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## **AN ANALYSIS OF THE ROLE OF BICYCLE-SHARING IN A EUROPEAN CITY: THE CASE OF DUBLIN, IRELAND**

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### **Abstract**

In recent years, problems associated with automobile use have led to a marked shift in the orientation of transportation policy towards the promotion of more sustainable modes of transport. Central to this policy has been a heightened interest in bicycle-sharing schemes in major cities in the developed world. These initiatives seek to increase the modal share of cycling, improve the mobility of the general public and reduce the environmental impacts of private automobile transport. Existing research investigating the role and impact of bicycle-sharing schemes in European cities is sparse. Within this context, this paper investigates the role and impact of the recently implemented bicycle-sharing scheme in Dublin. Using evidence from 360 questionnaire surveys, the research focuses on the use of the bicycle-sharing scheme as an integrative mode for the rest of the city's transport system, and particularly for the public transport system. The research also examines the scheme's dichotomy in terms of its functionality during the peak and off-peak periods as well as investigating the socio-economic profile of its users.

### **Introduction**

The role of cycling in the city transportation system has gained increasing attention in recent years due, at least in part, to its rise popularity as an alternative mode of transport in many European cities. Its rise in popularity is related to numerous factors in individual countries but there is little doubt that it is due, at least in part, to the fact that it is an environmentally-friendly and healthy alternative to motorised transportation. In addition, the move in some cities towards transport policies that are more facilitative of cycling as a mode of transport in terms of fiscal incentives, improved infrastructure and enhanced safety have undoubtedly increased the appeal of cycling as a mainstream mode of transport not only for commuting but for other non-work trips also.

Chief among these policies has been the advent of bicycling-sharing in many European cities. In western cities, increasing interest has been brought to bear on bicycle-sharing in recent years including the advent of initiatives to increase the modal share of cycling; better meet the demands of an increasingly mobile public; and lessen the environmental impacts of motorised transportation systems. The basic premise of the bicycle-sharing concept is sustainable transportation and in particular that of sustainable public transportation via the use of the bicycle. Under these sharing schemes, bicycles are available throughout the city often without charge or for a small fee. The intention of the scheme is for bicycles to be used for relatively short trips, often providing the missing link between existing points of public transportation and desired destinations. Indeed, the pricing structure of the scheme is often designed to encourage short-term usage, usually of 30 minutes or less. The scheme also offers a new form of mobility which has the potential to complement and enhance the existing transportation network. In terms of operationalisation, various agencies may be responsible for providing bicycle-sharing schemes including governments, quasi-governmental transport agencies, universities and advertising companies, the latter of which is the most popular [1].

While there is a plethora of literature investigating various aspects of cycling as a mode of transport in cities, there is a distinct lack of research available on bicycle-sharing schemes and their functions and impacts. Within this context, the current research sought to investigate three specific aspects of the recent bicycle-sharing scheme in Dublin.

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Specifically, our objectives were: first, to assess the socio-economic characteristics of the users of the scheme; second, to investigate the impact of the scheme on the modal choice of users; and finally, to examine whether the functionality of the scheme differed between the peak and off-peak periods in term of the trip characteristics of its users.

### Relevant literature

Quite a significant amount of literature has emerged in the last decade or so in relation to cycling, socio-economic issues, public health and safety among other things. In the case of the socio-economics and cycling the majority of studies conducted find that males cycle much more frequently than their female counterparts [2-8]. Dickinson et al. [4] have suggested that women cycle less because they often trip-chain undertaking activities such as shopping, transporting children as well as commuting to work; obviously, this type of trip pattern is facilitated to a much greater extent by the private car than by public transport or cycling. In addition women tend to be much more conscious of the safety risks associated with cycling while they also tend to be more aware of their appearance when going to work [9]. However, exceptions do indeed exist, and some research has suggested that in countries with very high levels of cycling such as the Netherlands, “as many women cycle as men”, while in countries with much lower cycling levels, men tend to cycle at least twice as much as women [10: 6]. This assertion is supported by the research of Stridwick [8] and also by Garrard et al. ([9] who found that in countries with high cycling levels, women tended to cycle even more frequently than men. The implication here is that gender imbalances are less likely to occur where cycling is recognised as a main mode of transport.

There is also general agreement in the literature that cycling numbers decline with age [7,11,12]. Moudon et al. ([7] found cycling levels to be highest among 25-45 year olds with a significant drop off in commuting and utilitarian cycling occurring beyond 55 years old. Similar conclusions were drawn by Parkin [12] who found that a greater proportion cycle to work in areas with a high working population below the age of 34. This is related to numerous factors including the physical nature of cycling; a lower level of car ownership among younger age cohorts and the fact that individuals in those age cohorts tend to live in more central locations [10].

In the literature, the association between cycling and income level is somewhat ambiguous. As Horton et al [10: 6] assert, it ‘can be confused and confusing’, with literature offering conflicting views on its significance. Commins and Nolan [8] found those in the top three socio-economic groups are significantly less likely to cycle to work. Indeed, Horton et al [10: 6] point out that ‘if, in some places, cycling is understood as a practice of the poor, in others it is increasingly a practice of the rich’. However, Pucher et al. [11] stress that this is not always the case. In countries such as Denmark, Netherlands and Germany there are high bicycle modal shares among all socio-economic groups. Moreover, in assessing cycling levels in the Netherlands, Germany and the UK, Pucher and Buehler [18] found that low-income groups cycle only slightly more than high-income groups. Moreover, because cycling is affordable by a broad spectrum of the public, it is considered to be among the most equitable of all transport modes. Guo et al [13] purport that a combination of low income, a high number of bicycles and a low number of cars per household are linked to a tendency to use non-motorised transport modes. Whilst cycling levels are assumed to be higher among people without cars [6,14-16], research carried out by Parkin et al [17] in the UK suggests that car-owning households are more likely to generate cycling trips than households without cars. Indeed, while Denmark, Germany and the Netherlands have very high cycling levels, they also have among the highest levels of car ownership in the world [10,18]. Zacharias [19] concludes that the levels of cycling are more susceptible to locality, with income having little or no significant effect.

Given the foregoing discussion, there does not appear to be a definite association between socio-economic factors and cycling although some strong trends do indeed emerge from the literature. The influence of gender appears to fluctuate with males dominating cycling numbers in countries where cycling is not mainstream and a gender balance occurring in countries with high cycling levels. The evidence based on income levels is

conflicting and it may be the case that country-specific issues affect the outcome considerably.

Su et al [20: 496] argue that cycling promotion should be geared towards ‘the next generation of cyclists’; people who would be willing to start cycling if they considered the circumstances to be correct. Thus the promotion bicycle-sharing schemes increases bicycle ridership in general by virtue of introducing the bicycle as a means of everyday travel to a new groups of travellers [21]. Similar views have also been expressed by DeMaio [1] who contends that bicycle-sharing has had profound effects not only on increasing the level of cycling but also increasing transit use, decreasing greenhouse gases, and improving public health more generally. DeMaio (2009) argues that bicycle-sharing contributes to an increase of 1.0-1.5% in bicycle mode share in cities with pre-existing low levels of cycling. Indeed, this argument is supported by evidence from the ‘Velib’ bicycle-sharing scheme in Paris and the ‘Bicing’ system in Barcelona [22]. However, it is worth noting also that cycle infrastructure improvements were also made in both cities during these time periods making it difficult to assess the exact impact of bicycle-sharing on changing modal choice over the period.

Moreover, quite aside from the obvious benefits of cycling in terms of reducing congestion and reducing harmful environmental emissions, bicycle-sharing is less expensive than other modes of transport; it requires less financial investment than other transport services and it promotes greater transit use through modal integration [23]. Coming from the Dutch experience of bike-and-ride, Martens [21: 331] is a strong advocate of bicycle-sharing or what he refers to as the ‘public transport–bicycle’ (PT-bicycle). In the Netherlands, the bicycle-sharing system is integrated into the wider public transport network and led to a considerable increase in bicycle use for egress trips; not only replacing egress trips made by bus, tram and metro but also those made by car and taxi [21]. Martens [21] concludes that the high share of business trips suggests that the combined use of the train and bicycle-sharing can compete with the private car in terms of comfort and travel time. In fact, Martens [21:337] found that bicycle-sharing is ‘the only measure that has some chance of succeeding in other cities and countries’.

## **Methodology**

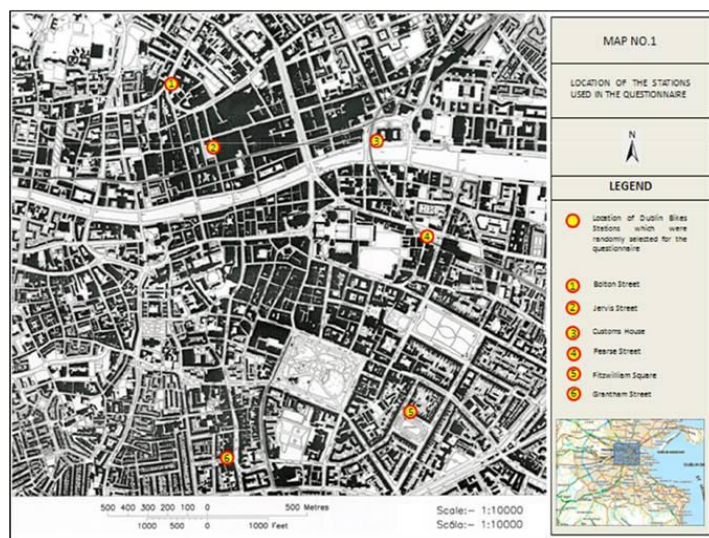
The dublinbikes scheme officially opened in September 2009. At that time, the scheme had 450 bicycles installed at 40 stations throughout the city centre. It currently has 550 bicycles at 44 stations, a radius of c. 300 metres in the central area. The scheme is modelled on the Parisian Velib scheme and like its counterpart is operated as a public private partnership (PPP). It is operated and maintained almost entirely by advertising company JC Decaux who do so in exchange for the use of 72 advertising spaces (valued at €54.36 million) in the Dublin City Council area for a period of fifteen years ([www.dublincity.ie](http://www.dublincity.ie)).

The scheme has been hugely successful; it currently has in excess of 58,000 subscribers (up from 38,000 in July 2010) with an average of c.5,000 trips being made daily ([www.dublinbikes.ie](http://www.dublinbikes.ie)). On the 14th of August 2010 (after 11 months) the scheme reached its one millionth trip after only eleven months in operation; only nine months later (12<sup>th</sup> May 2011), the scheme reached its two millionth journey highlighting its increasing popularity. In a recent survey conducted by Dublin City Council, 95% of respondents felt the scheme had either a positive or very positive impact on the city ([www.dublinbikes.ie](http://www.dublinbikes.ie)). Such is the success of the scheme that plans are already being discussed for a major five-year expansion of the scheme. This includes a considerable extension of existing geographic distribution of the network, increasing the number of stations to 300 and the number of bikes to 5000 [24].

The dublinbike station network consists of 44 stations. At the time the research was undertaken it consisted of only 40 stations (Figure 1). Given the objectives outlined already, six bicycle stations were chosen in order to gather data from respondents. The stations were selected at random to avoid bias entering the data given that the stations vary considerably in terms of their proximity to the local rail system (Dart and Luas), bus routes, primary employment centres and various tourist attractions which influence the socio-economic make-up of respondents and the usage patterns at each of the stations. The sites selected for analysis are shown in Figure 1.

The sampling strategy focussed on attaining 60 questionnaire survey responses at each of the selected stations: 30 responses each for the morning peak and evening off-peak period. In line with the recommendation of the Automobile Association of Ireland, we took the morning peak and evening off-peak periods to range from 07:30-10:00 and 19:00-21:30 respectively. Thus, a total of 360 responses were attained representing c. 7.2% of average daily trips. Respondent were randomly selected at each of the stations and surveys were self-administered. The surveys has a series of open and closed questions focussing on key issues of interest including the socio-economic profile of respondents, primary usage functions during each of the travel periods as well as rates of usage, the role of the scheme in promoting cycling, potential for modal shift and the role of the scheme for assisting public transport trip interchange and integration.

**Figure 1. Questionnaire survey sampling sites**



## Results

### *Gender, Age and Income*

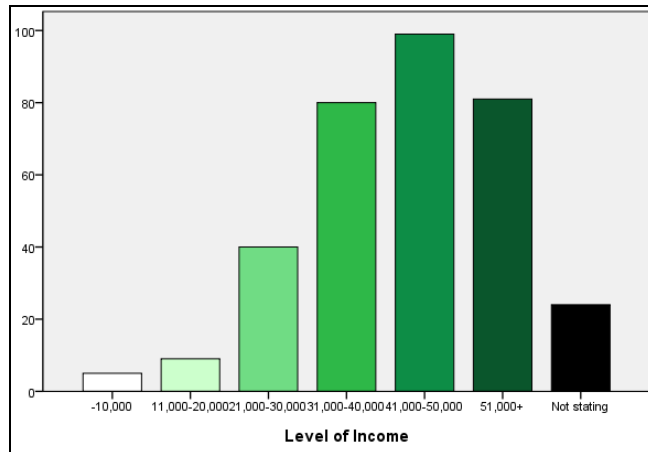
Cervero [25] asserts that whilst different regions and cultures can have a multitude of differing socioeconomic features, those that exhibit the strongest correlation in modal choice studies are gender, income and age. Thus, the extent to which the use of the bike scheme is differentiated on those grounds was investigated. The results demonstrate that the vast majority of Dublin Bikes users were male (78%); only 22% were female. This correlates closely with the outcome of similar research in area [2-8]. One reason for the considerable gender imbalance in the use of the bike scheme could be that females are more reluctant to cycle because of the associated safety risks; another reason is that females tend to have more complex trip patterns than males (for example, trip chaining on the way to and from work) and also that females are much more cognisant of their appearance at work than males [4,9]. Whatever the case, it is clear from the results that the dublinbike scheme has a predominantly male-oriented user-base. In policy terms this indicates significant potential for policies that target the female population and address their concerns over cycling in the city.

Turning to the profile of the respondents by age, it can be seen that the majority of respondents (58%) are between the ages of 25-36. These results conform to studies conducted by Parkin [12] and Moudon et al. [7] who suggest a similar trend in the age profile of bicycle users. There is little doubt that the decline in the proportional usage of the scheme beyond this age cohort is likely to be due to the physical demands exerted by cycling. Thus, the tendency for proportional usage to drop off with age is quite strong despite the fact that Dublin is a relatively flat city with gradient conditions that are particularly suitable for older age cohorts.

Perhaps one of the most interesting results to emerge from the socio-economic characteristics of the dublinbike user-base was with respect to income levels. Figure 2 shows the profile of the income distribution of the bike user-base. The results show that 53%

of respondents earn a salary of more than €40,000 while only 16% earned less than €30,000 annually. This indicates quite strongly that the dublinbikes scheme has an affluent user profile i.e. upper middle and higher income earners. This is an interesting result because traditionally (although not universally) public transport systems tend to be used to a greater extent by lower middle and lower income earners; however, the opposite is the case of the bike scheme. Thus, from a policy perspective, it is worth investigating whether there are significant barriers to lower income groups accessing the bike scheme.

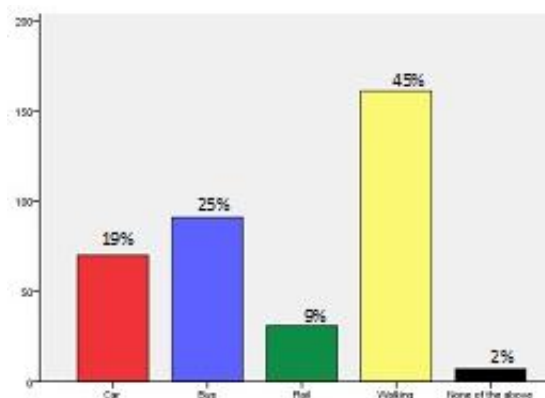
**Figure 2. Income level of respondents**



#### Modal Choice

As stated already one of the core objectives of the research was to determine the extent to which dublinbikes had an impact at influencing the modal choice of respondents. Respondents were initially asked whether or not they used a bicycle for their current trip prior to the initiation of the dublinbikes scheme. Interestingly, an overwhelming 68% of respondents claimed not to have cycled for their current trip prior to the launch of the dublinbike scheme. This implies a considerable modal shift to the bicycle for the respondents surveyed. In order to investigate this trend further, respondents were asked what particular mode they were using dublinbikes as a substitute for.

**Figure 3. Mode of transport used prior to using the dublinbike scheme**

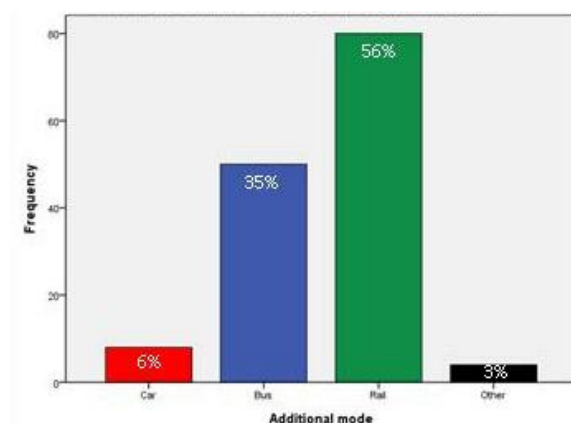


The results (Figure 3) show that 45% of respondents use the scheme as a substitute for walking. Given that the scheme is city centre-based and is primarily facilitative of short trips this may be somewhat unsurprising. Nevertheless the magnitude of the figure is quite large. Moreover, a further 34% of respondents use the scheme as a substitute for public transportation modes while only 19% use it as a substitute for the car. This implies that the scheme is being used primarily as a substitute for other sustainable modes of transport (78%) and in particular as a substitute for the most sustainable mode - walking. However, it is likely that if the scheme is expanded beyond the central area there could be a greater modal shift from the car to the bicycle given the greater propensity for the car to dominate

modal choice beyond the central area and the likelihood of modal shift from this mode would be greater.

Another trend to emerge from the results was the fact that 39% of respondents use dublinbikes in conjunction with another mode to complete their trip (Figure 4). The results in Figure 4 show that the scheme is primarily used in conjunction with public transport modes: 56% of respondents use it with rail while the corresponding figure for bus is 35%. To a large degree, this trend can be explained by the close proximity of the bicycle station to rail stations as well as the fact that the scheme is city-centre based as is in close proximity to where many bus routes converge. From a transportation planning perspective, the results are particularly interesting. They imply that a major role of the bike scheme is to provide intermodal connectivity between the two main public transport modes - namely bus and rail, which are largely segregated within the wider Dublin transport network. Moreover, they also imply that the bike scheme operates as a feeder service for trip origins and destinations within the central area. Rather interestingly, these findings correlate closely with those of Martens [21] who suggests that bike-sharing schemes are hugely beneficial in providing an egress solution for infrequent, non-recurrent trips.

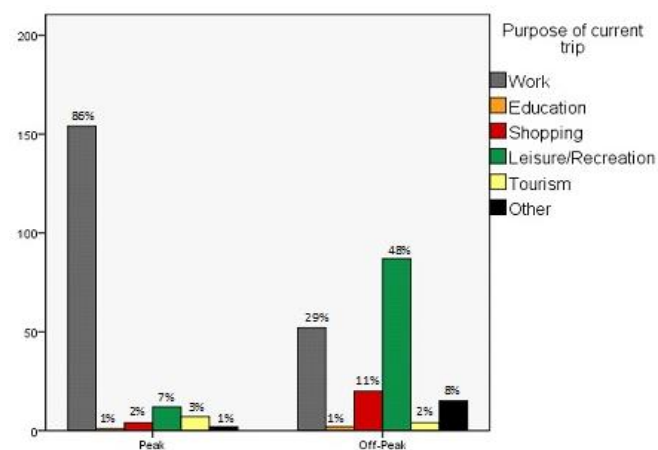
**Figure 4. Respondent using an additional mode in conjunction with the dublinbike scheme**



#### *Peak and off-peak trip characteristics*

Another objective of the research was to determine the extent to which the functionality of the bike scheme in terms of the trip characteristics changed between the peak and off-peak periods. Figure 5 outlines these results demonstrating that a change in trip-type characteristics does indeed occur between the two travel periods.

**Figure 5. Peak and off-peak trip usage characteristics**



More specifically, the results show that the peak period is dominated by commuting trips with 86% of respondents using the scheme for this purpose. However, for the off-peak period the

most dominant trip purpose is for leisure/recreation (45% of respondents) trips indicating that the scheme has a significantly different role and functionality between the two periods. Moreover 11% of respondents use the scheme for shopping trip in the off-peak period suggesting that it serves to facilitate retailing in the central area to a considerable degree. Rather interestingly though is the fact that even for the off-peak period work continues to be an important trip purpose (29%) indicating that individuals may use the scheme after undertaking errands or recreational/leisure activities after work hours before commuting back home. Overall, the results demonstrate that the scheme is used primarily for commuting purposes during the peak period while also providing for non-work related trips in the off-peak. This highlights the dual functionality of the scheme in providing a mode that caters quite well for the diversity of peak and off-peak travel patterns.

## Conclusion

In the academic literature, there is conflicting evidence emerging related to the socio-economic profile of cyclists and there is little available evidence specifically related to bicycle-sharing schemes. The results of our analysis of Dublin's scheme demonstrate clearly that the users of the scheme come overwhelmingly from middle-class and upper middle-class backgrounds (if we take income as a proxy for socio-economic class). This suggests that there are equity issues with regard to accessing the scheme and indicates also that impediments exist which prevent people from lower socio-economic backgrounds from using the scheme. These issues should be addressed as a matter of priority given that historically public transport systems have catered relatively successfully for all socio-economic groups in society. In addition, steps should be taken to encourage greater female use of the bike scheme which is overwhelmingly dominated by males at present.

In terms of modal choice our results show that the scheme has indeed been responsible for considerable modal shift. However, the prevailing trend was for a large modal shift away from other sustainable modes of travel to the scheme including movement from bus and rail but particularly from walking. It is important to note that the scheme has been much less successful at achieving modal shift from the private car to the bicycle. It seems then that the scheme is encouraging a shift between 'sustainable' modes of transport but is responsible for much less of a shift from the 'unsustainable' modes. Moreover, the results emerging suggest that the scheme is playing a very important role in trip chaining between the various forms of public transport within the city. In effect, the scheme appears to be acting as a key link in a respondents journey between origin and destination for public transport trips and this should be encouraged by placing more stations and providing more bicycle units within close proximity to public transport stops, and particularly rail stations.

Finally, the research has broader implications which should be borne in mind by policymakers. In particular, the results presented herein suggest that the expansion of the scheme beyond the central area could impact significantly upon modal shift from the car to cycling. In addition, the positive health and environmental impacts of cycling mean that the cost-benefit impact of investing in cycling as a real alternative mode of transport for peak and off-peak trip making is likely to be highly positive.

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