduced or eliminated. The City Council would not have the necessary budgets to provide for the operational costs of an expanded scheme owing to the demands made on such budgets from other competing sectors. It is desirable that any expansion of the existing scheme is cost neutral as was the case with the original Concessionary Contract."* It is not particularly evident how and by whom this funding and resourcing dilemma will be resolved.

In 2017, in order to help facilitate the schemes expansion and address funding concerns, DCC increased the annual membership from €20 to €25. In August 2017, *Just Eat,* an online food order and delivery service, was unveiled as the new commercial partner of dublinbikes, replacing *Coca-Cola* who had filled that role since the launch in 2009. *Coca-Cola* was understood to have paid €312,000 per annum in naming rights for the scheme. The Irish Times *reported* that the current deal will see *Just Eat* pay a contract value of €2.25m to DCC in the period to 2020; a reported 15% increase on the Coca-Cola deal but one that doesn't accord with figures previously cited by DCC in respect of naming rights.

In May 2018, DCC launched the first regulated dockless BSS in Ireland. Two Irish operators, *Urbo* and *Bleeperbike* were granted licences to operate the scheme. Chinese dockless operator *Ofo* withdrew from the tender process due to the DCC stipulation that dockless bikes be tethered to designated bike stands. The dockless scheme is intended to complement the conventional Dublin docked scheme with a particular objective to expand BSS options in the outer suburban area of the city. It is understood that the annual licence fee accruing to DCC is €200 and further charge of €50 per bike. Bikes are equipped with a smart lock fixed above the back wheel with usage controlled by communication with a custom built app. While usage range is flexible, the bikes must always be parked in a location specified in its *in-app map*. A specific requirement of the licence was that rather than operating as a "free-floating scheme" bikes were required to be locked to an

official *Sheffield stand*. Failure by the user to adhere to this condition makes the user liable to a retrieval fee of up to €250. To accommodate the scheme DCC increased cycling parking facilities throughout the city with over 1,300 extra cycle parking spaces installed over the past few months. Given the importance of students to the scheme the firm has also placed its bikes in third-level institutions to appeal to students in *UCD, DCU, Trinity and Blanchardstown Institute of Technology.*

At launch 200 bikes were to be made available throughout Dublin and gradually increased to 500 over the succeeding months with full interoperability between schemes. In September 2018, *Bleeperbike* had 450 permits a 50% increase on its numbers in July 2018. It is understood that *Bleeperbike* will seek to provide an e-bike option in the near future.

The dockless scheme operates seven days a week from 5am to 12am. Bleeperbike offers a range of subscriptions and usage options including an annual subscription (€75); a three month subscription (€20) and a one month subscription (€10). Each allows the user 4 rides of up to 60 minutes 365 days per year. A one day pass (€8) allows users access for 19 hours within a 24 hour period. A *pay as you go option* is also available (€1 per hour). Each subsequent hour is charged at €1. Applicable charges are debited from the payment card registered to the user account. Damage incurred to the bike makes the user liable for charges of up to €500, with a similar penalty being incurred for loss or theft.

It appears that *Urbo* has yet to take up the licence offered by DCC and it is not known whether it will do so. Uncertainty on this point comes on foot of the firm's decision in July 2018 to withdraw operations from the London Boroughs of Enfield, Waltham Forest and Redbridge *"due to these locations being unsuited to its business model".* This occurred nine months after *Urbo* had commenced operations in London. Similarly, operations which commenced in Ipswich in March 2018 were suspended in June 2018 and have yet to recommence.

REGIONAL SCHEMES

Following the immediate success of the Dublin BSS a similar scheme was procured by the NTA in 2014 and introduced to the second tier Irish Cities; Cork, Galway and Limerick.

The *regional scheme* is styled as *"Coca-Cola Zero® Bikes provided by the National Transport Authority in partnership with Galway County Council, Cork City Council and Limerick City and County Council, together with the assistance of Coca Cola Ireland and with funding provided by The Department of Transport, Tourism and Sport. The scheme is operated by An Rothar Nua on behalf of the National Transport Authority".*

While considered in the initial technical and commercial feasibility study, plans to introduce the scheme to Waterford City did not proceed. However, it is understood that the scheme may be introduced to Waterford city in 2019.

The study *Proposals for Introducing Public Bike Schemes in Regional Cities – Technical Feasibility Study, Jacobs, 2011* commissioned by the NTA for the regional scheme found that the cities had several of the characteristics that tend to result in successful bike sharing schemes such as very low current levels of cycling and cycle-friendly topography across large parts of the urban areas.

However, the cities also display characteristics which suggest that the success of any bike-sharing scheme would be limited due largely to the small size of the cities, the relative lack of congestion and the fact that car travel, rather than public transport, tends to be the dominant mode.

This study found that although the potential exists for successful schemes in each city, it would appear that schemes in Galway and Cork would be most successful partly due to the background levels of traffic congestion and the high price of car parking in both cities. In the initial technical assessment it was recommended that each of the regional city BSS's be scaled as shown on Table 6 below:

Table 6: Proposed scale for the Regional BSS

	Cork	Galway	Limerick	Waterford
Recommended number of bikes	265-235	200-250	135-165	80-100
Recommended number of docking stations (and docking points)	25 (510)	23 (380)	20 (255)	10 (150)
Average number of docking points per station	20	15-20	10-15	15
Estimated number of subscribers	2250	1500	1500	900
Estimated daily rents per bike	3	2	1.5	1.5

Source: Proposals for Introducing Public Bike Schemes in Regional Cities – Technical Feasibility Study, Jacobs, 2011

Based on these recommendations, the capital cost to include docking stations bicycles, maintenance, labour, ICT systems, national control room, redistribution costs and other overheads was estimated to be €6.4 million with the greater proportion of costs being incurred upfront. The total operating cost including staff, premises, vehicle maintenance, bike replacement and materials was estimated to be €23 million spread evenly over a 14 year period. *Telfourth Ltd* trading as *An Rothar Nua*– a consortium with a range of transit and technology interests - was awarded the contract to *supply, install, maintain and operate* the scheme in each of the cities. A French firm, Tracetel SA which provides docking stations and back end systems, is a member of the consortium. This contract was extended by the NTA in January 2018 for a further five years.

As with the Dublin scheme, the regional scheme is self-service service open to all from 14 years of age. The annual subscription is €10 Annual Card with a three day pass at €3. The security deposit of €150 also applies and usage fees are the same as charged in Dublin:

Currently Galway city has 16 stations clustered densely in city centre with provision for student use in some outlying areas. The scheme has 195 bikes. Limerick city has 23 stations and 215 bikes. The scheme is heavily oriented to the city centre and does not cover the University of Limerick. Cork city has 31 stations with 330 bikes. Maps of the each of the schemes are available on the official bike share *website*,

It is understood that the initial contract between the NTA and the Telfourth Ltd as contractor stipulated the minimum operational of bikes to be 740; of which 320 would be located in Cork; 215 in Limerick and 205 would be located in Galway. It is understood that the NTA is contracted to pay the operators €85,100 per month – an annual figure of €1,021,200. The figures for Cork, Limerick and Galway are €36,800; €24,725 and €23,575 respectively. Taken as an aggregate this is the equivalent of €115 per bike contracted per month.

Concerns have been raised as the quality of the service provided by *Telfourth Ltd* with some claims that bicycle availability can be limited owing to the less than the full complement being provided and further claims that some docking stations remain out of service for prolonged periods. By way of illustration, on February 6th, 2018, 266 bikes were operational in Cork with one docking station inoperable; 170 bikes were operational in Limerick where 3 stations were out of order and 152 bikes were operational in Galway where two stations were out of order. On March 30th, 2018, 243 bikes were operational in Cork (76%); 165 in Limerick (77%) and 135 (66%) in Galway. The operators have not listed any recent service updates on its *website*; the most recent being in March 2018.

Cork, unsurprisingly given its population, is the most successful location within the regional scheme with the number of trips having reached 1m. At the end of its first year, it had 1,369 subscribers. By the end of 2015 this had jumped to 7,270 and to 9,549 by the end of 2016, to 11,459 by the end of 2017. By June 2018 there were 11,951 yearly subscribers. Locally the scheme is considered to be a success and there have been regular calls for it to be expanded to other locations. The busiest station in the city is at

Table 7: Usage fees for the regional BSS

1st half hour	Up to 1 hour	Up to 2 hours	Up to 3 hours	Up to 4 hours	Every extra half hour
Free	€0.50	€1.50	€3.50	€6.50	€2.00

Source: *www.bikeshare.ie/pricing-and-subscriptions.html*

dublinbikes docking station

Fitzgerald's Park; adjacent to University College Cork (UCC).

A request to the NTA as to whether it has current or future plans to extend the regional scheme and current operating model to other large towns in Ireland has, at time of writing, yet to receive a response.

SLIGO

In March 2018, *Ecotravel* which styles itself as "*a future focused transport solutions provider*" commenced a pilot dockless scheme in Sligo. Based initially on the *Bleeperbike* system, the pilot scheme saw 50 dockless bikes made available in the first dedicated dockless system in an Irish rural town. The scheme was supported Sligo County Council, Institute of Technology Sligo, the Sligo Business Improvement District and local businesses. One notable feature of the scheme is that there are no associated capital costs for the host town as *Ecotravel* provide all the bikes, maintenance and insurance for a fixed annual contract price. They also have a data sharing protocol with Sligo County Council. On-bike advertising, location charges, data exchange and commercial sponsorship from local businesses are the revenue streams that support the business model.

As in Dublin, the scheme utilises existing public and private bike stands, thus allowing for a fast roll out without requiring any civil works or additional costs. Similarly, the sourcing, rental, unlocking and locking is all controlled by a mobile app which users can download free of charge. Terms and conditions, subscription charges and usage fees range from an annual subscription of €90 to €0.80 per hour *pay as you go* option, notably higher than the charges levied in the Dublin or in the regional cities BSS.

Having used the pilot process to trial improvements and adapt bike share for a rural context, *Ecotravel* currently has plans to roll out dockless bike share in other rural locations. As is the case with *Bleeperbike, Ecotravel* also intend to provide an e-bike option in the near future.

INFORMAL SCHEMES

Informal bike sharing schemes exist in Clonakilty West Cork and in Cavan town. Both schemes offer standard town bikes for rental with tourism use being the primary market. The former scheme offers 60 bikes at 8 hotels based in the town or adjacent settlements; whilst the latter provides 2 bicycles from the County Council. Usage is modest, infrequent and highly seasonal.

BSS USAGE IN IRELAND

The Transport Omnibus 2016 produced by the Central Statistics Office (CSO) provides comprehensive data on subscriptions and numbers of journeys for each of the BSS's in Dublin, Cork, Limerick and Galway. It notes that 57% of all BSS subscriptions are in Dublin.

Table 8: User data Dublin 2015-2016

Bicycle sharing scheme data for Dublin, 2015 – 2016								
	2015	2016		2015	2016		2015	2016
Month	Long term subscriptions[1]			Short term subscriptions			Number of journeys	
Jan	1,460	1,353		653	707		276,806	297,735
Feb	1,377	1,200		788	683		292,211	311,615
Mar	1,612	1,363		1,062	1,318		323,852	334,423
April	1,770	1,558		1,757	1,295		336,403	350,128
May	1,544	1,918		1,796	2,242		331,365	399,488
June	1,827	1,771		2,147	1,920		366,799	390,123
July	1,756	1,820		2,229	2,141		382,512	405,016
Aug	1,762	1,878		2,770	2,116		354,710	393,276
Sep	2,082	2,622		1,766	1,665		388,356	409,077
Oct	1,779	1,797		1,946	1,934		397,012	403,070
Nov	1,235	1,323		1,012	767		345,249	365,182
Dec	664	849		724	1,010		277,603	296,304
Total	18,868	19,452		18,650	17,798		4,072,878	4,355,437
Source: JC Decaux								
[1] **Data refers to new memberships each month**								

Source: Central Statistics Office, 2018

This reveals that there were 19,452 annual subscribers to the Dublin Bike scheme. This was augmented by 17,798 short term subscribers which combined accounted for over 4.3m journeys made - the largest number of journeys by users being in September when 409,077 journeys were made.

Table 9: User data in the regional cities BSS for 2015-2016

	Annual subscriptions[1]			Short-term subscriptions[2]			Number of journeys		
	Cork	Gal	Lim	Cork	Gal	Lim	Cork	Gal	Lim
January	7,655	1,987	2,466	33	10	3	18,494	898	2142
February	7,759	1,991	2,478	43	31	4	23,278	1,035	2096
March	7,847	2,008	2,490	83	37	13	23,764	1,042	2613
April	7,955	2,032	2,511	97	77	10	26,318	1,217	3101
May	8,108	2,034	2,542	123	120	36	25,748	1,321	3387
June	8,270	2,036	2,584	169	137	43	23,058	1,363	3139
July	8,411	2,059	2,616	159	155	20	22,334	1,236	2691
August	8,539	2,071	2,649	164	117	23	21,924	1,074	2821
September	9,151	2,163	2,802	114	79	21	26,594	1,181	2749
October	9,434	2,149	2,837	88	79	33	32,652	1,425	3290
November	9,523	2,140	2,836	48	31	24	28,045	1,075	2739
December	9,549	2,143	2,840	37	16	19	18,381	707	2124

Source: Central Statistics Office, 2018

Cork with 9,549 annual subscribers in addition to 1,158 short term, Galway 2,143 annual subscribers in addition to 889 short term and Limerick with 2,840 annual subscribers in addition to 249 short term subscribers accounted for 291,590, 13,574, 32,892 journeys respectively. For Cork and Galway, the month of October had the most bicycle journeys when 32,652 and 1,425 journeys respectively were undertaken.

In total, 4,692,493 BSS journeys were undertaken by subscribers in Ireland; of which 93% were in Dublin. Data summarised for each location reveals:

Dublin

- 4,355,457 journeys were undertaken in 2016.
- 17,767,766 journeys have been undertaken since the scheme commenced.
- 68,074 people had subscribed to the scheme by year end 2016.
- Journeys totalling estimated 39m kilometres have been undertaken since launch.
- The busiest day's usage was 16th September, 2016 with 18,041 journeys undertaken.

Cork

- 290,590 journeys were undertaken in 2016.
- 580,656 journeys have been undertaken since the scheme commenced.
- 9,549 people had subscribed to the scheme by year end 2016.
- Journeys totalling an estimated 914,953 kilometres have been undertaken since launch.
- The busiest day's usage was 30th September, 2015 with 1,756 journeys undertaken.

Galway

- 13, 574 journeys were undertaken in 2016.
- 35,384 journeys have been undertaken since the scheme commenced.
- 2,143 people had subscribed to the scheme by year end 2016.
- Journeys totalling an estimated 69,002 kilometres have been undertaken since launch.
- The busiest day's usage was 10th February 2015 with 128 journeys undertaken.

Limerick

- 32,892 journeys were undertaken in 2016.
- 74,174 journeys have been undertaken since the scheme commenced.
- 2,840 people had subscribed to the scheme by year end 2016.
- Journeys totalling an estimated 118,218 kilometres have been undertaken since launch.
- The busiest day's usage was 12th October 2015 with 213 journeys undertaken.

In its report *Transport Trends 2017,* the Department of Transport, Tourism and Sport cites 2015 data from the NTA, CSO and Dublin City Council showing the number of journeys for each city on a per bike basis. Dublin had by far the highest number of journeys per shared bike in 2015 at 2,715. Cork had the second highest at 904, while Limerick had 186 and Galway had 97. A similar pattern is evident for the number of annual subscribers. Dublin also had the most valid annual subscribers per shared bike in 2015 at 38.5, with Cork second at 23.5, Limerick third at 11.4, and Galway fourth at 9.7 annual subscribers per bike.

An assessment of progress and success since then is instructive. The most recent figures cited by *dublinbikes* are as of 21st August 2018 are as follows:

- 66,739 current valid long-term users.
- 9,757 short term subscribers in the year to date.
- 2,192,892 journeys in the year to date.
- 24,062,484 journeys since launch.
- An average duration of journey of 15 minutes in the year to date.
- A free journey rate of 96% in the year to date.
- 18, 041 journeys on its busiest day in the year to date.

Table 10: Membership and trips taken in the regional cities BSS 206-2017.

Location	Trips in 2016	Membership 2016	Trips 2017	Membership 2017
Cork	290,590	9,382	281,266	11,278
Galway	13,574	1,984	23,758	3,312
Limerick	32,892	2,684	32,481	2,955
Cities combined		213		229
Total	**337,056**	**14,263**	**337,505**	**17,776**

Source: NTA, 2018

Allowing for the differences in data sources, it appears that current usage figures indicate a decline in subscription numbers of almost 2% since 2016. More significantly, it can be estimated that journeys undertaken have declined by almost 12% in the same period. The reasons for this are not known. However, it is apparent that usage figures for the regional scheme are flat at best. In its 2017 Annual Report the NTA provides an update:

This reveals that growth was static across the locations combined, with substantial growth in Galway city (75%) – albeit from a very low base - offset by a fall in demand in Cork city (-3%) and in Limerick city (-1%). For context, it should be noted that the drop in demand occurred at a time when subscriber numbers increased by 24.6% and additional stations and bikes were provided.

PROPENSITY TO CYCLE IN IRELAND

Given the static performance of the Dublin and regional city schemes it might be useful to consider exogenous factors that influence cycling in Ireland. Government spending on cycling infrastructure has fallen significantly over the past three years Figures provided by DTTAS show almost €19 million was allocated to cycling infrastructure in 2015. This almost halved to €10.5 million in 2016 and fell further to €7 million in 2017. Some €8 million is earmarked for cycling infrastructure in 2018. However, such reductions should be considered against a backdrop of a significant rise in the number of people cycling.

Between 2011 and 2016 there was the sharp rise in the number of people who cycled to work from 39,803 to 56,837, an increase of 43%. This may be attributable to a range of factors and incentives to include the Cycle-to-Work scheme; BSS initiatives in Dublin, Cork, Limerick and Galway: and the introduction of new cycle pathways in urban locations. In Ireland the number of cyclists peaked in 1986 at 60,750, when cyclists made up 6.8% cent of the commuting population; however, while the 2016 numbers were again close to the 1986 peak, cyclists only accounted for 3% of commuters. According to the *CSO 2016 census figures*, those in their early 30s are most likely to cycle to work when compared to other age groups. Non-Irish nationals accounted for 27% of all cycling commuters.

A study, *Commuting by bicycle: Why the Irish aren't like the Dutch (yet),* 2014, determined that only a minority of people who signed up for the *dublinbikes* scheme commute to work by bicycle each day. The study, which examined the under-utilisation of urban bicycle commuting, found that between 2006 and 2012, the number of cyclists in Dublin city rose 42%. However, the study of 936 Dublin commuters found that 60% of people of those who have signed up for the scheme never cycle to work. Just 14.9% said they cycled to work every day, with another 14.8% reporting that they cycle to work up to two times a week. The study found the main reason people said they did not cycle to work was inconvenience — with respondents noting that cycling was "*a nuisance*" and that "*any other mode of transportation is more enjoyable than bicycling*". Other reasons given were "*poor weather*" and that cycling in Dublin City was "*too dangerous*". However, the study pointed out the probability of getting rained on during a commute in Dublin lies between 4% and 6%, while eight cyclists died in road incidents in 2012, compared with 29 pedestrians and 95 car occupants.

According to the recent Garda *'Lock it or Lose it'* campaign, 14,000 private bikes worth €2m have gone missing since 2016. 83% of the thefts having occurred in four cities: Dublin, Galway, Cork and Limerick.

8.0 KILKENNY: CHARACTER, DEMOGRAPHICS AND ECONOMY

Having regard to the importance of its urban character, demographics, topography, climate, economic and employment activity and their individual and collective impact on user acceptance and the sustainability of a BSS, a summary of each of these elements is presented. Unless otherwise stated, all data cited is based on the 2016 Census of Population.

PLAN FORM AND URBAN CHARACTER

Characterised by a rich architectural and industrial heritage, Kilkenny is considered to be the medieval capital of Ireland. Its compact urban core and attractive streetscape contains many historical sites and it, along with its outstanding public realm, is carefully protected and maintained by Kilkenny County Council (KCC) and other stakeholders; whose shared ambition and resolve is to retain and enhance its essential character.

KCC view Kilkenny's heritage as that *"which makes the county unique, what gives it its special character and its 'sense of place'. It is a valuable economic resource. It is the basis for Kilkenny's tourism industry and brings significant economic benefits to the county. Heritage is also vital for the health, well-being and quality of life of communities. Built heritage includes all man-made features, buildings, and structures in the environment. It includes our rich and varied archaeological and architectural heritage. The historic, innovative or rare buildings and other man-made structures constructed by previous generations of Kilkenny inhabitants as homes or places of industry, commerce, defence, leisure or worship form the architectural heritage of the county".*

Development is strictly controlled within defined policies and parameters set by KCC. Legal protection for this purpose is provided for by the *Planning and Development Acts 2000-2014* by way of the *Record of Protected Structures* (RPS) which lists in excess of 250 structures in the city and *Architectural Conservation Areas* (ACAs). These are defined as places, areas, groups of structures or townscapes, taking account of building lines and heights, that are of special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest or that contributes to the appreciation of a Protected Structure. The purpose of an ACA is to protect the general character of an area in regard to building scales, proportions, historical plot sizes, materials, building lines and height, historic street paving and street furniture, as well as general use. Works undertaken should respect historic character with regard to the use of materials and design. There are 9 ACA's in the city; *the city centre, Kilkenny Castle; St. Canice's; John St, Patrick St, Michael St and Wolfe Tone St; St. Mary's; Lacken; and Talbotsinch.*

The most significant aspect of the built environment of Kilkenny is the quality of the city centre; a combination of the natural features of river and topography, the street spaces, the fabric buildings and the numerous iconic buildings and artefacts of historical and archaeological value. *Kilkenny Castle* and *St. Canice's Cathedral* are situated at opposing poles of the central area located on an east-west axis. The enclaves of these two buildings and the spaces, which link them – *Irishtown, Parliament Street* and *High Street* form the spine of the central commercial area. The main spine tends to run parallel to the contours traversed by minor streets and lanes. These narrow lanes or "*slips*" as they are locally known are a particular feature of Kilkenny's townscape. Some

Canal Square, Kilkenny

are pedestrian ways, which form short cuts across the width of particularly long city blocks and do not have frontage development. Others act as narrow streets with buildings fronting onto them or are ambient laneways.

The network of streets and laneways is complemented by buildings of different uses, architectural quality and historic backgrounds, including many examples of traditional shopfronts and of domestic housing; these along with fine civic or public buildings with a variety of architectural styles are symbols of the social, economic and cultural development of the city and contribute to its essential character. Kilkenny features a host of buildings constructed entirely from limestone or incorporated within its decorative dressings. The River Nore flows through the city and its tree-lined banks and adjacent open spaces provide an important natural element in the overall townscape character of the city.

The city is a keen participant and frequent prize winner in the *Tidy Towns* competition. Organised nationally, emphasis is placed on the quality of overall development approach, the public realm, the built environment, landscaping, biodiversity, wildlife & natural Amenities, litter control, tidiness, waste minimisation and the presentation of residential areas, streets, back areas and approach roads.

POPULATION AND DENSITY

For the purposes of this study the city is defined as the *Settlement of Kilkenny.* This comprises the Electoral Divisions of *Kilkenny No.1 Urban* and *Kilkenny No. 2 Urban* and some of the Electoral Division of *Kilkenny Rural*. Census 2016 records the population of Kilkenny city as 26,512. It is the 11th largest urban settlement in the state; its population having increased by 8.6% in the period from 2011. The city comprises an area of 12.5 km^2 and has a population density of 2,115.9 people per km^2; an increase of 1.64%/year in the period between 2011- 2016.

The urban core of Kilkenny is essentially comprised of the legally defined boundary of the city, the *Electoral Divisions* of *Kilkenny Urban No.1* and *Kilkenny Urban No.2.* The former is a compact area of 1.91 km^2 with the latter being 1.83 km^2. The population density within the urban core has increased notably between 2011 and 2016 being 3,027 people per km^2 in *Kilkenny Urban No.1* and 2,228 people per km^2 in *Kilkenny Urban No.2*.

9,842 people or 37.1% of the population reside in the legally defined boundary of the city. Of this amount 5,782 or 58.75% reside in Kilkenny Urban No.1; a 10.95% increase since 2011. 4,060 people (41.25%) reside in Kilkenny Urban No.2; an increase of 16% since 2011. The remaining population comprising the Settlement of Kilkenny 15,712 or 64.3% reside in the suburbs or environs of the city. In total the Settlement of *Kilkenny* comprises 9,689 households and 6,516 families. 51% of the urban population is female. 67% of households have a personal computer with 80% of households having internet access. 16,767 people or 63% of the city's population is aged within the economically active cohort.

The Pobal HP Deprivation Index provides a method of measuring the relative affluence or disadvantage. Percentage data is provided under a range of categories such as unemployment, educational attainment and population change. Kilkenny Urban No.2 and *Kilkenny Rural* are classified as *marginally above average* whilst *Kilkenny No.1* is classified as *marginally below average*.

The social class and skills profile of Kilkenny residents is oriented towards professional, managerial, administrative and skilled manual employment with 67% falling within these categories.

The KCC *County Development Plan 2014-2020* predicts a future population in the city of 28,200 by 2022. However it should be noted that the current population trajectory suggests that the actual population in the city is likely to be in excess of this. The National Planning Framework (NPF) - the Government's high-level strategic plan for shaping future growth and development in the period to 2040 - seeks to build urban scale prioritising compact growth in urban locations such as Kilkenny in the order of 20-25% over the duration of the plan.

Table 11: Age profile Kilkenny

0-9 years	3,823
10-19 years	3,202
20-29 years	3,233
30-39 years	4,784
40-49 years	3,731
50-59 years	3,118
60-69 years	2,435
70-79 years	1,435
80+ years	751

Source: Central Statistics Office, Census 2016

TOPOGRAPHY AND CLIMATE

Kilkenny city has an elevation of 60m above sea level and is overwhelming flat throughout the urban centre. The climate of Kilkenny, as is generally the case in Ireland, is defined as a changeable oceanic

Table 12: Social class Kilkenny

Social Class	Male	Female	Total
Professional workers	1,126	862	1,988
Managerial and technical	3,266	4,067	7,333
Non-manual	1,806	2,897	4,703
Skilled manual	2,307	1,347	3,654
Semi-skilled	1,618	1,232	2,850
Unskilled	521	547	1,068
All others gainfully occupied and unknown	2,279	2,637	4,916
Total	**12,923**	**13,589**	**26,512**

Source: Central Statistics Office, Census 2016

climate with few extremes. An oceanic climate, is the *Köppen* classification of climate typical of west coasts in higher middle latitudes of continents, and generally features cool summers (relative to their latitude) and cool winters, with a relatively narrow annual temperature range and few extremes of temperature. Oceanic climates are defined as having a monthly mean temperature below 22 °C (72 °F) in the warmest month, and above 0 °C (32 °F) (or −3 °C (27 °F)) in the coldest month. Weather-wise, Kilkenny is generally representative of wide river valleys in the region with low temperatures on cloudless nights and is significant in that it records some of the highest summer and lowest winter temperatures in Ireland.

COMMUTING PATTERNS IN KILKENNY CITY

As is the case generally in Ireland, the private car is the mode most frequently used in travel to work, school or college in the City. Census 2016 records 61% of residents either travel as a driver or passenger; higher than the national average of 58%. Vehicular traffic is overwhelmingly the most popular mode used. Soft transport modes account for 26% of travel.

Of the 9,059 city residents with a fixed place of work, 5,910 work in Kilkenny; 3,149 work elsewhere. When account is taken of the City's daytime working population of 13,738, and allowance is made for 7,828 people commuting into the city, there is a net daily inflow of 4,679 persons. 7,723 or 80% of all city households own at least one motor car. Average commuting time to work in in County Kilkenny is 25.6 minutes. 61.7% of the population has a commute of less than 30 minutes. When Kilkenny city is compared with other urban locations in the state (towns of 10,000 and over but excluding cities), it exhibits lower public transport usage at 4% compared with 8.9%.

Cycling to work accounts for 3.5% of commuters and only 3% of the combined travel to work/school in the city. Of the 500 or so commuters who travel by bicycle, 356 or 71% are male.

Whilst cycling commute levels in Kilkenny appear low, it accords with national figures which show a sharp increase between 2011 and 2016 in the number of people who cycled to work; by nearly 43% from 39,803 to 56,837. Historically, the number of cyclists peaked in 1986 at 60,750, when cyclists made up 6.8 % of the national commuting population; however, while the 2016 numbers were again close to the 1986 peak, cyclists still only accounted for 3% cent of commuters.

Nationally, the greatest number of cycling commuters is in the 25-34 age bracket (18,885), comprising a third of all cyclists commuting to work, followed by 17,350 or 31% in the 35-44 age bracket. However commuters in this cohort grew at a far higher rate than in other age brackets. The largest increase in cycling to work was found among younger workers aged 15 – 24, a rise of 81% to 4,682 and representing 8% of all cyclists. Indeed those under 40 made up almost 60% of all cyclists, although they represented only 48% of the commuting workforce. Despite not being as common among older members of the workforce, cycling did grow in popularity among workers over 40 with an almost 43% increase in the number of cyclists in this age group, growing to 23,556 in 2016.

Nationally, professional workers made up 9% of the working commuting population, accounting for 16% of those cycling to work; managerial and technical workers account for 31% of the working commuters, but account for 34% of cyclists. Skilled manual workers were underrepresented among cyclists, possibly because of the need to commute by van, or the need to carry tools, equipment or other goods.

Non-Irish nationals accounted for 27% of all cycling commuters in the state although they comprise only 15% of the commuting working population.

Table 13: Means of travel to work, school or college Kilkenny

Means of Travel	Work	School or College	Total
On foot	1,971	1,816	3,787
Bicycle	399	101	500
Bus, minibus or coach	81	446	527
Train, DART or LUAS	72	44	116
Motorcycle or scooter	29	3	32
Car driver	6,684	210	6,894
Car passenger	623	2,509	3,132
Van	541	8	549
Other (incl. lorry)	32	2	34
Work mainly at or from home	300	3	303
Not stated	407	184	591
Total	11,139	5,326	16,465

Source: Central Statistics Office, Census 2016

Non-Irish nationals account for 17% of Kilkenny city's population; a similar proportion to 2011.

Although Kilkenny City doesn't have a third level institution it's worth noting that nationally the number of cyclists commuting to college rose by 2,148 (25.2%) from 8,530 to 10,678 in the same period, which accounted for almost 6% of college commuters. It's likely that BSS in Dublin, Cork, Galway and Limerick accounts for a good proportion of the increase.

Census 2016 records 37 persons who commuted by bicycle from within the electoral division of *Kilkenny No. 2 Urban* to their place of work elsewhere. There were 75 persons who commuted by bicycle from outside the electoral division of *Kilkenny No. 2 Urban* to work within this electoral division showing a net bicycle commuter inflow of 38 persons. There were 65 persons who commuted from within the electoral division of *Kilkenny No. 1 Urban* to their place of work elsewhere and there were 81 persons who commuted by bicycle from outside to work in the electoral division of *Kilkenny No. 1 Urban*; a net bicycle commuter inflow of 16 persons.

51.8% of those travelling to work, school or college depart from home between 08.00 and 09.00 suggesting a conventional 9-5 working day as well as proximity to place of employment or education.

Table 14: Means of travel to work, school or college Kilkenny

Time leaving home	Persons
Before 06:30	753
06:30-07:00	849
07:01-07:30	967
07:31-08:00	2,024
08:01-08:30	3,981
08:31-09:00	4,398
09:01-09:30	1,068
After 09:30	1,450
Not stated	672
Total	**16,162**

Source: Central Statistics Office, Census 2016

The short nature of the commute in the city is further supported by Census 2016 which records nearly half of all commutes completed within 15 minutes duration.

Table 15: Means of travel to work, school or college Kilkenny

Journey time	Persons
Under 15 mins	7,585
1/4 hour - under 1/2 hour	4,449
1/2 hour - under 3/4 hour	1,535
3/4 hour - under 1 hour	556
1 hour - under 1 1/2 hours	554
1 1/2 hours and over	440
Not stated	1,043
Total	**16,162**

Source: Central Statistics Office, Census 2016

TRANSPORT INFRASTRUCTURE IN KILKENNY

Public transport is provided by a variety of modes and operators; all of which are regulated and licensed by the NTA to provide an agreed range, schedule and standard of service.

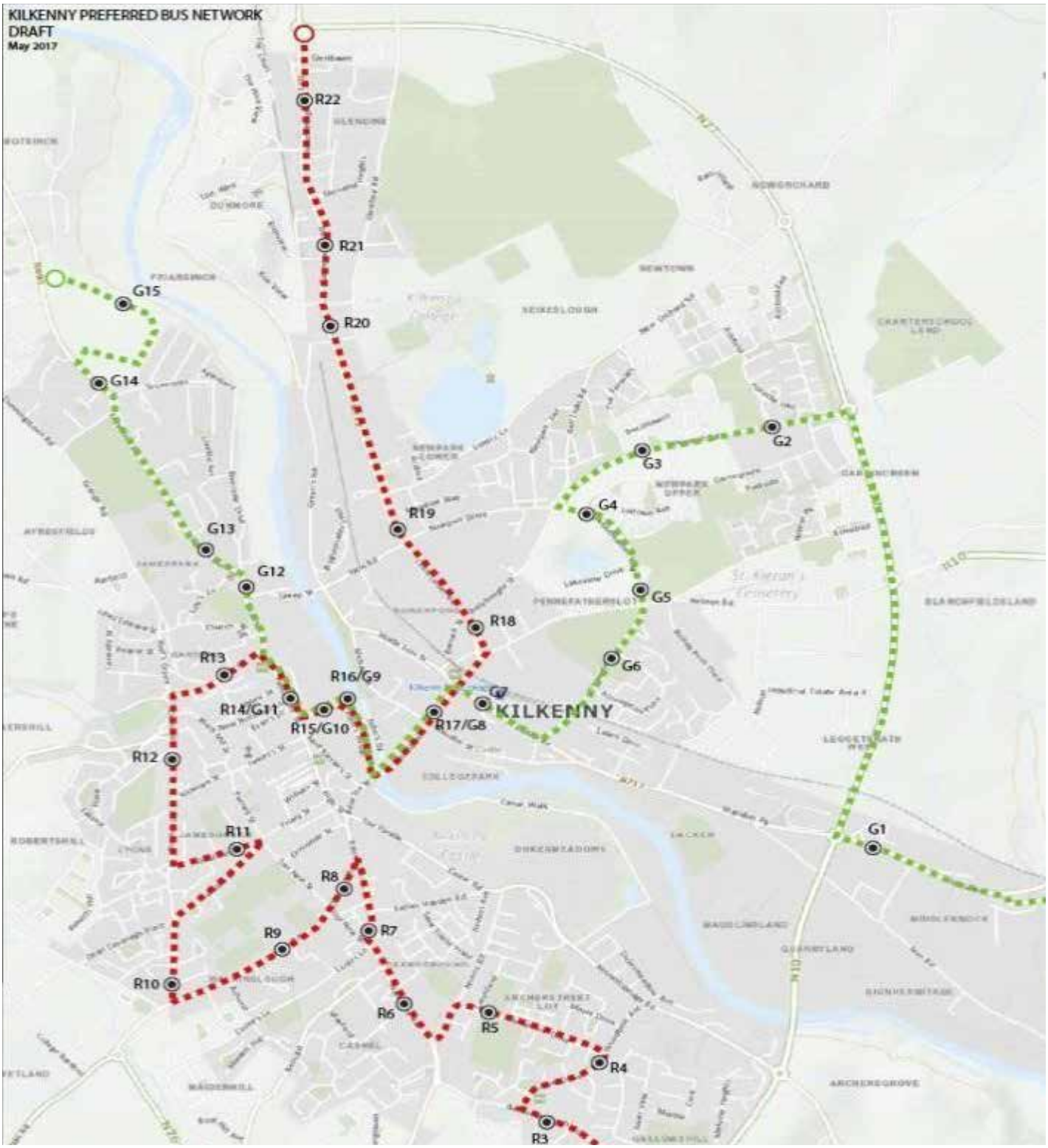
Public Transport

Provision is currently limited to rail and bus, which encompasses Bus Eireann Expressway, regional and local services, and the Locallink service which connects the city to outlying rural settlements as well as several private operators providing scheduled or specific purpose routes.

Public transport will be enhanced in 2019 when the NTA launch of two *Public Service Obligation* (PSO) bus routes in the City. These services will provide comprehensive coverage by serving areas of high population density, deprivation and low car ownership. Retail, services, schools, businesses, tourist facilities as well as the train station will be directly served.

The *Green* route will operate on an east/west axis route from *Talbotsinch* to *Purcellsinch* and 2 buses per hour will service 14 stops throughout

Figure 3: Proposed cross city bus route



Source: Kilkenny County Council/NTA, 2018

its 8.5km length with an estimated journey time of 27 minutes. The *Red* route will operate on a north/south axis from *Castlecomer road* to *Loughboy* and 2 buses per hour will service 19 stops throughout its 8.7km length and its estimated journey time of 36 minutes. Both routes feed into a central spine, doubling bus frequency across the city centre.

The city does not have a formal transport hub or defined modal interchange which inhibits connectivity and transfer between services and modes.

Kilkenny station at McDonagh Junction is serviced by up to seven services daily on the Dublin – Waterford line. The current schedule does not facilitate inward commuting for a standard 9-5 working day. Patronage of the services is denoted by the average daily movements of travellers.

Table 16: Train passenger traffic Kilkenny

	2017	2016	2015	2014	2013	2012
Alighting	499	348	285	404	346	263
Boarding	473	400	355	350	362	328

Source: National Heavy Rail census 2017, NTA

ROAD TRAFFIC

Vehicular traffic is monitored by TII at one location in the city; the N77, north of the ring road roundabout. It records Annual Average Daily Traffic (AADT) volumes for all motorised modes of transport but does not do so for bicycles. Data for 2018 and previous years are as follows:

Table 17: Traffic Volumes Kilkenny

	2018	2017	2016	2015	2014
AADT	11,743	11,236	10,822	10,293	9,793
% HGV	4.8%	4.6%	4.5%	4.5%	4.5%

Source: nratrafficdata.ie, TII, 2018

The morning peak is 11am with peak volume of 360 vehicles while the afternoon peak is 2pm with 645 vehicles recorded. As can be seen, traffic volumes at this location have increased by 20% since 2014.

In 2018 research conducted by INRIX determined that despite being the eleventh largest urban settlement in the country, Kilkenny is the fifth most congested urban area in Ireland behind Galway, Dublin, Cork and Sligo. It is deemed the 323rd most congested city in Europe and the 568th most congested city globally surveyed. *(Source: Inrix congestion scoreboard, 2018).* Drivers in Kilkenny city spend on average 8% of their driving time in congestion accounting for up to 17 hours per annum; the latter being to equivalent to Naples, Alicante and Liege whose City and Metropolitan populations are 967,069 & 3,115,320, 330,525 & 757,085 and 197,013 & 750,000 respectively. *(Source: Inrix congestion scoreboard, 2018)*

The city is served by more than 4,500 public parking spaces, most of which are located to provide ease of access to the commercial and retail core in the city centre and at *MacDonagh Junction.* KCC controls 2,100 spaces including 930 on-street and 1,170 off-street at thirteen locations. Rates for short stay car parking in the city centre are €1.50 per hour.

EMPLOYMENT PROFILE

11,512 - 43.4% - of the city's residents are classified as "at work"; 58% of those "at work" are employed in professional services, commerce and trade and public administration. The breakdown by industry type is as follows:

Table 18: Employment profile Kilkenny

Industry	Male	Female	Total
Agriculture, forestry and fishing	123	24	147
Building and construction	456	32	488
Manufacturing industries	816	259	1,075
Commerce and trade	1,488	1,464	2,952
Transport and communications	385	122	507
Public administration	424	266	690
Professional services	819	2,236	3,055
Other	1,366	1,232	2,598
Total	5,877	5,635	11,512

Source: Central Statistics Office, Census 2016

Previously identified as a Hub under the *National Spatial Strategy 2002 – 2020,* Kilkenny city is an important residential and commercial centre and will continue to be the main focus for public and private sector investment locally.

The scale of Kilkenny City's function as an employment node and service centre is reflected in its day time working population of 13,738; the eighth largest in the state. Between 2011 and 2016 there was an 11% increase in the numbers at work in County Kilkenny.

The city has a strong market presence and notable employers in the agri-food, bio-economy services, healthcare, financial services, creative industries, ICT, light manufacturing, retail, tourism and hospitality sectors; many of which have significant internationally traded dimensions.

Significant private sector employers include Taxback International, Glanbia, Business Services, Carne, Immedis, CF Pharma, Dunreidy Engineering Ltd, Gaeltec Utilities, Duggan Steel, Veolia Water Ireland, Modubuild, Asgard Cleanroom Solutions, Duelchem, Coating and Technical Tapes, Koverto Envelopes (Ireland) Ltd, Cartoon Saloon and Connolly's Red Mills. State Street International Ireland Ltd and Mercury Filmworks/Lighthouse Studios represent significant successes as Foreign Direct Investments (FDI) secured for the County by the Industrial Development Authority (IDA).

The city also has a developing ICT sector industry supported by the 2012 development of the Kilkenny Research and Innovation Centre, a joint initiative between Waterford Institute of Technology (WIT), Institute of Technology Carlow (ITC) and KCC.

Private sector employment is further augmented by a number of public, state and semi-state organisations, involved in public administration and local government. These organisations account for significant local employment and are principally headquartered or located in or adjacent to Kilkenny City. They include:

Table 19: Principal Public Sector Employers Kilkenny

Public Administration	Nature
Dept. of Agriculture, Food & Forestry	Regional Veterinary Laboratory
Dept. of Enterprise, Trade & Innovation	The Patents Office
Revenue Commissioners	Taxation & customs
The Office of Public Works	Regional depot
Ordnance Survey	Mapping & data
Environmental Protection Agency	Regional Inspectorate
Kilkenny County Council	Local Government, Development & Advisory
Design & Craft Council of Ireland	Advisory & development
Teagasc	Farm advisory
VH	Insurance
The Heritage Council	Heritage management and advisory
Kilkenny Local Enterprise Office	Enterprise supports
Kilkenny Research and Innovation Centre	Research & innovation
Three Counties Energy Agency	Project management , energy advisory and management

It is notable that there are a relatively limited number of locations within or adjacent to the city that hosts a significant concentration of employers. These include the *Hebron Industrial Estate; the Kilkenny Business & Technology Park at Loughboy; the IDA Business Park, Dublin Rd/ Purcellsinch, Kilkenny; Cillin Hill* and the city centre itself. It is understood that no employer – public or private sector – in Kilkenny has adopted a Workplace Travel Plan.

Aside from commercial and enterprise activities the city fulfils an important service function for its resident and visiting population as well as for a large rural hinterland. Retail, education, medical and other social supports account for a significant level of employment as well as mobility throughout the city. Of particular importance are *St. Luke's Hospital and Aut Even Private Healthcare* in the western part of the City with these augmented by a host of smaller medical facilities and services throughout the city and its environs. There are 15 primary and secondary schools within the city.

Employment intensity in City Electoral Divisions is measured by commuting flows – inward commuters less outward - Kilkenny city has a net commuter inflow of 6,606.:

Table 20: Commuter flow Kilkenny

Location	Commute Outward	Commute Inward	Net Flow
Kilkenny No.1 Urban	1,267	3,322	2,055
Kilkenny No.2 Urban	896	3,351	2,455
Kilkenny Rural	3,898	5,994	2,096
Total	**6,061**	**12,667**	**6,606**

Source: Central Statistics Office, Census 2016

TOURISM

Kilkenny City has a sophisticated tourism and hospitality product. This is characterised by an enviable heritage product, attractive public realm, a burgeoning reputation for food tourism, innovative festivals and events as well as a prominent activity and rural recreation product. Kilkenny is marketed as a heritage destination and has a large number of visitor attractions associated with heritage.

Kilkenny is a key destination within the *Ireland's Ancient East* Signature Experience Brand and is specifically programmed within the *Castles and Conquests Visitor Experience Development Plan.* Failte Ireland has determined that the key market segment for the brand proposition is the *Culturally Curious,* defined as being couples or independent travellers who choose their destinations carefully, looking to visit new places and expand their experiences by exploring landscape, history and culture. Ireland's Ancient East's objective is to turn the area from a transit region into a touring region and to grow the value of tourism to the region by 28% in the next 4 years resulting in an extra €204m in tourism revenue for local businesses and communities by 2020. Kilkenny is well placed to benefit from expected tourism growth from mainland European, North American and long haul markets. This is driven by a strong value proposition and alignment to the Failte Ireland brand proposition.

Tourism is growing, both in absolute numbers of overseas and domestic visitors and the sector's contribution to the national economy. The characteristics of tourists are also changing, with an increase in the proportion of independent tourists who often visit more than one location during their stay, and have a higher propensity to use public transport while travelling in Ireland. In 2017, 315,000 overseas visitors generated €55m in tourism revenues for the county. This represents a dramatic increase of 52% in overseas visitor numbers and a 41% increase in overseas revenues since 2013. Fáilte Ireland data for visitors and revenue to County Kilkenny indicate that the county attracted more than 600,000 visitors in 2017, generating close to €100m in revenue. Based on Fáilte Ireland data, spend per head of overseas visitors to the county is lower than in other flagship rural locations reflecting the higher number of overseas tourists on day-trips or shorter visits.

Kilkenny City is the tourism hotspot within the county. In 2016, *Kilkenny Castle* became the third most popular OPW heritage site in Ireland with 385,000 visitors and the 14th most visited fee paying tourism attraction in the country. In 2017 visitor numbers further increased to 420,000. Anecdotally, there is some concern that visitor numbers concentrate overwhelmingly on the Castle and do not circulate throughout the city in substantial numbers.

The development of the *Medieval Mile* concept and a supporting wayfinding strategy is a means to mitigate this. Tours to the city are popular but tend to be mainly day-trippers; often overseas tourists on itineraries out of Dublin. This is partly because of difficulties in the availability of accommodation in Kilkenny during peak periods, but partly also because the city is within relatively easy reach of Dublin. Aside from visitor numbers to the Castle and hotel occupancy rates, Fáilte Ireland has no specific data on tourist numbers to the city.

Overseas visitors and revenues were augmented by 298,000 trips from the domestic market generating revenues of €39m. (Source: Failte Ireland, 2018). Kilkenny's reputation as a lively compact city makes it very appealing to domestic visitors, particularly at weekends; many of whom are attracted by innovative, high quality festivals and events held regularly throughout the year

Hotels in the Kilkenny city centre and environs account for nearly 1,100 rooms and 2,600 bed spaces, or 83% of all registered bed spaces in the city. Guesthouses and B&B'S account for another 11% of bed spaces, with the remaining bed stock comprised of self-catering, hostel, caravan and camping and Fáilte Ireland "Welcome Standard" approved properties. When examined by grade, 4-star properties account for 59% of room stock and 57% of bed stock in hotels in Kilkenny. About 25% of stock is in 3-star hotels, with 5-star hotels accounting for 13% of room stock and 17% of bed stock. Based on the evidence from prior year Fáilte Ireland registrations, less than 20 rooms have been added to Kilkenny's hotel room stock in the last five years, all through extensions to existing hotels.

Currently, there is no consistent series of hotel occupancy data available for Kilkenny. However, occupancy rates in the peak season are believed to be very high, and the city has a strong domestic leisure market that raises offseason occupancy. Annual occupancy rates in Kilkenny city centre (around 400 rooms) are typically about 78% with seasonal variations in the January-February and November-December periods (55%-60%); March-April (70%); May, September and October (80%); June (85%) and July and August (90-95%). Failte Ireland estimates the market mix in Kilkenny to be 70% domestic leisure, with a very strong weekend trade; 40% of revenue being obtained on Friday and Saturday nights. The market is divided between tourists and the corporate market, with around 10% being organised tours, but the mix will differ across the hotels, with some having a relatively good corporate business. Overall though, corporate business is not particularly strong in Kilkenny, again because of its proximity to Dublin.

10.0 A BIKE SHARE SCHEME FOR KILKENNY?

The question of a BSS in Kilkenny city requires the careful analysis of a number of critical factors including strategic, demographic, infrastructural, cultural, demand and financial considerations. While these issues need to be addressed mindful of Kilkenny's particular characteristics and context, this analysis can be aided, to some extent, by the experiences, practices, successes (or otherwise) and critical success factors referenced elsewhere in this study.

DETERMINING THE SCALE OF A DOCKED BSS

Resident population and population density is a prime indicator used to determine the optimal scale of a BSS. It is therefore necessary to consider how Kilkenny compares with other urban locations in Ireland where BSS's are currently in operation. Sligo has been included for illustrative purposes, however as its' BSS is dockless, privately operated and only recently launched, it does not lend itself to direct comparison.

In 2016, Kilkenny City had a population of 26,512; a third of the population of Galway, the smallest of the cities in the regional scheme. Kilkenny's small size and compact urban scale however has a higher population density than all other urban locations with the exception of Dublin. Kilkenny is alone amongst the urban locations in not hosting a third level institution.

Table 21: City population and population density

Location	Population	Population Density/km²
Dublin and suburbs	1,173,179	3,689.2/ km²
Cork city and suburbs	208,669	1,197.6/ km²
Limerick city and suburbs	94,192	1,591.0/ km²
Galway city and suburbs	79,934	1,475.2/ km²
Kilkenny	26,512	2,115.9/ km²
Sligo	19,199	1,858.5/ km²

Source: CSO; Census of Population 2016

Using the 1:500 median ratio of BSS bikes to population size as suggested by the OBIS *Optimising Bike Sharing in European Cities* Handbook, indicates that the resident population in Kilkenny could sustain a BSS in the order of 53 bikes. Based on a docked system this would likely require up to 90 docked spaces, shared across 6-8 locations in total. The same source suggests a median ratio of scheme members to population of 1:67; thus Kilkenny might be expected to have 395 annual subscribers. This number would be augmented to some extent by short term subscribers, principally tourists and visitors to the city. While these estimates are a useful proxy it should be noted that the OBIS handbook synthesises research from European cities in which the BSS can differ substantially in scale and nature and where demographic and demand characteristics might be fundamentally different.

Allowing for this caveat, it should be noted that the OBIS methodology was used in 2011 to suggest the scale and design of the BSS in the regional cities in Ireland; its recommendations for the number of bikes, docking stations and subscribers being:

Table 22: Recommendations for the regional cities BSS

Location	Recommended no of Bikes	Recommended no of docking stations (points)	Estimated No of Subscribers	Estimated daily rents per bike
Cork	235-265	25 (510)	2250	3
Limerick	135-165	20 (255)	1500	1.5
Galway	200-250	23 (380)	1500	2
Waterford	80-100	10 (150)	900	1.5

Source: Jacobs; Proposals for Introducing Public Bike Schemes in Regional Cities – Technical Feasibility Study, 2011

By 2018 some four years after its launch, it can be seen that the regional scheme had in fact

delivered a greater than planned capacity in Cork (330 bikes across 31 stations) and Limerick (215 bikes across 23 stations and a lower than expected capacity in Galway (195 bikes across 16 stations). For comparative purposes, figures for docked scheme in Dublin have been included and serve to confirm the general principle that smaller cities require more bikes per head of population than larger cities.

As noted previously in this study, despite being evaluated at the feasibility study stage the scheme in Waterford city did not proceed. The reasons for this are not known but are likely to be instructive given that Waterford is a useful comparator for Kilkenny City; having roughly twice its urban population, albeit with a different demographic composition. In this regard, particular attention should be paid to the third level student populations in each of the cities; this being a key user demographic as evidenced by the strong demand generally observed between campus docking stations, city centre and transport locations in urban environments. In 2017, Cork, Limerick and Waterford had third level student populations of 36,142 (UCC & CIT), 28,017 (UL, LIT & MI) and 9,334 (WIT) respectively. In the same year Sligo had a total third level student population of 6,210 (ITS & St. Angela's). The Kilkenny Campus of Maynooth University closed in June 2018.

Table 23: Total number of bikes, docking stations and population per bike/docking station

Location	Total Number of Bikes/ Docking stations	Population Per Bikes/ Docking station
Dublin & suburbs	1600/116	733.2/10113.6
Cork city & suburbs	330/31	632.3/6731.2
Limerick city & suburbs	215/23	438.1/3475.3
Galway city & suburbs	195/16	409.9/4995.8

Source: www.dublinbikes.ie;www.bikeshare.ie

As can be seen there is considerable variation between the median ratio of bikes to population size in each of the cities with this increasing as scheme size and population reduce. Despite this variation, the median ratio as proposed by the OBIS handbook remains a reasonably reliable basis for scheme planning in Kilkenny. In order to estimate capital and current costs for this study a docked BSS comprising 50 bikes is assumed.

CAPITAL AND OPERATING COSTS FOR A DOCKED SYSTEM

The costs required to plan, develop and operate a docked BSS in Kilkenny City depend on a variety of factors including site specific considerations, the use or otherwise of proprietary systems, civil engineering works, bespoke or customised specifications, utility and technology requirements, adaptation to localised needs, etc. For the most part, precise costs can only be determined at procurement phase. However, there are some useful comparators to inform and guide development costs.

In its analysis ***Proposals for Introducing Public Bike Schemes in Regional Cities – Technical Feasibility Study***, Jacobs Engineering Ltd suggested a capital cost of €6.35m incurred over a 15 year period would be required to develop the BSS of the scale proposed in all four Irish regional cities; the bulk of which would necessarily be spent in year 1 and would be accounted for by planning and assessment, construction of docking stations, purchase of bikes and maintenance vehicles, technology and control room monitoring. Of particular relevance to Kilkenny is the €830,000 capital cost estimated for the Waterford scheme comprising up to 100 bikes and 10 docking stations; roughly double that modelled as optimal for Kilkenny city. In addition to the capital costs proposed, outline operating costs for the regional scheme based on four cities with a common control room were estimated to be €23.16m over the 14 year contract period, subsequent to installation. Such a sum would be made up of general administration, staff costs, premises, bike replacement, storage, redistribution costs, maintenance and materials. Annual operating costs for the Waterford scheme were estimated to be €270,000, totalling €3.78m over 14 years.

It should be noted that the regional scheme, planned and resourced by the NTA, is a high end, automated, permanent, city-scale system complementary to the public transport offering. It is understood that the capital costs and operating costs incurred in the development of the schemes in Cork, Limerick and Galway are largely in line with costs estimated at the feasibility stage; being €4.5m and approximately €1.25m per annum respectively. As such the regional scheme, scale and demographics, capital and operating costs reflect a context and circumstances that are not extant in Kilkenny. There is little to suggest a change in these factors over the medium term.

The OBIS research suggests that an effective functioning BSS can be implemented at a comparatively modest cost. It suggests implementation costs in the order of €2,500 - €3,000 per bike depending on system configuration. In such an instance, typically 70% of the costs will be absorbed by the development of docking stations, civil engineering and ancillary works; the bikes themselves will account for 17% with the remaining 13% on miscellaneous set-up, administration, communication and logistics cost. The likelihood is that costs in Ireland will come in at the higher end and may well exceed the OBIS estimates, reflecting the higher costs involved in construction, utilities and ancillary works.

Based solely on the OBIS estimates a minimum capital cost in the order of €150,000 would be required for a modestly spec'd docked scheme of 50 bikes in Kilkenny. Additional bikes must also be factored into the planned capital budget in order to mitigate repairs, replacement, theft and damage to ensure that a fleet of 50 bikes remains operational at all times. Thus a scheme necessitating 60 bikes would add in excess of €5,000 to the initial capital budget.

As a guideline OBIS suggests an operating cost of up to €2,500 per bike per annum. Of this amount redistribution (30%); Bike Maintenance (22%) and Station Maintenance (20%) account for the bulk of costs with the back end system, administration and replacements accounting for the balance. All told this would amount to an operating cost of €125,000 per annum for Kilkenny, roughly in line *pro-rata* with operating costs suggested for the 100 bike scheme in Waterford.

In summary, based on the OBIS research, the minimum expected capital and operating costs – undiscounted, without consideration of inflation and net of VAT - required to implement a standard BSS in Kilkenny over a 15 year period would likely

be in the order of €2m. This is accounted for as follows:

Table 24: Anticipated costs for a docked BSS in Kilkenny

Nature of Cost	Amount
Capital	155,000
+10% contingency	15,500
Operating (over 14 years)	1,750,000
+10% contingency	175,000
Total	**€ 2,095,500**

For comparative purposes and as a means of validating these costs, some insight into the costs to develop a BSS can be gleaned from an examination of the *BICY* Scheme in Velenje, Slovenia. In 2012, local stakeholders with support from the *EU Central Europe European Regional Development Funds* (ERDF) collaborated on the development of a bike share initiative with project partners in 7 countries. This project culminated in the development of a proprietary system tailored to Velenje's particular circumstances with 25 bicycles installed at 5 stations throughout a city with a population of 28,000. The costs incurred in the initial phase were:

Table 25: BSS development costs - Velenje, Slovakia

Nature of Expenditure	Amount
Bike purchase	€ 8,400
External Expertise	€ 11,856
System Development	€ 47,424
Promotions	€ 4,832
Miscellaneous	€ 7,889
Total	€ 80,401

Source: BICY Velenje; 2018

The success of the *BICY* scheme is such that it has continued to expand its scale and reach in Velenje. Its proprietary systems have been further developed to include electric pedal-assist options. The system and technologies developed in Velenje have now been commercialised and can be installed using either permanent fixed or moveable, solar-powered modular systems that can be relocated should demand or circumstances dictate. This substantially reduces the need for and cost of extensive civil engineering, construction or utility works. Informal quotations provided from Velenje suggest that a similar system could be procured for Kilkenny broadly in line with the OBIS estimates. However, accurate and definitive costs can only be provided at a procurement stage when system scale and specification are agreed. Aside from the capital costs incurred, it should be noted that Velenje system is free of charge for users and its annual operating costs- which have not been provided for this study– are absorbed by the Municipal Authority.

COST MITIGATION

The potential costs involved in the development of a docked BSS can be mitigated in a number of ways. It would be expected that EU or national exchequer funds would resource, at least in part, the capital development costs. To date, funds provided by the NTA have been central to offset the capital costs of the regional scheme and to enable the expansion of the Dublin scheme. Given the substantial financial subvention required to support operating costs in both schemes – by the NTA for the former, DCC in the latter- it is not clear whether the NTA has plans to extend the regional scheme to secondary urban locations in the future or indeed whether such a development could be justified on cost grounds alone. Furthermore, due consideration must be given to the disruptive changes in the micro-mobility landscape that have occurred – most notably with the introduction of dockless schemes - in the period since 2011 when the regional scheme was first planned. Put simply, there are more cost effective micro-mobility and BSS options available than heretofore.

Aside from the NTA, grant assistance for capital development of a docked BSS could be sourced through alternatives such as the *Rural Regeneration Fund*, Local Authority or LEADER funds, although matched funds in the order of 25% of the eligible capital costs would likely be required in each instance. As is the case in other urban environments, these costs could be mitigated through medium term commercial contracts for scheme naming rights, docking station location and/or sponsorship. The regional cities scheme attracted sponsorship of €3m from *Coca-Cola Ireland* – the initial sponsors of the *dublinbikes* BSS - for a five year period from 2014.

The issue of commercial risk and the ability to meet the significant operational costs of a BSS on an ongoing basis is far more problematic. Such costs are estimated to be a minimum of €125,000 per annum and depending on scheme design and operations have the potential to escalate. In Kilkenny it is not evident how and by whom such a risk would or should be managed. Inevitably, given that subscriptions will likely comprise the greater proportion of user income generated for a BSS, a subvention from public funds to meet operating costs would be required. The magnitude of this amount might be indicated by low level of user fees generated outside subscription income. In Dublin subscription fees currently account for 96% of all journeys made. By this measure, noting the predicted subscription numbers in Kilkenny and assuming annual subscription charges in line with the regional scheme, a user income of less than €5,000 per annum would be generated. This would leave an annual operating deficit in the order of €120,000 per annum. A poorly planned or resourced BSS without a viable and consistent funding framework over the medium to longer term would likely be fatally compromised.

Some modest level of commercial income from scheme naming or sponsorship could be apportioned to reduce the anticipated deficit to a limited extent. Financial contributions provided by businesses where docking stations are located in close proximity to retail or service premises are an option but coherence and suitability within the overall network and to the scheme objectives would need to be assured. Subscription and user fees can be increased over time as has been the case in Dublin but pricing is sensitive, requiring a balance between BSS budget requirements and acceptability and value to the scheme user. Alternatively, in circumstances where the Municipal Authority is active in the planning and operation of the scheme a local subvention could potentially be funded from parking fee income, parking fines or as an agreed percentage of ring-fenced amenity development or outdoor recreation budgets. The JC Decaux outdoor advertising-led model used in Dublin is not regarded as appropriate for Kilkenny given the premium placed on the stewardship of the public realm locally nor indeed likely, given the City's small scale and population.

In more sophisticated and evolved city schemes other funding mechanisms have been developed. These include the commercialisation and sale of trip and travel data; discounts and feed-in business partnerships where operators ally with retail to offer in-app based digital coupons and discounts, setting incentives to feed riders into their businesses; public transport feed-in subsidies, where operators actively feed in passengers to the public transport systems by offering first and last

mile solutions; gig economy and crowdsourced logistics for deliveries; service expansion with bike-sharing viewed as only one element of a mobility mix feeding users to other modes and platform co-operations and cross-industry alliances where bike-sharing offers high-frequency interactions with consumers for both use and transacting payments. Given that few, if any, of these sources have been used successfully in Ireland to date, it is thought unlikely that any could be expected to underpin a proposed Kilkenny BSS by yielding sufficient revenues to offset the likely operating deficit.

In considering the sources of funding to best mitigate capital development costs and operating overheads due consideration must be given to the core objective of the scheme; each potential source of funding must be aligned with and reflective of the scheme's ethos and purpose. Each potential funding source available involves an opportunity cost and trade-off, in so far as the available resources can be deployed elsewhere and for other purposes; those resources potentially making a greater contribution to other municipal, citizen or commercial goals in Kilkenny. So while there might be some logic to the contribution of a BSS in facilitating modal shift, addressing traffic congestion or enhancing local amenities, it is unlikely that a BSS would be the principal means by which any of these issues are addressed or resourced.

UNDERSTANDING USER NEEDS AND MOTIVATIONS

An analysis of user demand and motivations provides a powerful insight into the localised potential for a BSS in Kilkenny. To this end an online survey was devised and circulated through local stakeholder networks from 5th September 2018. The survey sought to elicit information on the level of interest or otherwise in a Kilkenny scheme, user and demographic profiles, the purpose and regularity of use, the potential destinations served and sites for docking stations as well as the willingness of the user to pay, amongst other issues. Saturation – the point at which the survey no longer yielded additional perspectives or information – was reached by November 11th 2018. In total, feedback and qualitative data was sourced from 156 respondents; a useful though not overwhelmingly comprehensive response. Some salient findings from the survey are:

- 44% of respondents identified as *cyclists* with a further 42% indicating *occasional* cycle usage. 18% indicated that they were not cyclists.
- 80% of respondents had never used a BSS in another Irish city. 18% had used the BSS in Dublin. 2% had used the scheme in Cork city.
- 58% of respondents stated *recreational* use and 18% stated *social* use as their primary interest in using a BSS. 24% of respondents stated *work* as their primary interest.
- 43% of respondents stated that they travelled over 5kms to work, 30% travelled between 1 and 3kms and 20% travelled between 3 and 5kms; the remainder travelling less than 1km.
- The relationship between commuting distance and frequency of use indicated that 28% of users travelling between 3 and 5kms daily expressed interest in using the scheme for commuting purposes. 16% of commuters travelling less than 1km and 17% of users travelling between 1 and 3kms likewise. Only 5% of those commuting over 5kms would opt to use a BSS.
- 72% of respondents currently travel to work by *car,* 15% *walk* and 13% *cycle.* 10% of respondents stated that they travel to work by *multiple* modes, although public transport was not cited by any respondent. Only 9% of those commuting by car would consider

Helsinki City Bikes

daily use of the BSS.

- Irrespective of intention or motivation to use a BSS, 95% of respondents believed that there was merit in a Kilkenny scheme.

- 49% of respondents stated an interest in *occasional* usage; 35% stated an interest in *weekly* usage and 13% stated an interest in *daily* usage. 4.5% of respondents stated that they would not use the scheme. Users in the 21-29 and 30-39 age brackets exhibited a greater tendency to *daily* usage. In contrast older users tended towards occasional usage.

- 64% of respondents stated that they would pay a *subscription to* a BSS in Kilkenny. However the vast majority - 77% - favour a *pay as you go* option, strongly suggesting a tendency to occasional or infrequent use.

- 35% of respondents stated safety as a specific concern for a BSS. 26% stated routes served as a concern while 14% stated cost concerns. The remainder stated theft (18%) and nuisance (2%).

Allowing for some confirmation bias and the likelihood of general goodwill towards the BSS concept, the survey offers little substantive data to support the introduction of a BSS in Kilkenny. It should be noted that the demographic profiles of respondents to the survey appeared at odds with BSS usage elsewhere in Ireland with 70% of respondents aged over 40 and 51% of respondents female. In any event, it should be noted that the primary interests of respondents are in the occasional use of the BSS for recreational use, preferably on a *pay as you go* basis. This does little more than affirm the idea that cycling is generally seen as a *'good thing'* which in Kilkenny's case can make a notable addition to already high levels of urban liveability and quality of place.

ESTABLISHING A CORE RATIONALE

At the heart of any analysis as to why a BSS might or should be developed in Kilkenny lies its core objective. Why do this? Or to put this another way, what issue, problem or need is the development of a BSS intended to address or meet. A clearly articulated and reasoned objective – or ordering of priorities - allows the question of a BSS to be placed in some context. At the outset it is essential that the scheme objectives are identified and agreed upon. A BSS for Kilkenny cannot be all things to all people and it must be agreed whose needs it is intended to serve. Different types of scheme can have very different costs and funding mechanisms depending on the core objective and user needs. A BSS can be part of an integrated transport solution but this must be planned, configured and resourced differently to a scheme primarily oriented to serve leisure or tourist users, for example. While different user groups are compatible and can have their needs met through a BSS, the question arises as to whether their competing needs should be met in such a way through the use of scarce public funds. Indeed caution must be urged where modal shift appears unlikely to be achieved and where a BSS facilitates leisure and tourist use primarily, due to the risk that existing commercial activity (bike hire, tour guides, taxi, etc) would likely be displaced. Amongst other issues, displacement would reduce the impact of value for money; diminish local goodwill and scheme credibility.

At this point it appears that no specific overriding objective has been determined by stakeholders for a BSS in Kilkenny City, whether that is to form an integral part of the city's transport network, to facilitate modal shift, reduce vehicular congestion, address environmental or emission concerns or simply as an aid to promote enhanced liveability and wellbeing for locals and visitors alike. The likelihood, therefore, is that a BSS for Kilkenny

BikeMi, Milan, Italy

would seek to address all of these issues variously and to some extent in a general fashion. The answer to the question as to how well might it accomplish any or all of these tasks, then offers clues as to how a BSS should be scaled, and resourced.

CONCLUSION

In current circumstances, having due regard to the critical success factors and enablers as well as to the financial and general administration resource required, the viability of a docked BSS for Kilkenny City appears questionable. Central to this assessment is the issue – and uncertainty - of risk management and risk sharing in the operation and resourcing of a docked scheme and particularly the burden that a BSS will likely place on scarce public funds over the medium to longer term.

Static user levels and the ongoing requirement for significant subventions from public funds in the Dublin and regional cities scheme offers much food for thought.

Risk, however, can be mitigated. In the event that clear objectives and scheme goals can be established and agreed by stakeholders, consideration could be given to facilitating and supporting the introduction of a dockless scheme in Kilkenny. While substantially different in scale, cost, operation and ethos this would represent a cost-effective, flexible micro-mobility solution where the operational and financial risk is fully borne by a commercial operator rather than by public funds. As referenced elsewhere in this study dockless schemes have been introduced in Ireland and their operation is governed by regulations and performance standards stipulated by the relevant Local Authority.

Eco Travel Ltd, which operates the Sligo dockless scheme and which seeks to expand to other urban locations, quotes a combined annual capital and operating cost of €37,500 excluding VAT for a 50 bike scheme. The operating model would see Eco Travel Ltd supply, operate and maintain a 50 bike scheme on a 365 day basis over a five year period. This would include end user smart phone software to operate the scheme, via iOS and Android platforms and all necessary back end operating systems. Eco Travel Ltd would provide member services via a national operations centre through which issues or feedback can be provided on a 24/7 basis. Flexibility exists within the proposed operating model to employ local staff to implement maintenance and relocation/ redistribution services. This could be adapted to engage local bike retail, hire or guiding services to miminise potential displacement effects or alternatively through the introduction of equity goals to include underrepresented user groups or demographics. Performance standards, GPS or RFID geo-fenced locations and GDPR compliant data protocols can be determined and agreed with the Local Authority, which would bear no cost in the scheme's operation. The financial model proposed is predicated on the capital and operational costs being met by local corporate sponsors and patrons in exchange for on-bike advertising and sponsorship.

The Netherlands: OV-fiets

11.0 RECOMMENDATIONS

This study establishes the context, characteristics and enablers critical to the successful planning, development and operation of a BSS. It offers insights into the nature, operation and performance of BSS's in Ireland and considers if and how, a BSS can be optimally planned, developed, implemented and sustained in Kilkenny. The study also seeks to identify risks and constraints and suggest how these might be managed or mitigated. It is understood that an opportunity and resources may currently exist or be made available under certain circumstances to allow local stakeholders in Kilkenny consider the development of a BSS particularly in light of current reflections and assessments to enhance traffic management and sustainable mobility in the city. That being the case, several objectives, key principles and methodologies should inform and shape ongoing discussion and analysis between stakeholders. Ultimately, a determination on these issues and their appropriateness in a local context are a matter for the project sponsors and other stakeholders to consider and evaluate. As part of these deliberations a *Critical Path* for the development of a BSS in Kilkenny might include:

1. The adoption of project management principles and disciplines to shape the BSS concept appraisal as well any subsequent planning, implementation, operation and monitoring. This would require a well-defined project management plan (PMP) with agreed objectives, outcomes, processes, milestones, budgets and key performance indicators.

2. The development of a BSS should only be considered within the context of a *Citywide Cycling Master Plan* supported by enabling policy measures and resources.

3. The engagement of the primary stakeholders (the local authority, development agencies, sports partnership, civic interests, public transport operators and licensees, public participation network, user forums, chamber of commerce, business and employer interests, sports and fitness groups, health agencies and medical authorities, etc) to determine whether to proceed with a BSS and if so, to define its objectives, scope and resource needs.

4. The agreement by the primary stakeholders of the social, economic and environmental objectives for a BSS through which community needs, wellbeing and social equity is maintained; economic development opportunities are optimised and the attractiveness and quality of the city's public realm, built and natural environment is enhanced.

5. The appraisal, scoring and ranking in order of priority the BSS objectives to include modal shift; the integration of public/sustainable transport modes; the capacity to serve as viable *first/last mile solutions*; citizen health and wellbeing; *SMART* city and innovation; tourism, leisure and recreation, climate mitigation and adaptation; public realm and environmental management; competitive positioning and liveability, amongst other criteria.

6. An agreed stakeholder approach through which extensive localised engagement and multi-level public consultation can be facilitated allowing a fuller understanding of the role and contribution that can be made by cycling generally - and the BSS more specifically - within an agreed overarching vision and implementation plan for transport and mobility management in Kilkenny. Stakeholders might reasonably assess if and how a BSS can be a catalyst or pathfinder for changes in mobility management and modal shift in Kilkenny.

7. A comprehensive appraisal as to how the expressed needs, aspirations and vision of all stakeholders in Kilkenny can be harnessed and aligned to ensure that the development of cycling and a BSS is a viable component in the sustainable transport infrastructure and system.

8. Incentivise local employers to facilitate modal shift by employees through the active promotion and adoption of workplace travel plans in which cycling is facilitated and the supporting cycling infrastructure (stands, lockers, etc) is developed.

9. The identification of opportunities and latent resources as well as of the constraints and inhibiting factors unique to Kilkenny. It should also seek to identify champions or advocates for a BSS and for the broader issue of sustainable mobility in Kilkenny city.

10. A critique of docked vs dockless BSS options and agreement on the optimal fit for Kilkenny in meeting the agreed BSS objectives, given Kilkenny's context, demographics and resources. Such an appraisal should be viewed through the context of existing or planned future Local Authority traffic and mobility management initiatives in the City. Due consideration should be given to the impact on the public realm and the built and social environment including the impact of a BSS and its infrastructure on vehicular or pedestrian flow; clutter, litter or nuisance; hazards or impediments to health and safety and/or to those with mobility issues.

11. A detailed assessment of the locally available resources and funds that can be sourced or redeployed in order to mitigate/or reduce the need for a subvention from public funds to meet BSS operating costs.

12. The trialling of a BSS over a short-term period in order to more accurately define BSS objectives; optimise project scale and scope; assess infrastructural challenges and constraints; determine user needs and scheme acceptance; identify operational and viability issues, etc.

13. A comprehensive audit, critique and assessment of the existing City cycle infrastructure, network and resources. This is to establish a current baseline as well as to identify the nature, location, scale and cost of infrastructural repairs, enhancements and new developments necessary in the short, medium and long term.

14. An assessment of the potential to integrate the development and promotion of the urban cycle infrastructure, network and resources with those of the rural *Trail Kilkenny* initiative in order to create a compelling countywide cycling recreational and amenity proposition.

15. The identification of specific supporting project actions (infrastructure, capital investment, public realm, research, marketing, amenity and recreation, social inclusion initiatives, stakeholder management etc) that can be resourced and implemented from within existing strategic and operational plans of the stakeholders. A range of capital and non-capital actions/projects that can add value to and progress the implementation of a BSS initiative should be prioritised; implementation timelines agreed; lead and supporting partners identified and budgets and funding lines sourced.

16. The development of a wayfinding strategy to improve the access and mobility flow through the city for residents and visitors alike. The system which should incorporate directional and informational signage to direct people to major civic, cultural and transport destinations across the city centre. The way-finding strategy should accord and support the priority objectives as agreed by the stakeholders for the BSS.

17. Agreement by the stakeholders on the configuration, scale, scope, range and cost of a BSS allowing the necessary latitude to scale capacity, adapt location or introduce enhancements (such as electric power assist, cargo bikes, scheme reach, intermodal connectivity, etc) as necessary or appropriate.

18. Given the agreed configuration and scale proposed, the identification and agreement of the optimal bicycle pickup/drop off locations in the City that best contribute to agreed scheme objectives to facilitate modal shift and interconnectivity between modes and locations.

19. Agreement on the scheme configuration and specification taking account of stakeholder requirements, operational issues to include scheme ownership; contractual issues; duration of operations; terms and conditions of use; bicycle specification and characteristics; safety requirements; pricing strategy; billing and payment systems; technological requirements for users; back end systems; data management and protection, maintenance and repair protocols; marketing and promotion; scope and nature of advertising allowed. This process should seek to establish the criteria to be used for the selection of a scheme operator.

20. The assessment of specific displacement issues that might arise particularly in relations to traditional bike rental and tourist use. This can be mitigated by incentivising annual subscriptions rather than short term rentals, developing partnerships and by providing information about services and facilities available from bike rental shops. Furthermore, local bike retailers and guides could potentially be engaged to redistribute or rebalance bike stocks.

21. Identification of the necessary level and mix of project financing required as well as the appropriate funding sources available to meet the capital and operational needs of the scheme over the medium to long term.

22. A comprehensive assessment of the relevant regulatory, compliance, site development and operations requirements by the Local Authority.

23. Unanimity amongst stakeholders that the maximum possible value for money is achieved through the targeted use of existing available resources, targeted investment and leveraged funds from the private sector and/or through the use of public funds and resources.

24. The strategic alignment of a Kilkenny BSS to the relevant EU, national, regional, sectoral and local development policies, plans and strategies and funding opportunities.

25. Agreement and communication of the key performance indicators and performance metrics to be used as baseline data for monitoring purposes and post-implementation evaluation. This should consider the requirements for data collection, processing, storage and GDPR compliant data sharing protocols,

26. A determination of the appropriate length and terms of contract and the parties to the contract and their respective responsibilities and roles.

27. Agreement on scheme configuration, specification and conformance to include the performance targets and service standards to be achieved by the selected scheme operator.

28. The management of the public procurement process as applicable for scheme operator, supporting services, engineering, utilities and/or other ancillary works development.

29. The apportionment of operational and monitoring responsibilities between the Local Authority, the selected operator and other stakeholders.

12.0 APPENDIX 1: WHAT COULD A BIKE-SHARING SCHEME IN KILKENNY LOOK LIKE?

URBAN QUALITY, PLACEMAKING AND CYCLING

Cycling has undoubtedly become a key component of city planning. It is perceived as green, desirable and fashionable. Inspired by examples in Netherlands and Copenhagen which show cycling as an integral part of public transport at all scales from national to local, many European countries have adopted proposals to improve cycling infrastructure and there is pressure from cycling groups and transport lobbies to prioritise cycling over private cars – and in some cases, even over pedestrian facilities.

In many European countries there has been a culture of cycling throughout most of the 20th century. In Denmark, Netherlands and Germany cycling is normal for all ages. It is protected to an extent by legislation and highway codes in many countries. In these countries, cyclists may have rights of way at junctions and cycle lane provision is commonplace.

> The Dutch have '*wielrenners*, or "wheel runners" — "the sporty cyclists" — and they have a '*fietser*', which is just "someone on a bike." When you talk to somebody in the Netherlands about what makes biking so special, most of them will say, "*What are you even talking about? It's no different than when I get on the train or go for a walk*." You're no more a cyclist than you are a pedestrian or a driver or a public transit user.

Melissa Bruntlett, '*No helmets, no problem: how the Dutch created a casual biking culture*', https://www.vox.com/science-and-health/2018/8/28/17789510/bike-cycling-netherlands-dutch-infrastructure

This distinction between "sporty cyclists" and "someone on a bike" is important. Much of the proposed provision for cyclists is often aimed at sporty cyclists rather than normal people. With increasingly strident calls for segregation and protected lanes, in some instances even in pedestrian areas, the idea of cycling becoming 'normal' tends to be lost. Yet the normalisation of cycling is a highly desirable outcome.

PLACE AND KILKENNY

Aside from the important matter of public transport, there are other ways in which increased cycle use could improve the environment of the City. Kilkenny has places, focal points and hubs which are popular and where street activity is pronounced. From a visitor point of view, obvious examples would be High Street, The Parade, Canal Square and Kilkenny Walk, the Railway Station and car parks. There is some limited cycle infrastructure at these points, but they seem natural locations for the expansion of facilities such as bike stations.

Bike hire stations offer the opportunity to enhance special places/social hubs/focal points and they can also help to create such places in other locations that do not necessarily have these positive characteristics now. They can generate cafes or bike shops or enhance meeting places - for example at the station, existing urban squares and features. Moreover, they enable KCC to have a degree of control over the creation of a better and more dynamic environment in Kilkenny.

The core idea that bike stations can be network related and created is a positive starting point. It leads logically to the generation of place. Going dockless would mean that KCC would lose the ability to locate and create positive outcomes for Kilkenny - they would effectively be spectators in this. There is a halfway house between docked and dockless (docked-dockless) which is explained later on page 45 "*An Approach to Developing a docked Bike-Sharing System or a Geo-Restricted Parking Dockless System*" which may offer a compromise between the two.

Network analysis of the City suggests a range of locations for different scales of provision. From a range of 2 to 50, the analysis homed in on 10 stations with a radius of 800m (5 minutes from any point in the city to a docking station) as a realistic starting point. Locations include tourist and visitor destinations, transport hubs and employment centres.

KILKENNY'S HISTORIC CORE – GETTING THERE AND BEING THERE

The next consideration is the environment of the centre of Kilkenny and its current lack of suitability for bike use. The Council have done some good work in establishing strategic bike lanes in the countryside and around the outer edges of the city. In the city centre, the provision is sub-optimal on the approaches to the historic core. Of course, the historic core does not lend itself to the provision of segregated cycle lanes and neither should it – it would be difficult to provide (dimensionally an issue with narrow streets) and controversial with other user groups particularly car users, pedestrians and accessibility groups, especially those with impaired eyesight.

The core should be an area of pedestrian priority but there must be a sense of a hierarchy between that core and the means of getting there - the distinction between arrival and travelling to the point of arrival and currently there are gaps in provision on the approaches to the core.

The most straightforward and cheap solution to this is the introduction of a 20kph speed limit in the historic core. 20kph creates a calm environment in which cars, cycles and pedestrians can coexist. It cuts down emissions and noise pollution. It is a tried and tested practice in historic town centres in Germany. The next stage after that would be to start reconfiguring the public realm to create wider footways including cycling provision and introducing pedestrian areas. Every user group should accept that sharing the environment is in everyone's interest. These steps would help to normalise cycling in the City centre.

SELECTING A DOCKED OR DOCKLESS BSS?

Mindful of the rapid growth and the ever-widening range of available options, a key consideration in the planning and development of a BSS is whether to invest in a docked or a dockless system or perhaps to develop a hybrid system with one complementing the other. Each system has its own

characteristics and offers both advantages and disadvantages. These must carefully be weighed up and considered in the context of the scheme objectives, available resources, user demands and the specificities of location and context. Consideration should also be given to the overall scheme objective and whether different schemes have substantially different user dynamics and patterns.

In general, the key characteristics of a docked scheme will include:

- Operation by a municipal or publicly funded scheme.
- Permanence, visibility and solidity within urban environment.
- Strategically sited at key locations of interest.
- Identifiable and visible manifestation of a cycling culture.
- Integration within the public transport network.
- Location in areas of high usage and demand.
- Higher upfront capital development costs.
- Higher operational costs arising from need to redistribute bikes and rebalance stations where usage is greater.
- User data tends to be shared.

In general, the key characteristics of a dockless scheme will include:

- Low capital cost and market entry.
- Generally operated by a private commercial operator.
- Lower operating costs.
- Simplicity, convenience and availability.
- Greater flexibility in use and range, allowing reach and access to outlying or peripheral areas.
- Easily and quickly scalable.
- Available to all demographics as where and when needed
- Ability to undermine or "disrupt" expensive docked systems and other public transport.
- Rapid expansion and potential failure rate.
- Abandonment and prone to misuse.
- User data is proprietary.
- Unproven business model.

On the face of it, dockless or free-floating schemes may appear to offer numerous advantages over conventional docked systems, not least in providing a lower cost opportunity to broaden the mobility offering within an urban location and increasing the potential range and usage for users. Free-floating schemes are often sold or positioned as having no cost to an urban location, but due consideration should be taken of the financial costs in managing the public realm; ensuring bikes are parked appropriately and not cluttering an already busy urban landscape or increasing health and safety risks.

Such concerns have often been expressed about dockless schemes, in the main fuelled by some high-profile failures by dockless operators with *Ofo, Mobike, oBike, Reddy Go* and *Gobee* all ceasing operations in major cities around the world. In 2018 alone, *Ofo* has quickly withdrawn from Australia, India, Israel and numerous cities across the US including Washington D.C., Chicago and Miami. In China, where dockless bike-share systems account for many trips, the micro-mobility landscape is undergoing convulsions, with *Bluegogo* going bankrupt in 2017, only 18 months after its launch. The company had raised US$90m from venture capital investors and operated around 600,000 bikes across China. At its peak, the company had claimed 20m registered users and daily bookings of 3m.

Even where the schemes have endured, the experience and insights from the US - while not directly comparable to Kilkenny - are nonetheless instructive. Recent growth in BSS has tended towards dockless systems with dockless operators adding 44,000 bikes to US streets in 2017. In comparison station-based systems added 14,000 bicycles in the same period. In some cities, notably Seattle and Dallas, the scale of dockless bike-share rivals now exceeds the largest station-based bike-share networks in cities like New York and Chicago.

Despite the large influx of dockless bike share bikes across the U.S. this has yet to translate into meaningful mobility gains or shifts. NACTO estimates that up to 1.4 million trips were made on dockless bike share bikes in the U.S. in 2017, making up about 4% of trips; this, despite accounting for 44% of the national bike-share fleet.

Mindful of the very visible failure or abandonment of some free-floating or dockless schemes worldwide some Municipal Authorities have sought to mitigate risk by seeking to:

- Implement and amend bye-laws limiting use, scale and volume.
- Introduce scheme trials on a limited basis.
- Introduce permits for time-limited duration to the preferred operator; with options and incentives to renew.
- Incentivise scalability depending on success of pilots or trials.
- Levy an annual licence fee as well as a charge per bike in the system. This has also allowed revenues to be raised to fund public realm or infrastructural enhancements.
- Designate special zones for use and operation to ensure complementarity rather than competition with existing docked systems. This approach can also be targeted to prioritise category of user (commuter), locations (to address mobility gaps) or target group (lower income; socially excluded, etc) depending on scheme objectives.
- Stipulate that dockless bikes incorporate "*lock-to*" technology in order to use designated physical infrastructure and bike racks/stands.

A COMPLEMENT TO PUBLIC TRANSPORT?

Currently public transport in the city is relatively limited with several licensed private operators and Local Link services passing through or servicing locations in the City. However, the transport infrastructure and network will be enhanced by the introduction of two cross- city bus services in 2019. Operating on an east/west and north/south axis and converging for a time in parallel in the city centre, the routes will serve most, but not all, destinations and key points of interest in the city. Given the small scale of the city, the introduction of the service will be likely to compete with a BSS

Figure 4 - Disconnections in the Cycling Network

which, while potentially offering greater speed and flexibility of travel, will not appeal to all users. The user profile of the bus service isn't yet clear, but it might be expected that the service will be favoured primarily by social and leisure users rather than commuters. Free travel concessions for some user demographics will also apply for the bus service. Existing rail services to the city make no appreciable contribution to commuting and at best a BSS can only be considered as a first/last mile solution in very limited circumstances.

As referenced previously in this study, it has been shown that a BSS tends to switch users from one form of sustainable transit such as walking and public transport to another, cycling. That being the case, the prospects for modal shift in Kilkenny appear extremely limited; there being little locally to suggest that Kilkenny can buck trends observed elsewhere. As such, expectations that the development of a BSS might precipitate a significant shift in the habits of a car dependent populace need to be tempered. All the more so when one considers the oft-cited concerns by current and prospective users as to the quality of the cycle infrastructure in the city as well as general safety concerns, While modal shift might appear unlikely for now, a BSS still has the capacity to contribute to an efficient urban transit network complementing and extending the reach of existing modes and public transport networks in the city and in outlying areas. However, the prospects of this occurring in Kilkenny without the active support and resourcing by the NTA appear remote.

AN APPROACH TO DEVELOPING A DOCKED BIKE-SHARING SYSTEM OR A GEO-RESTRICTED PARKING DOCKLESS SYSTEM

In this section, a physical implementation plan for a bike sharing scheme is proposed, focusing on where docking stations can be located, why, and how the scheme can be scaled and expanded in the future. This proposal is identical for either a docked BSS or a dockless BSS where parking areas are geo-restricted. This discussion will be prefaced with an examination of the existing cycle network, with commentary and ideas for future development -- especially in the context of a new shared bicycling scheme -- presented as well. This discussion will be framed by a presentation of the *'place-space'* principles, which offer an understanding of how valuable and active places in the city emerge more effectively in response to a thorough understanding of the unique arrangements and connections of spaces in the city.

NETWORK, CENTRALITY AND PLACE

The existing bicycle network in Kilkenny, including the recent expansions to the network and proposals for the future, demonstrate many characteristics of a strong bicycle system, especially for such a small city. There is a good mix of leisure bicycle lanes and urban lanes intended more directly for commuting or reaching final destinations in the city centre. Further, the lanes radiating from the centre to the outer ring of the city provide a high level of service to different neighbourhoods, and this arrangement of bicycle lanes proves to be the most effective and efficient. The newer bicycle lanes built on the perimeter of the city need to be commended for their design, connectivity, and integration with traffic, for example how they cross roundabouts or continue across intersections. This provides a level of safety, visibility, and prominence on the streets that allows bicyclists to move safely and efficiently without prioritising them over other modes of transport.

While there are many strengths of the existing

network, some more critical observations may also be made. There are some instances where a logical connectivity in the cycle network is interrupted -- while this may be due to changing dimensions of the streets, necessity to prioritise other modes of transport, lack of available space, or any other reason, the issue of perceived connectivity in the cycle network is essential. Now, cyclists may be confident on the bicycle, particularly merging with traffic and other forms of transport, navigating while being aware of hazards, motorists, and pedestrians, and in moving between designated cycle lanes and general traffic.

However, with any sort of public bicycle sharing system, there will be a sudden influx of lesser skilled riders, casual users, elderly users, and children, and therefore safety and perceived ease of using the system become critical. When there are disconnections in the network, new cyclists may be discouraged or uneasy when merging with general traffic, and this may pose a safety risk to more vulnerable users. There is a risk from drivers who may not be accustomed to or necessarily prepared for a sudden influx of new cyclists, especially if they do not have separate bicycle lanes and ride with general traffic. For this reason, ensuring maximum continuity of cycle lanes is important.

Figure 4 demonstrates a few points where these logical connections could be considered - the exact means by which the network is extended at these points of course depends on many other factors and may range from simple signage to physical intervention and building new bicycle lanes. A few alternatives and ideas for consideration are presented, as well as an illustration of the point.

Another factor to consider is regarding the instances when the bicycle network spans paths that perhaps less than ideal for bicyclists, may pose a hazard with other forms of transport, and again must be considered more critically in light of the potential influx of new, lesser skilled and vulnerable cyclists that will surely occur with the implementation of a bicycle sharing scheme in Kilkenny. Particularly there are some instances of the cycle network traversing back lanes such as at (indicated also in Figure 5 Father Murphy Square, Roberts Hill Alley, and Coote's Lane. A more complete discussion of the characterisation and classification of the existing bicycle network may be found on page 54..

Overall, the current structure of the city's bicycle system is well-connected and suitable to a variety of user types. As it is, integrating a new bike sharing scheme - and the new users that accompany it - should not pose any problems nor require significant physical interventions. However, there are issues such as logical connectivity and specific attention to parts of the network traversing lanes or other tight spaces which should be considered. By ensuring that there are minimal risks, hazards, and conflicts in the cycle network, it becomes more likely that new and vulnerable users can gain confidence in the bike sharing system. For users who are sceptical or nervous about cycling, the eventual success of the scheme will depend on the ability of these users to feel confident in the system and see the value in choosing bikes over other forms of transportation.

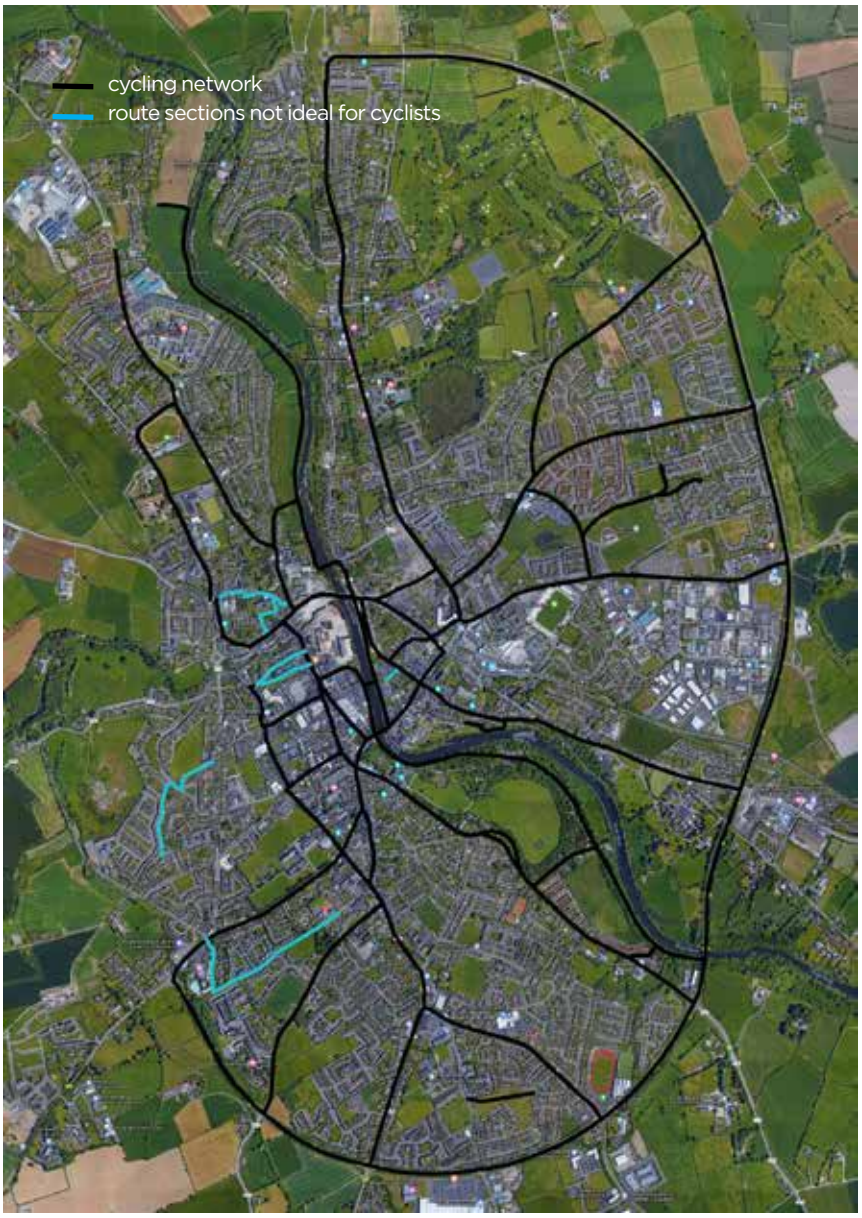


Figure 5 - Routes not ideal for Cyclists

Centrality

The concept of urban network centrality seeks to quantitatively assess various aspects of the street network in any sized town or city through mathematical analysis. While employing advanced methods of mathematical graph theory, the results of an urban network centrality analysis are simple to visualise and immediately comprehensible and applicable. This type of analysis reveals information about connectivity, accessibility, intuitive connections, shortest paths, and places

Figure 6 - Kilkenny Global Choice

which naturally become destinations.

The application of urban network analysis ties into the "place-space" approach, through which it is argued that the creation or strengthening of urban 'places' must be intrinsically linked to a comprehensive understanding of 'space'; network analysis reveals many of the hidden structural characteristics defining the 'spaces' of Kilkenny.

While there is a multitude of measurements that can be made in Kilkenny and at various scales, the simplest application is the most appropriate. Here the idea of 'betweenness', or 'choice' is introduced. *Choice* is the measurement reflecting how frequently a street segment will form the part of the shortest paths between other origin and destination points in the city. A street with high *Choice* values is on the shortest path from many places to many other places, whereas a street with low *Choice* values does not form a part of other shortest paths in the network.

More succinctly, *Choice* corresponds with the "through" potential of a street - when a street is naturally on the shortest path between places, it has the highest potential to be used as a through route. On one hand, streets with high *Choice* values will be those streets where cyclists naturally and intuitively want to go, in order to navigate to their final destinations. An element essential in developing a cycle culture and an optimally-performing cycle network is ensuring that the streets with high *Choice* values have adequate provision for cyclists, which will establish a cycling network that responds to the intuitive needs of cyclists and that provides the minimum number of cycle lanes to serve the largest portion of cyclists in the city. In some cases, it might be expected that cyclists naturally tend to using these streets, and without adequate cycling provision, may pose a safety hazard.

In Figure 6 the *Choice* computation is shown in Kilkenny. This is referred to as '*Global Choice'*, meaning that it does not take into consideration any limitation of trip distance. As Kilkenny is a compact, contained city, it is not necessary to consider such limitations on trip distance as the most common trips (from the outskirts to the centre) do not exceed a distance uncomfortable for average cyclists. The most interesting choice values in Kilkenny are those streets in the upper quantile -- the top 10%. These are the most important 'through routes' to consider and are shown in Figure 7.

In Figure 8 the overlap between the core *Choice* routes and the existing/ proposed cycle network is depicted. There is already strong agreement between the existing/ proposed network and those natural 'through' streets -- this demonstrates that the decision-making process used to determine the best courses for bicycle routes rather parallels this centrality assessment, an excellent indication to the efficiency of the network. It is not necessary nor advisable to propose matching a bicycle network solely to match the Choice Core network, but three key observations and proposals are given here:

The North/ South stretch of Butt's Green southward to Old Callan Road intersecting with College Road has one of the highest Choice scores in the city but does not have bicycle lanes. The road dimensions and design suggest it could accommodate and integrate bicycle traffic. Including this route in the bicycle network would create a strong and intuitive connection between the Northwest and South/Southwest neighbourhoods in the city. Also, this section of bicycle lane would bypass the historic city centre, and minimise the time cyclists would have to spend in that historic core if that is their final destination.

The streets to the North of MacDonagh Junction, including Hebron Road, Ballybough Street, and Castlecomer New Road, have been shown in image 1 (image), depicting instances where the cycle network is not continuous but could logically be connected. These streets have extremely high Choice and through potential, providing further justification for the proposal that they should be included in the cycle network.

The Choice centrality analysis means that a street that is a natural 'through' route for cyclists is also a natural 'through' route for drivers and pedestrians. Ultimately, there may be points of conflict in these places. This area of MacDonagh junction is the last entrance to the historic centre from the north of the city. It is, is adjacent to the train station and shopping centre, is a part of the natural routes in the city and could form a logical connection with the rest of the city. Therefore, to maximise efficiency in the bicycle network and ensure a sufficient provision for the safety of new cyclists, consideration should be given to this area either through new cycle lanes or other treatment.

The final observation is regarding Dean Street. The newly developed cycle lanes on the Wolfe Tone Street bridge already form an excellent connection to the city west of the river and to MacDonagh Junction. This route could be logically extended to the east along Dean Street and connect to the existing network at Irishtown (and form a seamless connection to the city centre), Coach Road, and St. Thomas's Square.

Network centrality can be used to provide a constructive understanding of the city's form, how its spaces are connected and how better proposals can be made for the bike sharing scheme as well as complementary infrastructure improvements. In developing a bike scheme in Kilkenny, the routes must be safe, direct, and natural. An understanding of Choice centrality provides valuable information towards achieving these goals.

Figure 7 - Kilkenny Choice Core Routes

Implementation Theory/ Strategy Method

The focus of the strategy is the optimum locations for docking stations. Precise locations for physical docking stations are proposed but alternatively these could equally be the centres of radii within which dockless bikes could be left.

Through a docked bike-sharing system, there is an opportunity to strengthen the urban impact of key locations in the city through the placement of docking stations. As these stations are permanent, they will also take on a permanent role in the city; cyclists will regularly be moving more frequently to and from these locations, strengthening the significance of these. Much like bus stops, tram stops, and metro stops, public transport nodes have a large potential to become hubs in themselves, attract business, and support retail.

A dockless system on the other hand, does not afford these same opportunities to the city. While for individual users it may be more convenient to use a sustainable form of public transportation, this type of system does less to contribute to the greater urban character of a place. One day there may be users coming to and from a bike drop location, and another day not. This inconsistency does little to promote a strengthening of the urban environment, attract commerce, or represent any permanent change.

A suitable alternative could be a sort of docked-dockless scheme. A docked-dockless scheme is one in which docking 'zones' may be established, usually in a radius from a certain point or along certain streets. This moderate restriction on the otherwise total flexibility of a dockless system can bring some of the benefits of a docked system without compromising the freedom offered by a dockless system. It can create a degree of permanence in the urban form and the associated benefits. This system of 'bike-drop zones' is

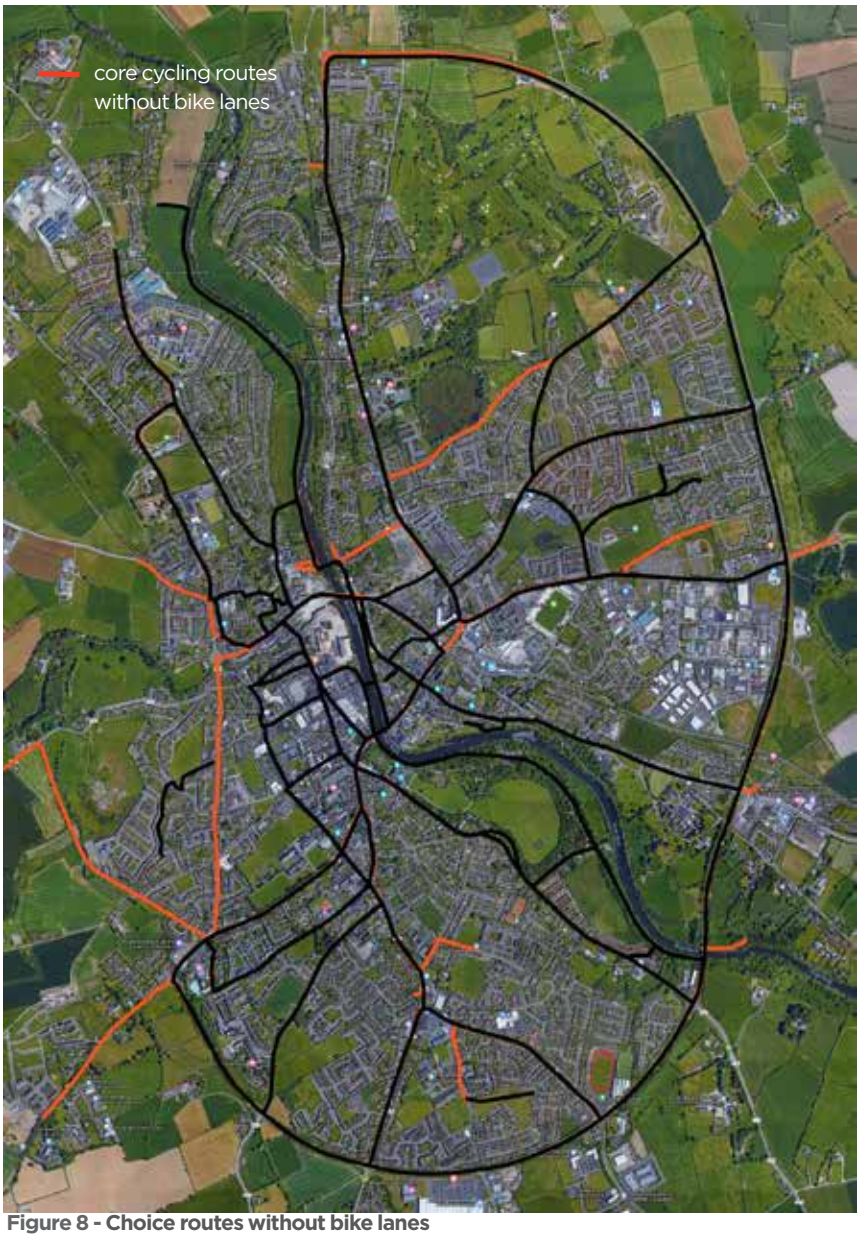


Figure 8 - Choice routes without bike lanes

commonplace in many contemporary dockless systems and can be mandated as a necessary requirement prior to implementing the BSS.

Considering a docked system, or some form of dockless where the bicycles must still be left within a certain distance of indicated points, a strategy for the determination of docking locations is presented. A general principle in urban planning is that 400 metres generally corresponds with a 5-minute walk. Average users begin to consider alternative modes of transport when facing journeys longer than 5-minutes. For practical if a user cannot reach a bicycle within 5-minutes, then it is likely that they will reconsider taking the bike and perhaps opt to drive.

One of the most important keys to success for a bike-sharing scheme in Kilkenny is the ease of use for all users. It is important that users can reach the bikes quickly, intuitively, and that it is not perceived as an inconvenience to go to or from the bike sharing docks or locations. The implementation of a bike sharing system is that it should be attractive to all users and it should be a convenient alternative to other forms of transport; while there will always be more committed users who go out of their way to cycle, the success of the scheme cannot be based on these users.

In the development of the docked BSS distribution strategy, the main criteria are that:

- any user should be able to reach at least one docking station in a 5-minute walk
- the city and its significant points of interest should be completely or near-completely covered by the docking 'catchment areas' (areas within a 400m / 5-min walking radius) of the docks

Geometrically, to ensure that from any point in the city a docking station can be reached within a 5-minute walk, the docks must be distributed so that there is an 800m distance between any of them. Figure 6 depicts this principal.

An exemplary case study is demonstrated in Velenje, Slovenia, where the docking stations are distributed at approximately 500m or less intervals. When the stations are distributed 500m apart, this means that the maximum walking distance to reach any station is just over 3-minutes. Figure 10 depicts this principle.

Figure 11 shows an abstraction of how stations with distances between them of 800m can be arranged to cover a concentrically-shaped city. The abstract image shown considers stations that are perfectly perpendicular one to another, which technically leaves a pattern of areas that fall outside the 5-minute catchment area, from where it would take longer than 5-minutes to reach a docking station. Because this is purely an abstraction, it can be said that an 800m distance between stations still corresponds to a 5-minute walk to the nearest station, and that any 'grey' areas not served perfectly can be considered on a case-by-case basis when discussing the actual allocation of the stations in Kilkenny.

Besides Velenje, many other examples of docking stations distributed with less than 800m in-between them are seen, for example in the case study of Stirling. In many large cities, the distance between docking stations is significantly less than 800m, often reaching 300m between stations. There are two reasons why distributions of docks less than 800m are not proposed in the introductory stage of a Kilkenny bike share programme:

In its incipient stages, a proposal must balance the cost of additional with accessibility to the system. A minimum requirement is that a user

Figure 9 - 5 minutes walk theory

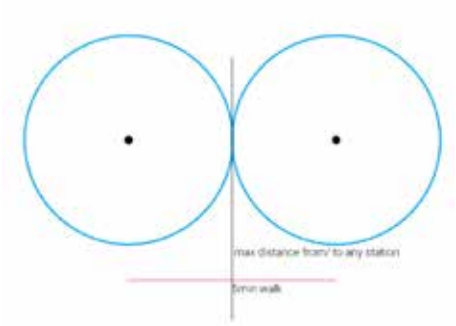


Figure 10 - Theoretical distance between stations

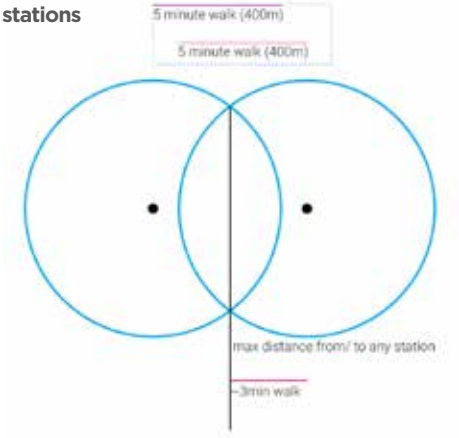
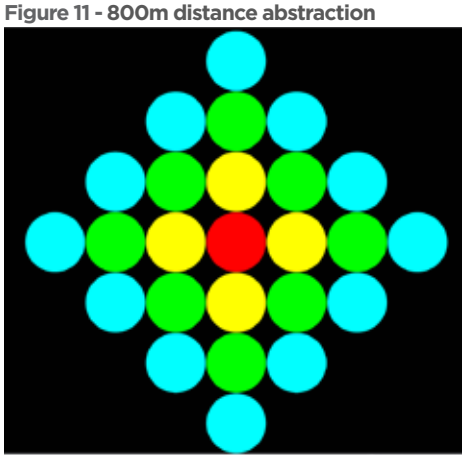


Figure 11 - 800m distance abstraction



must be able to reach a bicycle within 5-minutes. Anything beyond that would impose a financial and maintenance strain on the system that can be avoided in the early phases, without compromising the level of service offered.

The first aim of the bicycle sharing system should be to ensure adequate access to the largest portion of the city as possible. In this way the system can become established quickly as all residents will have an opportunity to reach a bike quickly and feel that the system is useful and convenient. As the service becomes more popular and more embedded, and the mobility and cycling patterns of the users begin to emerge more clearly, it will be more clear which stations are the busiest and which areas could benefit from a higher level of service. Then, determining the location of a new station halfway between existing stations would be the logical choice. This would result in a distance between stations of about 400m, meaning in these central/ busy/ desirable places, users could reach a bicycle dock within a 2.5- minute walk. Especially in a small city like Kilkenny, this is a very high level of service.

The proposal aims to maximise accessibility to the service while simultaneously setting a pattern for smart growth and expansion into the future. By increasing the distance between stations to 800m, the area in the city which has access to the system is maximised, but without having the same area served by two docking stations. The comparator case studies (presented in Appendix 2) can be referred to in order to examine the distribution between stations in comparison to the percentage of the city covered. It is observed that in several of these comparable case studies, the average minimum distance (as the crow flies) between docking stations is less than 800m. However, in many of these examples the total percentage accessible by 5-minutes or less to docks is reduced: for example, in Yverdon-les-Bains, the average distance minimum between stations is only 533m, however only around 36% of the city has access to the bicycles. Similarly, in Montecatini Terme, Italy, stations are around 360m apart, yet less than 35% of the city has access to the bikes within 5-minutes.

None of the case-study cities has aimed to maximise urban coverage in exchange for distance between stations. However, there are examples of cities that have managed to both maximise coverage and minimise distance between stations, for example in Chivasso where 74% of the city has 5-minute access to a bicycle dock, yet the stations average only 395m apart. This is a standard that Kilkenny may aspire to, but not in the initial stages. A phasing programme to build reliance on the system and to integrate bike sharing into the city's mobility culture must be developed gradually.

Survey Results

A user survey asked participants to list where they would like to have access to bicycles (docks) within Kilkenny. The question was open-ended and did not request a specific answer, nor did it give respondents a set of options. This format was selected to ensure that the survey could be completed and that respondents would not feel there was any bias in the questions they were being asked. For that matter some constraints were implemented to select meaningful responses:

- Responses giving 'advice' were not considered, for example that docks should be 15 minutes apart or that they should connect to the city centre
- General suggestions such as 'near car parks' and 'near bus stops' were excluded.
- It is worth noting that many respondents suggested installing docking stations near car parks. Likely, this is due to a natural thought that bikes could be a great multi-modal option, or serve in the 'last mile' of their journeys. They may also see bicycles as solving parking issues in the city centre.
- Non-specific locations were omitted from consideration, for example when responses were the names of neighbourhoods or long streets without a specific location state
- In many cases, similar places in Kilkenny were suggested by different names. For example, Kilkenny Castle, The Parade, and Castle Road were often identified separately, but later merged to correspond to roughly the same place in the city.

The survey results are shown in Table 26. Because respondents were not limited in how many locations they could list, nor gave any order of preference, the results are reported as a simple count of each time a location was mentioned. Demonstrating that a certain percentage of respondents wanted a dock in a certain location gives misleading conclusions of the results, as some respondents listed one location and others ten. The results of this survey are displayed on the map in Figure 12. Locations are geo-referenced and the darker the point, the more times it was requested as a good docking location in the survey. Locations indicated by 2 or fewer respondents are not visualised. There are concentrations of preferred docking locations around the city centre from Kilkenny Castle north towards Irishtown Road, as well as around MacDonagh Junction and the train station. A significant number of respondents also indicated a desire to have a dock at the Hospital and at the Loughboy Shopping Centre, two important points of interest in the city. The business parks and industrial centres were indicated as well, likely due to their draw of working commuters.

Table 26 - Kilkenny Survey Results - preferred Bike Station Locations

Number of Returns	Location	Number of Returns	Location
76	Castle / The Parade / Castle Road	3	Watergate Theatre
47	City Centre / High Street	2	Dean Street
34	Loughboy	2	Dublin Road
33	Train Station	2	Gaol Road
24	McDonagh Junction	2	Glanbia House
18	Hospital	2	John Street
16	Newpark	2	John's Quay + City Library
13	Bus Stops	2	Melville Heights
13	Courthouse, Parliament St Brewery	2	Newpark Neighbourhood
13	The Watershed	2	Trails
12	Periphery	2	Waterford Road
9	Irishtown Road	1	Business Parks
7	Hebron Industrial Estate	1	Butt's Green
6	Car Parks	1	Clongowan
6	Castlecomer Road	1	Glendine
6	Hotel Kilkenny / Callan Road	1	John's Bridge
5	Market Yard / Dunnes	1	Kilkenny College
5	Schools	1	Kilkenny County Council
5	Woodies	1	Loreto Secondary School
4	Canal Square	1	Market Cross
4	Ormonde Road	1	Old Callan Road
3	Aldi	1	Parcnagowan
3	Ashfield / The Orchard / New Orchard	1	Patrick Street
3	Cillin Hill Business Park	1	Riverside Drive
3	College Road	1	St. John's Church
3	Nowlan Park	1	The Sycamores
3	Purcellsinch Business Park	1	VHI Healthcare

Figure 12 - Survey results: suggested docking station locations ranked

CYCLING INFRASTRUCTURE

The development of cycling infrastructure and a network in Kilkenny City has its origins in a *Pedestrian and Cycle Network Study* published in 2002. This was further enhanced by the 2009 *Mobility Management Plan* and a *Smarter Travel Group* established in 2010 comprising representatives of the local authorities, the HSE, the Kilkenny Recreation and Sports Partnership and Waterford Institute of Technology. A notable outcome of these initiatives was the concept of mobility centred on the principle of Kilkenny being a city – local facilities and services could be accessed within 10 minutes via cycling or walking. Infrastructural improvements and new road developments allow the city cycle network to encompass the main radial routes and an orbital route on the semi-completed ring road, linked by minor routes to the city core. KCC has provided 215 *Sheffield Stands* at strategic locations throughout the city. The Kilkenny City and Environs Development Plan 2014-2020 envisages a completed network of more than 50km of cycleway lanes throughout the City centre and environs.

The existing dedicated cycling infrastructure – which has generally been developed in tandem with road improvements and alignment - is however highly variable and lacks consistency of treatment and maintenance. It is comprised of:

Mandatory Cycle Lanes - cycle lanes marked by a continuous white line which prohibits motorised traffic from entering the lane, except for access. Parking is not permitted on mandatory cycle lanes. Mandatory Cycle Lanes are 24-hour unless time plated in which case, they are no longer cycle lanes.

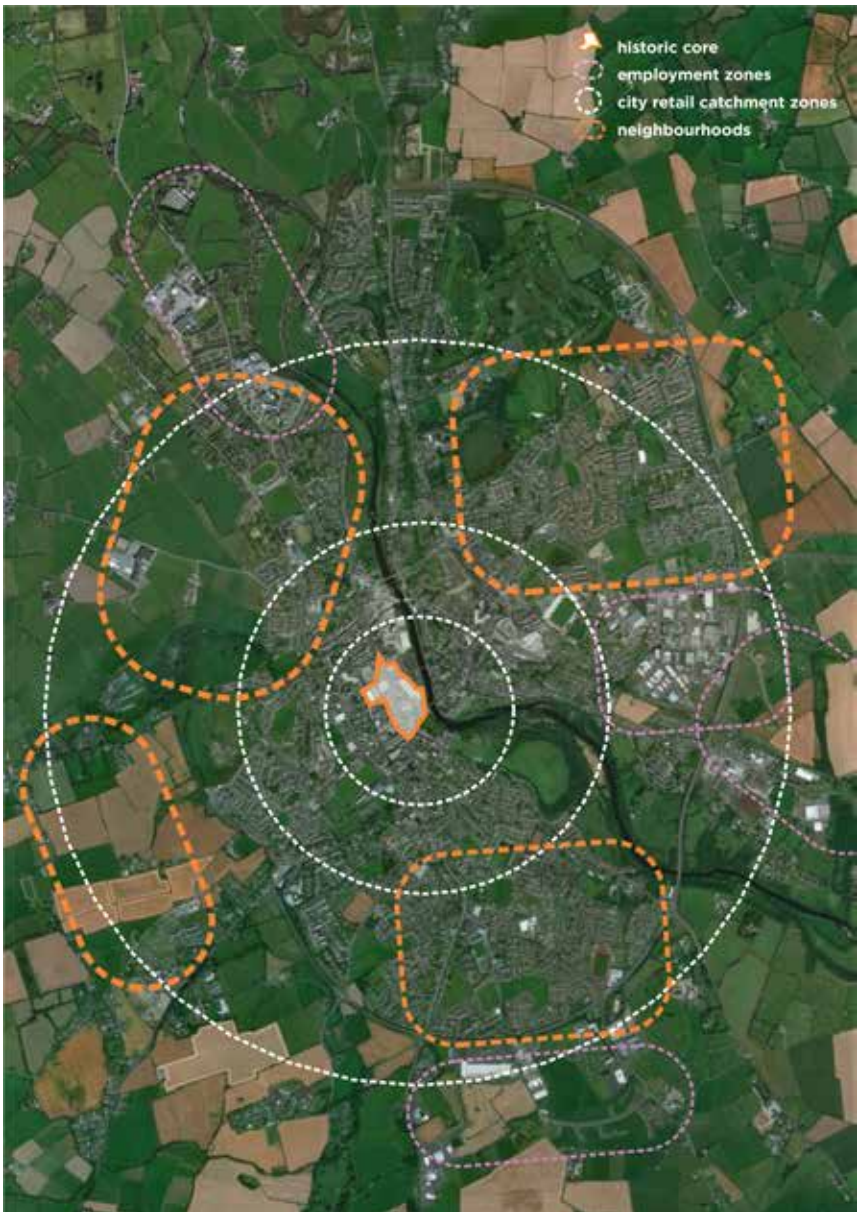


Figure 13- Strategic areas

Advisory Cycle Lanes - cycle lanes are marked by a broken white line which allows motorised traffic to enter or cross the lane. They are used where a Mandatory Cycle Lane leaves insufficient residual road space for traffic, and at junctions where traffic needs to turn across the cycle lane. Parking is not permitted on advisory cycle lanes other than for set down and loading. Advisory cycle lanes are 24-hour unless time plated.

Raised Cycle Lanes – are Mandatory Cycle Lanes that are raised by 25 to 50 mm from the main carriageway surface. They are in operation on a 24-hour basis and parking is never permitted. Their primary use is two-fold: along collector roads with frequent entrances and driveways where in a shelf arrangement the cyclist is slightly lower than the footpath and slightly higher than the road and where the cycle lane is adjacent to a bus lane and the position of the cyclist is reinforced at particular locations, such as when approaching junctions.

The partially completed ring road in the city forms the backbone of the cycling network but weakens in consistency and quality as it radiates into and reaches the compact, medieval urban core; at which point road use and space is contested with other modes.

Kilkenny has an extensive network of themed activity trails developed and promoted under the banner of *Trail Kilkenny*. This is comprised of national waymarked routes, scenic walks, river walks and cycling trails. The on-road cycling infrastructure in the County is limited to the 64km *East Kilkenny* cycle route links Gowran, Graiguenamanagh, Thomastown

Figure 14- Classification of Existing Cycle Lanes

and Bennettsbridge, where it intersects with the 41km *South Kilkenny* cycle loop connecting onwards to Stoneyford, Kells and Kilkenny city. The 27km North Kilkenny cycle loop connects with the 82km *North Kilkenny* cycle route at Jenkinstown, connecting onwards to Castlecomer, Ballyragget, Freshford and Ballymanagh.

The development of a national network of both rural and urban cycle routes remains a specific, although yet unfulfilled, objective of the National Cycling Policy Framework. This identifies the need to deliver high quality cycle routes on a nationwide basis to encourage cycling for transport, leisure, recreation and tourism to ensure the development of a culture of cycling in Ireland. Among its recommendations is the development of a National Cycling Network to connect all urban centres with populations greater than 10,000. Specifically, in County Kilkenny this would link Carlow and Clonmel via Kilkenny City on the proposed 213km Naas to Mallow route and onwards to all other inter-urban cycle routes. So far only a 35km dedicated on-road cycle route between Carlow and Kilkenny on the old N9/N10 road has been developed.

CHARACTER STUDY OF CURRENT NETWORK

A well-connected, continuous bicycle network that gives adequate provision for cyclists is important. If Kilkenny wishes to accommodate a growing number of cyclists, it is imperative that special considerations be given to the cycle network and the potential points of conflict between different modes of transport. It may be reiterated that bike-share users will likely be less skilled on the bicycle, less experienced, less comfortable sharing spaces with other modes of transport and pedestrians, and importantly, also consist of more children or vulnerable users than those who currently opt to cycle. A successful bike sharing scheme must cater to these 'average' users not only in the technology of the system, the location of docks and the associated costsbut also and importantly, in the actual design and distribution of bicycle lanes/spaces within the network.

Fortunately, the current cycle network in Kilkenny is in very good condition and already able to accommodate any new bike share users. There are many high-quality lanes and tracks with good connections between them. The locations where

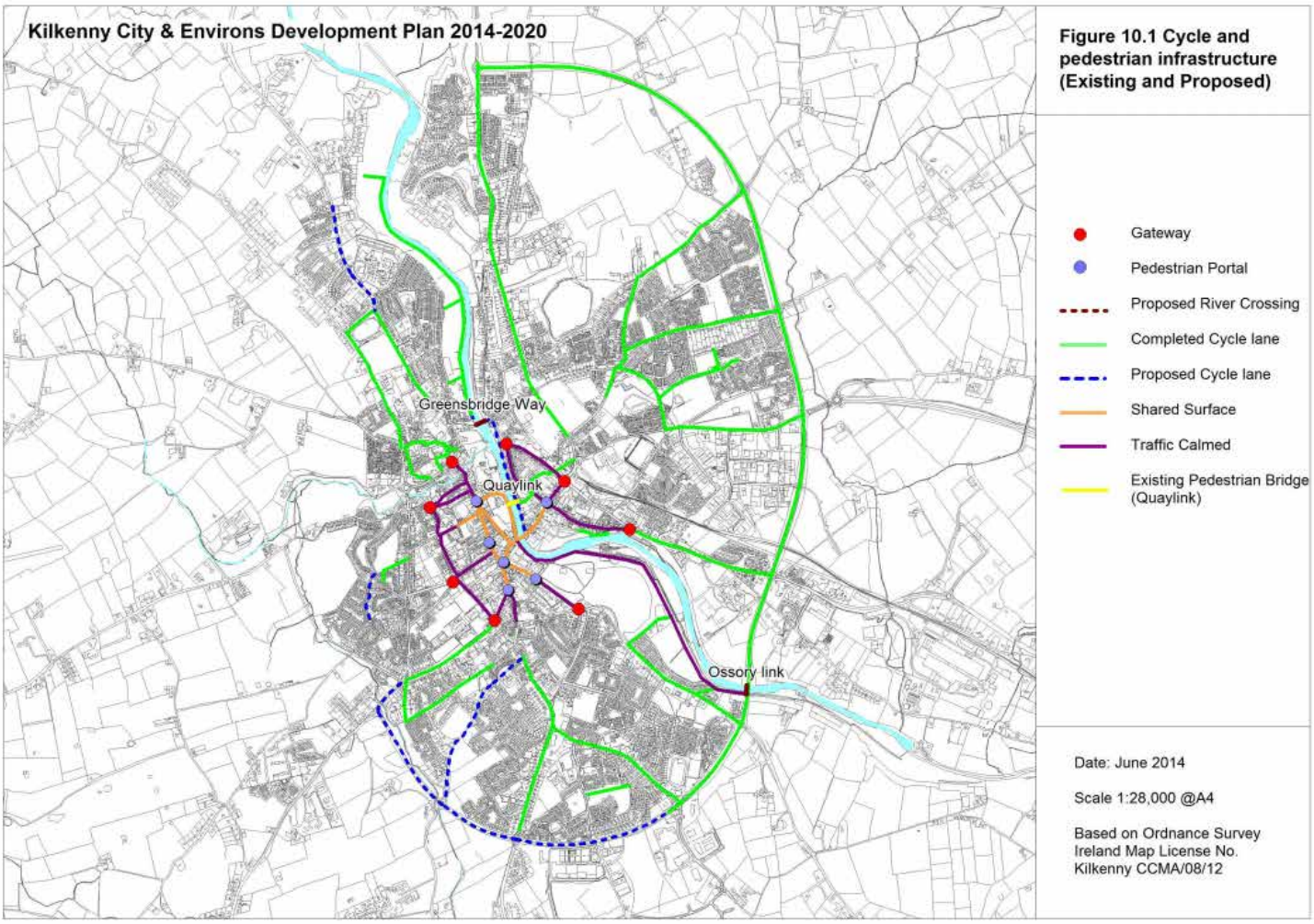


Figure 15: Kilkenny City Cycling Infrastructure - Source: Kilkenny City and Environs Development Plan 2014-2020

new connections could be made have been identified but here, a closer look at the type and quality of bicycle lanes in the city is explored.

Six types of cycle provision have been identified and these are show in Figure 14. This classification of cycle lanes identifies current, proposed, shared surface, traffic calmed and leisure (shown in Figure 15).

Class 1 - Exemplary

Exemplary bicycle lanes are the best cycle lanes present in Kilkenny and even on an international standard represent excellent provisions for cyclists. These lanes or designated cycle areas:

1. Have clear, demarcated spaces for cyclists that minimise conflict with other forms of movement
2. Afford generous apportionment of the spaces for cyclists
3. Allow unobstructed lines of sight by cyclists, drivers, and pedestrians to maximise inter-visibility and minimise potential for accidents
4. Painting and ground treatment is fresh and easily distinguishable.
5. Continuation through roundabouts and across intersections is fluid and safe

The image overleaf shows a view of exemplary provision in Kilkenny. It should be noted that these lanes are generally suited to wider, open roads and streets and are not feasible to consider in all locations in the city. These bicycle provisions are indicated as exemplary by their consideration of the cyclists and prioritization given to the cyclists, not only because they are wide and allow for fast movement.

Class 2 - Good

'Good' cycle lanes are those that are by all means sufficient for cyclists and offer a safe and protected movement channel. These provisions are definitely suitable for the potential new users in any bicycle-sharing scheme. Good cycle provisions:

1. Have few instances where there may be conflict with other transport modes

Class 1 - Exemplary

Class 2 - Good

Class 3 - Unacceptable

Class 4 - Special consideration

Class 5 - No current provision

Class 6 - Leisure

2. Have dimensions that are suitable for cycling, but cyclists may have to yield or slow when passing other cyclists, pedestrians, or drivers

3. Paint and ground treatment is present, but perhaps fading or in need of a new coat

4. Vision to and from cyclists may be obstructed by blind turns, overgrown vegetation, parked vehicles, or other obstacles.

5. May pass close to tall or blank walls which could obstruct vision and manoeuvrability

The image above highlights a sample of 'Good' bicycle lanes in Kilkenny. These lanes are definitively sufficient for all cyclists in their current state but might be given consideration if minor improvements are made in the future.

Class 3 - Unacceptable

In very few cases, roads, streets, or lanes that are indicated to be part of the city's cycle network, are deemed insufficient or unsafe for cyclists. These locations currently do not have any special provisions given to cyclists nor demarcated bicycle lanes but may be listed as part of the cycle network to demonstrate feasible alternatives to riders.

The few streets that were classified as 'unacceptable' for cyclists have very narrow spaces, blind turns, and very high potential for conflict with other users, particularly pedestrians.

Unacceptable cycle provisions:

1. Have dimensions which do not accommodate cyclists

2. Pose too many points of potential conflict

3. Cannot be remediated through design or prioritization of cyclists

The Class 3 image above identifies a lane unsuitable for cyclists and especially new cyclists using the bike share programme.

Class 4 - Special Consideration Required

There are many instances of streets or current bicycle provisions which arguably require special attention. They are deemed as requiring special attention predominantly because they are suitable for a wide range of 'average' users, but only if special provisions or treatments are made. These might be lanes in the city which have dimensions and visibility for cycling but could benefit from viewing mirrors or special signage. These for example could be streets where it is not feasible to design special bike lanes, but would require a highly-reduced speed limit, predominant, bright signage, or other treatments.

Special consideration streets:

1. Are streets and lanes that are acceptable for cyclists only if special treatment, prioritisation, or intervention occurs

One of the streets identified as requiring special treatment is shown in Class 4 above.

Class 5 - No Current Provisions

In the current cycling assignment in Kilkenny, there are a multitude of streets indicated as being 'traffic calmed' or 'shared surface'. These are the streets where it is not feasible to design special cycling lanes or other provisions but are still key routes in the network. A classification of streets with 'no provision' for cyclists is included because these streets are indicated as being part of the current cycle network but may not appear as such to cyclists. In their current state, these streets are cyclable, but would require a more pervasive cyclist prioritisation in order to be suitable to the anticipated influx of average bike-share users.

Overall, there is an inconsistency between how these streets are categorised and consequently considered as part of the cycle network, with how they serve cyclists. Indicating that these streets are 'shared surface' or 'traffic calmed' is not apparent in the analysis. This may undermine the efforts to reach a broader range of cyclists and hence ensure the success of the bicycle-sharing scheme.

One example of these concerns is on Upper Patrick Street. Here, the street is indicated as being 'shared surface', with a speed limit of 50km/h. A shared surface street is one in which cyclists, drivers, and pedestrians are all mutually de-prioritised and mutually aware -- the responsibility to avoid conflict is shared between all through groups of users. However, on a street without any indicated bicycle lanes and a speed limit of 50km/h, there is clearly a prioritisation of vehicles over cyclists and pedestrians. It is suggested that this inconsistency should be addressed or that the street be removed from the cycle network.

Class 6 - Leisure

Leisure provisions are those cycleways geared towards recreational cycling as opposed to commuting, for example along the riverbanks.

Sub-optimal approach

These lanes may be shared with pedestrians but not with cars, and in these instances, they would also be recreational routes for pedestrians. These cycleways provide a pleasant alternative for riders who wish to avoid vehicles, enjoy the scenery, or who are not commuting. They are classified accordingly to indicate their distinction from the more urban routes and due to their inherent lack of conflict with vehicles.

Overall the current state and character of the cycle lanes in Kilkenny is more than enough both for current cyclists and for those anticipated with the release of a bike-share programme. In very few cases some lanes/streets should not be included in the network, even nominally, and in other cases some instances where special design treatment would be required for safety measures and to accommodate the upcoming 'average' users.

DEVELOPING A PROPOSAL

While more detailed analyses and studies would be required to move to a more detailed planning stage, the proposals presented offer an informed starting point for more detailed planning and coincide with the preliminary financial considerations presented in this report. The proposal has considered the ideal distribution with 800m between stations and identified ideal locations for bike docks to realise this strategy. The actual determination of the station locations considers:

- The survey results
- The existing and proposal bicycle network
- Kilkenny Strategic Areas (shown in Figure 13)
- An evaluation of points of interest, density distributions, and neighbourhoods in Kilkenny.

A Potential Docked BSS

This report has identified potential scope for approximately 53 bicycles, spanning 6-8 docking stations that would require up to 90 docking points. If a docked BSS is determined to be the best option in Kilkenny, then a highly modular and mobile system is advised and the BICY system in Velenje is an excellent benchmark comparison.

Four development stages are proposed. The first stage corresponds to the minimum situation necessary to initiate a BSS in Kilkenny that is viable both financially and in level of service; this scenario offers adequate provision and coverage to key neighbourhood centres and additional coverage in the city centre. Eight stations are proposed. A typical modular configuration of a docking station may be in multiples of five, so 80 docking points could be found throughout the system. Then, 53 bicycles as discussed in the section "Determining the Scale of a Docked BSS" (page 45) would service the city without overcrowding the parking points.

Figure 16 shows the selection of the first 8 stations necessary to initiative a docked the bike sharing scheme. The 8 locations are:

1. Hospital
2. Loughboy Shopping Centre/ Business Park
3. Hebron Industrial Estate
4. Aldi/ Lidl (St. Rioch's Ct.)
5. Castle / Centre South
6. Courthouse / Centre North
7. Train Station / MacDonagh Junction
8. Newpark Shopping Centre

These 8 locations represent key points of interest, locations that would be conveniently served by bicyclists, places of work, places of transport, and shops which also are quite central in various neighbourhoods. The city centre/ MacDonagh Junction areas are the best served, as likely these are the most popular destinations in Kilkenny. It should be noted that a minimum level of service in the BSS is necessary to get the scheme off the ground. With too little infrastructure, bicycles, or docking points, users may be discouraged. These 8 docking points would provide the maximum coverage to the most essential areas in Kilkenny, without surpassing identified achievable cost or operational constraints as discussed previously.

A second phase of a docked BSS is proposed as viable in certain scenarios, if additional initial funding can be achieved or if the system quickly becomes more popular than anticipated. *Phase 2* proposes a further 5 stations that are deemed important, but not essential. These further 5 stations would maintain consistency with the bicycle strategy outlined earlier and maintain approximately 800m between stations while seeking to maximise coverage and access in the city. These further 5 docking stations are proposed at:

1. Hotel Kilkenny
2. The Watershed Leisure Centre
3. Purcellsinch Business Park
4. New Orchard
5. The Weir View

Figure 17 shows the proposed stations up through and including *Phase 2.*

These five locations expand the coverage of places of work, points of interest, and now provide accessibility to the system to residential neighbourhoods. While in the first phase covering the city's most important points of interest, the train station, etc. was essential, as the system becomes more embedded and popular in Kilkenny, service should expand to cover more areas that might be less busy, like residential neighbourhoods, as well as more places of work and key locations.

While *Phase 1* is in line with OBIS median statistics identified previously, *Phase 2* would not require significantly more infrastructure or bicycles. Other Irish cities have surpassed the median provisions (i.e. Cork, Limerick) and with the related marketing and strategies, a cultural shift in Kilkenny might

make an expansion beyond baseline possible. The number of bicycles necessary to sustain *Phase 2* would be approximately 5 per station, resulting in a total of around 75 bicycles. *Phase 2* is presented as a short-term aspiration for the BSS.

An additional two phases, *Phase 3* and *Phase 4* are presented for a potential docked BSS. It is acknowledged that with these stations and the number of bicycles necessary to support them, there would be cycling provisions in Kilkenny greatly surpassing the anticipated feasible operations. These phases are presented to contextualise a 'perfect situation' for Kilkenny and would be a medium to long-term aspiration for the city, contingent upon a significant shift in mobility patterns and cycling culture.

After *Phase 2*, the most significant points of interest, transport interchanges, and neighbourhood centres will be served by the bike share, also in accordance with the results from the survey. *Phases 3* and *4* propose stations at the remaining significant points of interest and seek to maximise accessibility to the remaining neighbourhoods/ residential quarters. In the third phase of expanding the service, a further 7 stations could be located at:

1. Aut Even Hospital
2. Kilkenny College
3. Loreto Secondary School
4. Stephens Street / Gaol Road
5. Bennettsbridge Road
6. Cillin Hill Business Park
7. Johnswell Road / Upper Newpark

Figure 18 shows the proposed stations up to and including *Phase 3.*

Phase 4 sees 6 more stations proposed at:

1. Castlecomer Road/ Newpark Lower
2. Dublin Road / Sion Road
3. Waterford Road / Upper Patrick Street / Coote's Lane
4. Woodbine Avenue / Bennettsbridge Road (east)
5. Kilkenny Education Centre
6. Kilkenny School

Figure 19 shows the proposed stations up through and including *Phase 4.*

Each phase of implementation could include:

Phase 1- 8 stations + 50 bikes

Phase 2- 5 stations + 25 bikes (13 total, 75 bikes)

Phase 3- 7 stations + 35 (20 total, 110 bikes)

Phase 4- 6 stations + 30 bikes (26 total, 140 bikes)

In total the four phases propose 26 docking stations in Kilkenny. With these 26 docking stations, over 76% of the city's area will be served -- higher than in any of the comparators cases examined in Appendix 2. While this is a good aspiration for Kilkenny, the proposal is flexible and may be altered as it is being developed. It is argued that *Phases 1* and *2* are the two most important phases in order to have an adequate coverage, and serve enough areas and points of interest to be viable in the city.

While *Phase 1* may be implemented with only the first 8 stations, it is envisioned that those opting to use the service at this time will be only those users with convenient access to the stations in their day-to-day activities, those users who are passionate about cycling, and potentially reach tourists as many of the city's important points of interest and historic core are accessible. However with 2 phases and 13 total stations, a large enough area and number of points of interest are served that the scheme will be more inviting and more accessible to a larger number of users.

If the service can progress to the end of *Phase 2,* then that would be a logical point to re-evaluate how it is being used, and to look at statistics about rider information. An alternate trajectory would be to cluster stations more closely together in popular destinations, instead of continuing with more stations to maximise coverage. This could be done by adding second and third stations in important destinations, for example in the area of the Castle or at the Hebron industrial area.

If a decision is made to utilise a physical docking system in Kilkenny the system should be designed to be semi-permanent, meaning that it can be easily moved and repositioned, or expanded to include more docks per station. This technology is readily available and used in many other cities worldwide. This system would allow popular stations to be expanded, and perhaps unpopular stations to be shrunk or moved to better locations. Also, this would allow a sensible redistribution of stations if a determination to densify docks in key areas is made.

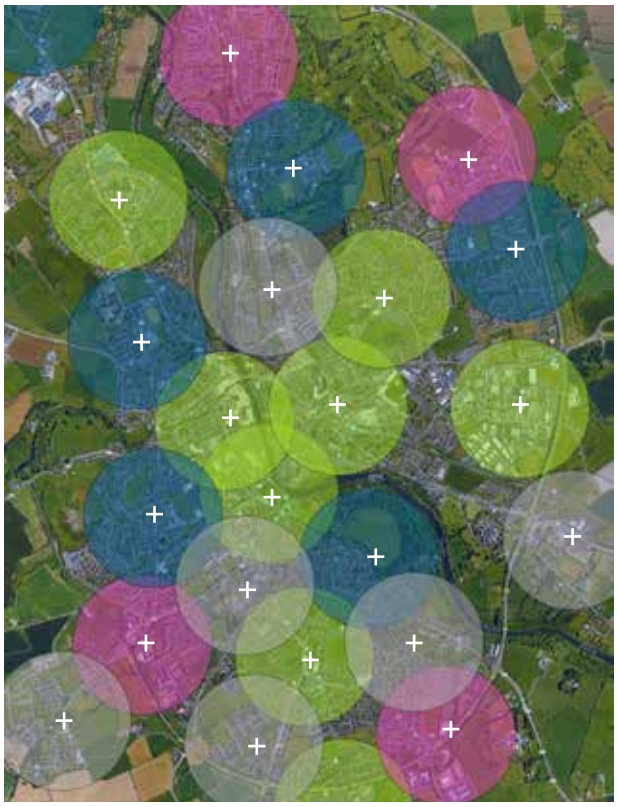
Considering the example of the Hebron Industrial Estate: in *Phase 1* a station is proposed on the north / south Hebron road, in the centre of the area. If this proves to be a popular station and a decision is made to provide more docks in the area, it would be possible to move it to the outside of the industrial area on the east / west Hebron road, and install another station as well. In the case of dockless bikes with designed parking zones, these zones can easily be changed through the technological interface of the system.

Figure 16- Phase 1 proposed stations

Figure 17- Phase 2 proposed stations

Figure 18 - Phase 3 proposed stations

Figure 19 - Phase 4 proposed stations



A Potential Dockless BSS

While the permanency of a docked bike sharing system can arguably bring more benefits to urban life in Kilkenny, a dockless system is undoubtedly less expensive, easier to implement, and poses fewer financial constraints on the city. A potential bridge between the benefits of the two systems is a 'docked-dockless' scenario, where bicycles can only be left in certain areas, radii around a point, or on certain streets.

A dockless scheme would overcome operational costs, and the initial investment would shrink from around €150,000 for 50 bicycles to €37,500 for 50 bicycles. This implies that for the same investment as a docked system, a dockless system could integrate 200 bicycles into the city. With the same ratio of approximately 5 bicycles per docking point, and up to 10 parked in any location, a dockless system could handle about 40 parking locations.

Therefore, the proposal is expanded from the four ideal phases in a docked system, to include a further two phases of a dockless system, resulting in a total of 40 stations/ parking zones. After *Phase 4,* there was an excellent coverage in the city and the strategic aim of spacing stations around 800m was adhered to. In-line with the same strategy, dockless parking locations could be inserted halfway between these stations and reach the goal of approximately 400 between parking areas -- roughly the minimal distance advisable, even in larger cities and implies that a user could reach a parking location in no more than a 2.5 minute walk. These further stations proposed under a dockless scheme would be focused on providing cycling accessibility to the residential areas, expanding accessibility in key areas and in the city centre, and extend coverage to the largest portion of the city possible.

While the first four phases in a dockless system would be identical to a docked system, *Phase 5* would include a further 5 parking locations located at:

1. R693 at Talbot's Inch Village
2. Greyhound Track
3. Hebron Road Aldi
4. Dublin Road near Lacket Drive
5. Presentation Secondary School

A further 9 docking stations could come together in the final stage 6. This phase would represent an extremely functional bicycle sharing system and would result in a total of 40 parking areas with around 200 bicycles. These stations are located at:

1. Castlecomer Road at Newpark Wildlife Farm
2. Golf Links Road at Newpark Lower
3. Johnswell Road Lidl
4. Dominic Street at Kickham Street
5. Dunnes Store/ John's Bridge
6. Castlecomer New Road at Maudlin Street
7. Upper Patrick Street
8. Kell's Road at Maiden Hill (North)
9. Kell's Road at Maiden Hill (South)

While more bicycles in the bike sharing system will not necessarily elicit better results or more riders, there is a higher likelihood of a user deciding to use the system if there are available bicycles and parking locations (docked or otherwise) near their homes, places of work, or usual destinations. It has been demonstrated with 40 parking points, there are no areas of Kilkenny not served by the system, and many areas with excellent coverage and access to stations in 2.5 minute walks. This is a highly comprehensive system and has been proposed to demonstrate what is attainable with a dockless system with the same investment as a docked system. This situation is still comparable in terms of urban place-space benefits as a docked situation, if compact parking areas are in fact established.

'dockless pile-up' in Beijing

CONCLUSION

The proposal for Kilkenny can be evaluated against the identified comparator studies presented in Appendix 2. These comparator studies are not distinguished as 'good' or 'bad' but only as references to how other cities of similar sizes and urban character have distributed their docking stations. In Table 26 the coverage ratio in Kilkenny is indicated for each phase of the proposal, as well as the average minimum distance stations. While Phase 1 and Phase 2 are enough to ensure a good start to the bike-sharing programme, in Phases 3 and 4 a more extensive coverage of the city is seen, and a reduced average minimum distance between stations/parking locations. In the situation where a dockless BSS is accepted, the coverage of the city is complete.

Table 26 - Kilkenny: Coverage Ratio

	Docked				Dockless	
	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Access Ratio	.3286	.4841	.6789	.7643	.8490	.8674
Min Distance	813.547	861.848	699.88m	659.82m	624.89m	495.82m

This proposal is relevant whether a docked or dockless system is implemented in Kilkenny. In the event of a dockless system, it is not advisable to allow a totally 'free' system without setting parameters for parking zones. This type of system will very easily - and has been proven to do so in other cities - result in bicycles left in isolated locations, inconvenient for most users. When a user living in a remote area of the city, or on the outskirts, rides a bike home and leaves it there, especially in less dense residential areas, there is potential for this bike to remain there for significant periods of time. Similarly, when parking areas are left unchecked in a dockless system, there is the risk that too many bicycles may be left in one location, if indeed that location proves to be a popular one. The image opposite shows a 'dockless pile-up' in Beijing.

To provide complete accessibility to bike stations in a 5-minute walk in Kilkenny, and minimise distance between stations to 400-500m, it would be necessary to assign at least 40-50 docking stations/ locations. Assigning and installing docking locations would also require that there be enough bicycles to populate these stations, as empty stations will frustrate users and undermine the functionality of the system. This necessarily means a high initial costs and a high operational costs that are unworkable for this type of bike-sharing.

For that reason, a trade-off must be made between the coverage area and the proximity to stations. Kilkenny is a radial city with a centre equidistant to the various neighbourhoods. These neighbourhoods, and the city centre itself, are relatively non-dense urban areas. Therefore, to situate docks close together would create redundancy, as most areas simply do not exhibit a sufficient density of users to justify this decision. One of the best comparator studies for Kilkenny is in Velenje, where the system may boast an average distance between stations of just over 500m. However, Velenje is also a much denser city than Kilkenny, where multi-story apartment blocks often characterise the city's urban form. In this case, shorter distances between stations can be justified, but not in Kilkenny.

For this reason, an 800m distance between stations is proposed so that users may still reach a bicycle station within 5-minutes of most locations in the city, but there will be no redundancy and areas 'double-served' which would mean a waste of resources. This distribution is also chosen so that there is an opportunity to install future stations or parking locations halfway between stations which would result in about 400m between stations, the minimum distance necessary before multiple stations become redundant.

In the initial stages, the image that a bicycle-sharing system serves the entire city is a better trade-off than serving few areas very well. Users who arrive in the city centre do not need to ride bicycles for 400-600m distances but would need bicycles to travel 2km from the residential zones or other points of interest to/ from the city centre. The aim in the early phases is to grow dependency on the bike-sharing system and foster elementary changes in the mobility culture of Kilkenny. For this reason, it is important that potential bike-share users feel that the entire city is accessible and connected by bicycle, and not just a few keys areas. More practically, if a user has multiple stops to make in one journey or one day, the feeling of having to change transport modes may be daunting and detract from their desire to use the new system.

Finally, Kilkenny is in a unique and beneficial situation where few changes are deemed necessary in the network of bicycle lanes and tracks in order to have a minimum suitable for a bicycle-sharing scheme. The existing/ proposed network is well-developed, provides reasonably good connectivity and is suitable also for novice and casual riders. A few suggestions have been made regarding the extension of some connections and provisions for certain spaces, both to ensure safety and comfort for all potential users.

13.0 APPENDIX 2: COMPARATOR LOCATIONS IN EUROPE

While it is evident that there are many different types of BBS, comparisons between operating models must take account of the scale, logistics, costs and demographics specific to Kilkenny. It is useful therefore to determine if there are BSS's in urban locations that might serve as a useful comparator to Kilkenny city. For the purposes of this study, similarly scaled urban locations were deemed most relevant.

The following methodology to select useful comparators was chosen:

1. Cities and towns with populations between 20,000 and 40,000 in the European Union (including Switzerland, Gibraltar, Monaco, etc.) Currently there are 135 bike-share systems locations within this range.

2. Schemes that are localised and not dependent on larger urban areas

3. Cities and towns in the Netherlands were omitted due to the highly-unique nature of the system there where the shared bicycles are part of the national transport network and placed in all national train stations. This system is primarily aimed at cyclists who need an alternative to their private bicycle.

4. All cities and towns that were part of a '*regional*' scheme were omitted. While of interest generally as they tend to succeed in economically and physically linked regions with good public transport; these factors are relevant to Kilkenny.

5. Locations deemed to have significantly different urban morphological patterns to Kilkenny were also omitted. These primarily included those cities that were peripheral to larger urban agglomerations.

Applying these parameters, the following cities and towns were identified. Their locations and their respective populations are outlined as follows.

Table 16: Comparator locations to Kilkenny

City/Town	Population	Country
Andorra la Vella/ Escalades Engordany	36,651	Andorra
Chivasso	23,017	Italy
Gibraltar	33,573	Gibraltar
Grodzisk Mazowiecki	26,684	Poland
Kranj	37,373	Slovenia
La Chaux-de-Fonds	38,965	Switzerland
Montecatini Terme	21,095	Italy
Oderzo	20,413	Italy
Pszczyna	25,288	Poland
Samos	32,977	Greece
Savigliano	21,471	Italy
Šibenik	34,301	Croatia
Stirling	34,790	United Kingdom
Velenje	24,923	Slovenia
Vilagarcía de Arousa	37,576	Spain
Vukovar	29,584	Croatia
Yverdon-les-bains	29,977	Switzerland

SYSTEMS AND OPERATORS

The salient features of these locations, operators and systems used – all of which are defined as 3rd or 4th generation systems – as well as applicable charges levied on use is as follows:

Pedaland (Andorra) – The sole BSS in Andorra is comprised of 14 stations with 100 slots and 50 bicycles. Given topography, all bicycles are electric power assisted. Uniquely, subscribers must evidence a bank balance of €300, which is not taken as a deposit. There is no subscription fee and charges increase incrementally as follows: 0-10 minutes: 0,20e; 11-20: 50e; 21-30: 1,00e; 31-40: 1,50e; 40-1hour: €3, 00 and similar per additional hour or partial hour after the first hour.

Redibike (Gibraltar) – The publically run scheme is sponsored by GibOil and comprises 105 bicycles and 120 docking points spread over 13 locations throughout Gibraltar including its airport. It uses a system which has been successfully deployed in the UK, France, Poland, Saudi Arabia and the

Czech Republic, with the largest scheme at present comprising of 1000 bicycles in Liverpool. £1.50 for unlimited 1 hour rides in a 24 hour period.

Bicincittá (Chivasso, Montecatini Terme, Oderzo, Savigliano) – This scheme is operational in over 100 cities in Italy with some services in Switzerland and Spain. It's owned by the "Comunicare Group" who plan, develop and operate all aspects of a BSS *(http://velo-citta.eu/wp-content/uploads/Bicincitt%C3%A0-Presentation-Velocitt%C3%A0.pdf).* They provide bespoke systems to include *Provision*: sale of equipment only; *Provision + Service*: call centre, maintenance assistance; *Provision + complete operations*: maintenance, redistribution, sale of memberships, marketing, customer care, revenues advertising, and sale of memberships and can accommodate unique branding and naming relevant to the local context. A point to note however is that although a shared system between locations each city in the system is responsible for maintaining the bikes and docks in their own city, despite the other aspects of the system being shared between them.

In Chivasso, fees are levied on a *regional* basis at a yearly €20 subscription; *town only* at a €10 yearly subscription. The first hour use is always free with each additional hour costing €1 euro per hour up to a maximum of 4 hours total per day. Users can also opt for a €5 annual charge for insurance.

In Montecatini Terme the €40 annual subscription includes the first 30 minute free with 31-60 mins: 50 cent; two hours: €2 (total); three hours: €4 (total) and four hours and beyond €4 + €2 per additional hour. Weekly, two day and daily passes – based on a maximum of 4 hours daily - are available for €18; €13 and €8 respectively.

In Oderzo a €5 deposit allows up to two hours free with the 3rd and 4th hour charged at €1 extra and a further €3 for usage in excess of 5 hours.

In Savigliano fees are levied on a provincial basis at a yearly €20 subscription; regional only at a €10 yearly subscription. Use is free for up to 6 hours per day and €1 euro per hour thereafter.

Grodzisk Mazowiecki (Nextbike) - There is no annual subscription but there is a charge of €2.33 (10zł) to access the bike. Usage charges are 1 to 20 minutes: free; 20 to 60 minutes: €0.23 (1zł); 60 to 120 minutes: €0.23 (1zł) additional (2zl in total) 120 to 180 minutes: €0.23 (1zł) additional (3zl in total); Additional hours (up to 12 in total): €1.17 (5zl) each.

Local Authority (Kranj,) - The system is run by the local authority. Annual subscription is €15 and allows an unlimited number of rides up to 14 hours per week.

Velospot (La Chaux-de-Fonds) - This system operates in 7 cities in Switzerland with 1 regional scheme in place. The scheme is notable for a number of unique features including a hybrid docked/dockless system requiring bicycles to be left within a radius of a "*velospot*"- a fixed and visible manifestation of the cycle infrastructure. Local companies can sponsor bikes and thus determine the location of the velospot. The system is proud to acknowledge that they work with homeless people to manage their maintenance and redistribution system.

The annual subscription is approx. €36 (40 CHF) and includes the first 2 hours of any ride for free. Subsequent hours cost approx. €1.80 (2 CHF) per hour. An unlimited daily pass costs approx. €5.40 (6 CHF) while a 4 hour half day pass cost approx. €1.80 (2 CHF).

Pszczyna - Registration for the scheme is free with rental fees only being incurred after the first 30 minutes use with a €0.23 (1zł) charge from 31 to 60 minutes; €0.46 (2zł) for the 2nd hour and €0.69 (3zł) for the third hour. The fourth hour and each subsequent hour thereafter is charged at €0.92 (4zł)

Easybike (Samos) – The scheme is operated by Easybike with 1,250 bikes in 17 cities. It offers 5 service adaptations including *Hotel* - designed at giving hotel guests an uncomplicated way of hiring bikes in the city; *Terminal* - dockless bike sharing with some smart lock technology; *Station;* Key - "Receives a key electronically and returns it manually and *Manual* – an attended service.

Šibenik (Netbike) - An annual pass costs €28 (200 HRK) for unlimited 30 minute rides +1200 bonus minutes. Every additional 30 mins usage is charged at 70c (5 HRK). A 7 day pass costs €14 (100 HRK) for unlimited 30 minute rides in a 7 day period + 600 bonus minutes with every additional 30 mins charged at 5 HRK extra. *Pay as you go* options are available and cost 70c (5HRK) for a 30 minute ride

Nextbike (Stirling) - This scheme is operated by Nextbike, a German company and a pioneer in bike sharing and mobility solutions operating over 150 schemes in 200 cities across 25 countries. It has 5 service offerings including *City Public Transport:* a standard bike sharing service provided to the city in which all aspects of the operation are provided; *BUSINESS Bike:* tailored for businesses and employee use. *ADbike and SPONSORbike:* advertising and promotional platforms with a variety of options; and *CAMPUSbike:* a student oriented scheme. The annual subscription is €67 (£60 with a monthly pass charged as €5.60 (£5) per month but requiring a minimum 12 month commitment. The first 30 minutes are free with a 50p charge per additional 30 mins up to a maximum of €5.60 (£5) per day. A casual pass costs €1.12 (£1) for 30 mins with each additional 30 mins costing €1.12 (£1) up to a maximum of €11.21 (£10) per day.

BICY (Velenje) – The scheme was launched in 2012 and initially it provided 5 stations and 25 bikes at a capital cost of approximately €80,000. It has expanded to 9 locations and 40 bikes. The scheme is totally free for up to 14 hours per week.

Arising out of an EU Transnational project, it has a number of interesting features not least that the hardware and software for the docked scheme were produced locally. It has continued to develop with modular, e-bike options now available; the latter requiring only the replacement of the rear wheel. The proprietorial system is available to purchase and can be tailored to the specifics of a location or client needs

LaBici (Vilagarcía de Arousa) - LaBici is a smaller level operator, present in 8 cities in Spain.

Annual, monthly and weekly passes – each limited to 2 hours usage per day - cost €25, €15 and €10 respectively.

Vukovar (Nextbike) - An annual pass costs €28 (200 HRK) for unlimited 30 minute rides +1200 bonus minutes. Every additional 30 mins usage is charged at 70c (5 HRK). A 7 day pass costs 100 HRK for unlimited 30 minute rides in a 7 day period + 600 bonus minutes with every additional 30 mins charged at 70c (5 HRK) extra. *Pay as you go* options are available and cost 70c (5HRK) for a 30 minute ride

Publibike (Yverdon-les-Bains) - This operates in 10 cities in Switzerland with 7 of these now operating a newly upgraded system with improvements in bike quality and technology. In the 7 new systems, some of these are regional and some are city based. It offers conventional as well as electric assist bikes. All locations are interconnected allowing ease of use in multiple locations and a common fee structure.

An annual subscription cost €22.50 (25 CHF) with the first hour free of charge. An additional hour is charged at €1.80 (2 CHF) for a standard bike and €3.60 (4 CHF) on an electric power assist bike up to €18 (20 CHF) respectively. Users can opt to pay an increased cost in order to keep the bike overnight, from 11pm – 7am with an overnight price of 45c (.50 CHF) on a conventional bike and 90c (1 CHF) on an electric power assist bike.

A detailed assessment of the characteristics of each location was undertaken to include:

- City Area - determined using EU Corine land-cover data (2012) selecting the contiguous built-up areas that defined the city
- Access Ratio – determines the percentage of the city which has access to a docking station. A 400m catchment area corresponds with a typical 5-min walk and is a common radius to use in mobility situations. (areas simultaneously served by two docking stations do not get counted twice)
- Industrial Composition -- the percent of the city that is defined as being in industrial usage.
- Industrial Access Ratio - this tells us what percentage of the industrial areas in the city are accessed and reflects the degree to which a BSS might be used for different purposes, who might be using it, and how the different towns think bicycle provisions should be implemented.
- Minimum Station Distance: This is the shortest distance between any two docking stations in the city.
- Average minimum inter-station distance – Records the shortest distance to the next station. For each station, the minimum distance to the next closest station is recorded, and then the Average Inter-Station Distance is this average in all the different cities. Simply, this measure reflects the typical distance bwe
- Average minimum inter-station distance -- For each docking station, the distance to the next closest station is recorded. The average of these minimum distances is computed. Effectively, this measure reports the typical distance between docking stations.

See table on following page

Table 17: Assessment of comparator locations

City	City Area	Access Ratio	Industrial Comp.	% Industry Accessed	Min Station Distance	Ave Min Distance
Andorra la Vella / Escalades Engordany					182.608	547.798
Chivasso	3,352,403.52	0.7386974106	0.1006289177	0.1898831588	166.361	395.122
Gibraltar	6,607,404.32	0.4788354217	0	n/a	187.98	549.077
Grodzisk Mazowiecki	10,833,133.92	0.3967468333	0.1168989434	0.01090344698	376.873	619.234
Kranj	8,875,472.12	0.4677220774	0.3037793105	0.03483241282	274.165	472.708
La Chaux-de-Fonds	8,465,099.52	0.5639640451	0.2017119489	0.1635409465	121.229	434.345
Montecatini Terme	9,244,623.46	0.3459332408	0.1324083712	0.004667669207	262.594	361.444
Oderzo	5,889,381.09	0.1832629674	0.2094781471	0	557.158	559.615
Pszczyna	25,673,111.15	0.1093535736	0.07634678963	0.03609637861	704.98	1810.87
Samos	1,309,602.69	0.5694192892	0	n/a	511.75	784.194
Savigliano	4,003,394.81	0.6525154938	0.2178655378	0.01540720688	110.74	288.778
Šibenik	6,707,342.65	0.2659162697	0.3165978273	0.006156781546	169.058	769.968
Stirling	17,035,655.57	0.4398564385	0.185155994	0.04057348	100.891	527.368
Velenje / Šoštanj	7,748,322.85	0.5345875404	0.3748481663	0.1058314508	178.816	709.129
Vilagarcía de Arousa	8,552,695.16	0.221554459	0.179416123	0.03976572415	720.405	1092.245
Vukovar	11,747,061.94	0.07364746909	0.1907668442	0.09675701523	4184.328	4184.328
Yverdon-les-bains	8,226,864.72	0.3575166875	0.1843469	0.2454762162	316.081	533.005

*note: Corine land-cover data was not available in Andorra la Vella/ Escalades Engordany and computations were omitted from this comparison.

14.0 APPENDIX 3: MONITORING AND EVALUATION

Following implementation of a BSS the monitoring and evaluation of its operation and impact is essential. The relevant Key performance indicators (KPI's) will be tailored to the scheme goals but should take account of a range of elements including infrastructure; user accessibility; safety; bike and station design; financing; transport integration and ICT. Suggested metrics for each are as follows:

INFRASTRUCTURE

The length of the cycle network in terms of cycle lanes or separated cycle paths developed.

The amount invested by public funds into cycling infrastructure: cycle paths and lanes, cycle parking, separated crossings, traffic lights, mobility centres etc.

Share of the cycle network in the total length of the road network.

Share of the investment amounts dedicated to cycling infrastructure or enhancement as a proportion of A) traffic investments B) public realm investments.

USER ACCESSIBILITY

Station-based systems: no. of slots/1,000 inhabitants.

Systems without stations: no. of bikes/1,000 inhabitants.

Station density (or bike density) in the effective area of the system/km^2.

Average no. of slots/station.

Opening hours per day/24.

Opening days per year/365.

Number of repairs per total rentals (per time unit, e.g. year).

Average and maximum repair service time.

Reported number of missing bikes at a station, or parking failures (arising from capacity issues) at desired return station, as a percentage of total number of rents.

SAFETY

Total cycle accidents per year/100,000 cycle trips.

No. of death injuries/100,000 cycle trips.

BIKE AND STATION DESIGN

Number of redistribution/rebalancing movements.

Costs of redistribution/rebalancing.

Number of thefts per year/no. of slots/bikes.

Incidents of damage per year/no. of slots/bikes.

Percentage of "in operation" time per slot/station per year.

Incidents of damage to stations per year/total no. of slots/stations and development over years of operation.

Number of severe damages to bikes per year/ total no. of slots/bikes/ and development over years of operation.

FINANCING

Yearly total cost (annualised investment and operation) of the docked or dockless system.

Daily no. of trips/slot (or bike if well-defined).

Daily no. of trips as a share of total cycling.

Cycling modal share in total daily no. of trips with at least one end of the trip in the effective bike sharing area, for (work trips; leisure trips and business trips).

Cycling modal share in vehicle-km travelled.

TRANSPORT SYSTEM INTEGRATION AND ICT

Maximum distance to nearest PT station or bus stop (over all bike sharing stations).

Share of intermodal trips (e.g. PT + bike sharing) in bike sharing trips.

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