Examining user behaviour on a shared bike scheme: the case of Dublin Bikes

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Abstract

Dublin, like many international cities, has recently launched a shared bike scheme called 'Dublin Bikes'. The scheme currently consists of 44 Dublin Bikes stations located across Dublin City Centre, housing 550 bicycles. Since the introduction of the scheme in 2009, it has been an unprecedented success and has been shown to be the most popular scheme of its type in the world. The research presented in this paper will examine how users of the scheme have been integrating their trips with other forms of public transport. An intercept survey of Dublin Bike users has been conducted to obtain a better picture of user behavior. This analysis will seek to ascertain if the shared bike schemes can be in were used as a means to increase public transport network coverage. The paper will also report how since the scheme has been introduced it has acted as a catalyst to the regeneration of cycling in the city, demonstrating how users of the scheme perceive the benefits of cycling. The results of this paper will provide other cities with a series of recommendations on shared bike schemes and a clearer picture of how individuals use the scheme.

Keywords
Bike sharing, cycling, behaviour change.

1. Introduction and Background

In 2006, Dublin city released 4,920k tonnes of CO_2 into the atmosphere; 1,240k tonnes of that was a direct result of transport emissions, this equates to 25% of all emissions (Dublin City Council, 2008). The emissions due to transport were second only to emissions released by the residential sector and more than the services or manufacturing sectors. Transport in the city also accounted for 23% of the city's energy consumption that year, 5TWh. The transport mode used most often in the city was privately owned vehicle and in Dublin in 2008 was 64% of all trips were made using this mode (Dublin City Council, 2008).

About 500,000 people move around Dublin City center every working day. The street network in Dublin City is at saturation point and this leads to widespread congestion and low traffic speeds (Dublin City Council, 2011). During the period of economic growth and expansion in Dublin there was a decrease in the numbers of individuals that cycled. There are many reasons for the drop in numbers that cycle. The primary causes of the decline are poor transport and housing planning as well as a shift in consumer preferences (Doherty, 2008). Urban sprawl has led to Dublin's suburbs expanding into other counties. It simply is not possible for those that commute from surrounding counties to use public transport to get to work because the facilities are not available, or the facilities that are available aren't sufficient (McDonnell and Caulfield, 2011). The poor transport and housing planning has led to a situation where people feel that their best option is to drive to work in the early hours of the morning. Dublin City Council's Cycle Policy (2006) conducted a survey of 300 cyclists and 300 car commuters. It concluded that 16% of car commuters felt that the distance was too far to travel by bicycle. Ideally there should be other more sustainable forms of transport such as the train or bus that could take these passengers into the city. Dublin has become more motorized, with a movement towards catering for cars and other motorized vehicles (Doherty, 2008). There appears to be little thought given in terms of the cycle lane itself or for the movement of a cyclist, who often find themselves in the same lane as a bus. Using the same infrastructure as buses to cycle is seen as very unattractive to cyclists (Caulfield et al, 2012). To halt this decrease in the numbers cycling the city officials have examined several ways to encourage cycling. One of these policies was the introduction of the shared bike scheme – Dublin Bikes.

2. Bike Sharing

2.1 What is Bike Sharing

The first generation schemes were introduced in Amsterdam in 1965 (White Bicycles), La Rochelle in 1976 (Yellow Bicycles) and Cambridge in 1993(Green Bicycles), which involved providing free bicycles throughout the city, to be returned at any location (Shaheen *et al*, 2009). The color of the bicycle was the only thing to distinguish them from regular bicycles. There was very little incentive to care for the bicycles and return them in good condition. The main issues were theft and vandalism. The system in La Rochelle, ''Vélos Jaunes'', proved to be successful and continues to operate today. A second generation of systems began in 1991 in Denmark to address the issues with the first generation, although it wasn't until 1995 that the first large scale programme was launched, in Copenhagen, known at 'City Bicycles' or Bycyken'. The bicycles were designed with solid rubber tires and wheels with advertising

plates to distinguish them from regular bicycles. They were picked up at specific locations in the city with a coin deposit. The bicycles still experienced theft because of the anonymity of the customer. Anyone could deposit a bicycle, much the same way as one might deposit a trolley (DeMaio, 2009).

The problems with the first and second generation gave rise to the third generation, with improved customer tracking. The first of these schemes was launched at Portsmouth University in 1996. Students needed a magnetic stripe card to rent a bicycle. Further technological improvements were made to smarten the third generation such as electronically locking racks or bicycles, real time information systems, smartcards and mobile phone access. These developments helped bicycle sharing become what it is today.

Montreal's BIXI system has introduced portable modular stations. The implementation of the station is dramatically reduced because of the use of pre-fabricated docking stations (Midgley, 2011). Installation can be as short as 20 minutes, as it consists of placing the module wherever desired. The installation is very efficient in terms of time labour and cost. The design of the station itself is changing in terms of minimal excavation work and solar generated power rather than grid connection. Another feature of the latest generation of systems would see the integration of the bicycle sharing schemes with other public transport and alternative modes. Smartcards which support the use of all the alternative modes would facilitate multi modal linkages and therefore greater reductions in emissions as more trips are supported by alternative modes. The bicycle security itself can be supported by further technological advances in terms of GPS and locking mechanisms. Fourth generation systems may also be very likely to incorporate electric bicycles, to enable longer distances and more difficult terrain to be covered (Shaheen *et al*, 2009).

2.2 Dublin Bikes

Dublin Bikes was launched on the 13th of September 2009. The network originally consisted of 40 stations and 450 bicycles spread across Dublin city center. Dublin Bikes is operated as a Pubic Private Partnership (PPP) with advertising company JC Decaux. This PPP agreement sees the scheme is operated and maintained in return for 72 advertising spaces in the Dublin City Council area for a period of 15 years. Dublin Bikes reached a landmark one million trips on the 14th of August 2010 and on the 12th of May 2011 it reached its two millionth trip (Dublin Bikes, 2012). Such was the success of the scheme that 4 new stations were added to the network. 287 new bicycles stands were added as well as 100 bicycles. As of the 8th February 2012, over 3.17 million trips have been made since the scheme began and there are just over 66,000 subscribers (Dublin Bikes, 2012).

One study suggested that whilst overall the scheme has been a success, there is a wide variance of activity across the network (Nash, 2010). The study took a count of the number of bicycles at each station every two minutes for over a year. The method is slightly biased in favor of stations with a more even turnover spread rather than stations that have intense periods. The busyness value represents the number of turnovers at the station during the data collection period. Some stations are particularly busy where at times demand exceeds supply. Other stations are vastly under used with effectively no activity. There are major expansion plans involved for the scheme (Dublin City Council, 2011), which should keep the failure of particular stations in mind when designing the new stations. If the new stations were the 'fourth generation', the entire network would improve as stations with demand issues could be facilitated by re-locating stations that have little activity (Midgley, 2011). A map of the stations can be seen in Figure 1.

Figure 1 Map of the Dublin Bikes Scheme

3. Methodology

This section of the paper describes how the analysis of the Dublin Bikes scheme was conducted and how the station types were identified. The Public Transport Rating for each station was calculated and then compared with the activity values of each station. The results determined the relationship between public transport and activity at the stations.

3.1 Station Type

All 44 stations in the network can be broken down into one of three types of station. The station types are based on the first activity of the station, which is generally in the morning, when most people make their first trip of the day. The stations are only analyzed for activity during the working week. Each station shows certain characteristics that can be broken down into one of the following:

- GT station: A 'Go-To' station is one where the activity in the morning is predominantly as a result of people docking bicycles in the stations, which sees a

decrease in the available spaces. In the evening period, the opposite happens as people leave the area.

- GF station: A 'Go-From' station is one in which the activity in the morning is predominantly as a result of people taking bicycles out of the station, which sees an increase in the available spaces. In the evening period, the opposite happens as people return to the area.
- SS station: A 'Self-Sustainable' station is one in which the activity is consistent in both directions throughout the day. The number of bicycles being docked at the station is similar to the number of bicycles being taken out from the station.

The station types were decided upon by examining the average daily usage from each station. Determining the station type is crucial to this research. With that knowledge, it was then possible to zone the city. Movement trends were easily identifiable once the type of station was evident. This was done using the data available and the real time information on the bicycles. The results of which could be used as a general movement pattern for commuters in general.

3.2 Station Rating

An analysis of all 44 stations was conducted to calculate how other public transport influenced the numbers at that station. Each station was marked on a map of Dublin, and plotted with a 200m radius. All stations received a Public Transport Rating (PT Rating) based on the transport services within the 200m radius. Each service was given a rating based on regularity, capacity and the numbers it could produce at each stop or station. In the case of over-lapping perimeters, the public transport facility that was closest to a Dublin Bike station was given to that station. An individual PT Rating was calculated for bus, light rail and heavy rail. Initially, when finding a PT Rating for buses, all bus stops in a 200m radius were counted. However the results were dis-proportionate, as some bus stops serviced more bus routes than others. There were cases of multiple bus stops in one 200m radius, servicing a low number of bus routes. This was completely different to other areas where low bus stop numbers serviced a high number of bus routes. The results of such a process were not as accurate as feasibly possible. Therefore, it was decided that the bus routes within that 200m perimeter would be counted rather than stops. Therefore, each bus route within a 200m perimeter was given a PT Rating of 0.05. Generally speaking that route would also be seen again in that perimeter, going in the opposite direction and that would be counted as another separate route. The formula for the PT Rating for bus routes is given in equation 1:

Equation 1

$$\text{Bus Rating} = \text{No. of bus routes serviced within 200m} * 0.05$$

The reasoning behind such a low rating for an individual bus was due to the number of people disembarking at one stop per bus, is very little in comparison to the number disembarking rail at each stop/station.

With respect to heavy rail, there are only 3 stations for all routes in the city centre with which one can dismount. The network is much more rigid. This leads to a far greater number of

people at a heavy rail station than in comparison to a bus stop. Therefore the PT Rating for a heavy rail stations is shown in equation 2:

Equation 2

$$\text{Heavy Rail Rating} = \text{No. of heavy rail stations serviced within 200m} * 3$$

Light rail falls in between the heavy rail and the serviced bus routes in terms of capacity. It is more flexible than heavy rail in terms of the number of stops in the city centre. On the relevant map there are a total of 11 stops, over the two different lines with which passengers have access to Dublin Bike stations. The greater frequency of stops diminishes the number of passengers disembarking at individual stops in comparison to those numbers disembarking at heavy rail stations. The capacity of an individual tram at peak capacity, is also significantly greater than that of the bus but less than that of heavy rail. Therefore the PT Rating of a light rail stop is equation 3:

Equation 3

$$\text{Light Rail Rating} = \text{No. of light rail stations serviced within 200m} * 2$$

3.3 Survey Data Collected

The surveys were used to satisfy some of the objectives outlined before any other analysis had begun. The surveys were conducted between October 2011 and March 2012. There were two different surveys used because some of the questions did not apply to all stations. There were 237 respondents in total. The surveys were conducted on inconsecutive days at each station at different times throughout the day, during the morning and evening period. The stations were visited over a period of at least two inconsecutive days at either the morning or evening time. Doing so at these times led to an increase in the number of people using the bicycles specifically as an element of their journey to work.

4. Results

4.1 Station Type

The station type is based on when the most activity occurs, generally at the start of the day. Therefore the pattern in the morning period generally indicates the station type.

- GT station: Fitzwilliam Square West, Station 13

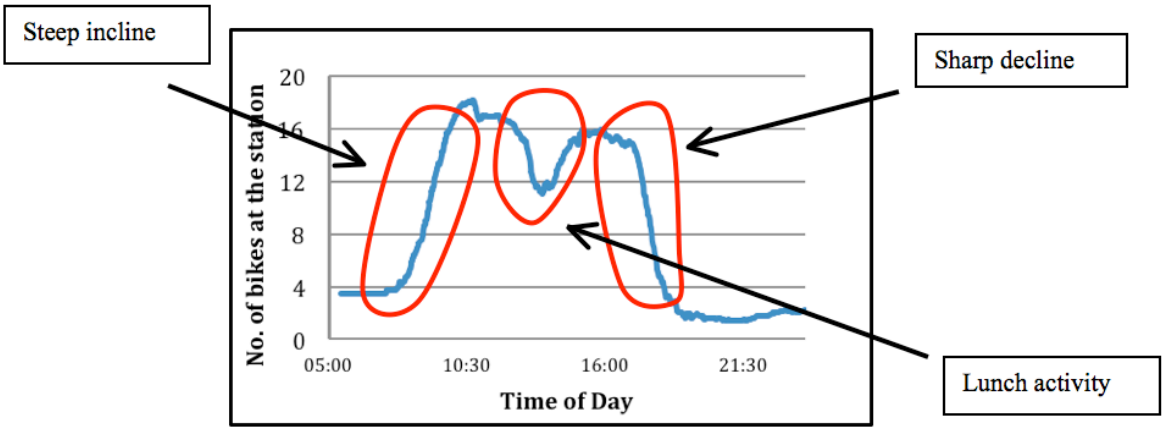

Figure 2: Example of a GT station

In the morning period there is a distinctly steep incline in the number of bicycles docked at a station (as seen in Figure 2). There is something in close proximity to that station that makes a user dock their bicycle at that station. This could be the final destination or the station closest to another service to get to the set destination. During the evening period a corresponding sharp decline in bicycles available at the station is evident. The decline of bicycles from the station is a result of people leaving the area with which the station services, generally to go home on the repeat journey. Depending on the location of the station, there may be some activity around lunchtime.

- GF station: High Street, Station 7

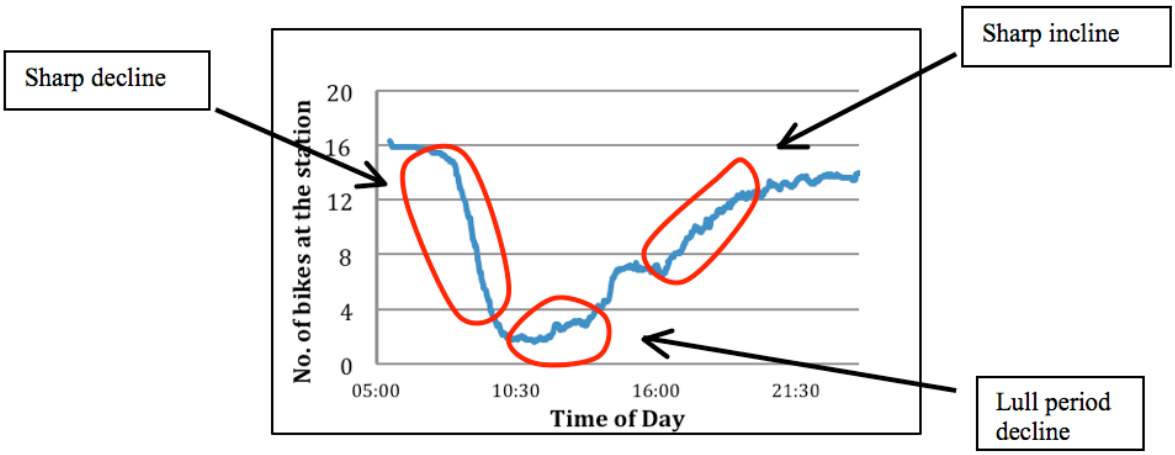

Figure 3: Example of a GF station

There is a clear distinction between the characteristics of a GF in comparison to a GT station (as can be seen in Figure 3). In the morning period, instead of an increase in the number of bicycles at the station, there is a sharp decline in the bicycles available. Generally, people use stations with such characteristics, to get to their final destination or as part of their final destination. This type of station is generally one where people have their first interaction with

the network, whether they live in close proximity to the station or not. In the evening period, there is an increase in the number of bicycles at the station, as people return from wherever they were throughout the day. There is an evident lull in activity in the intervening period, because people tend not to return from work or college for lunch in significant numbers.

- SS station: Fownes Street Upper, Station 14

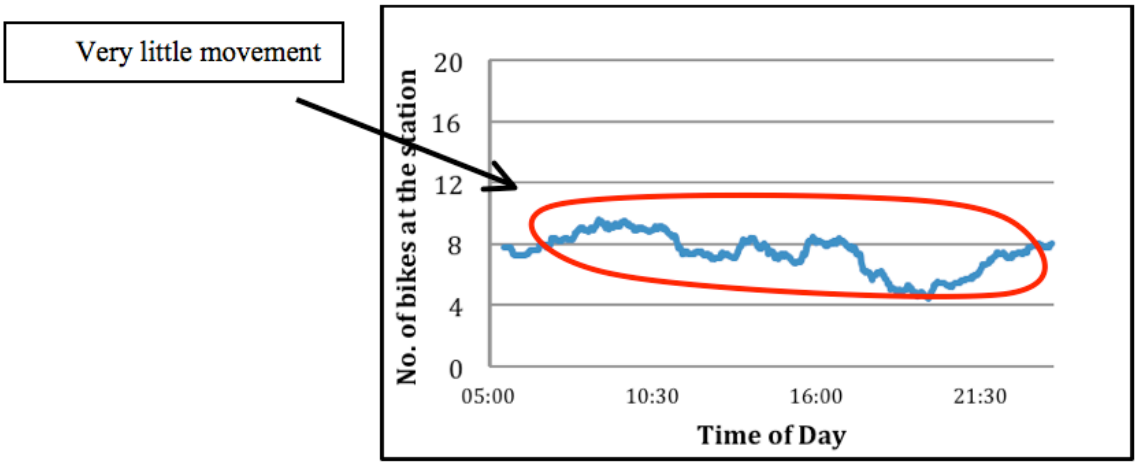

Figure 4: Example of an SS station

There is very little movement in the number of bicycles at the station, throughout the day. This type of station is ideal. If there are equal numbers going in and out of a station at any one time, there will never be a shortage of bicycles or spaces. With GF and GT stations, in many cases one could find oneself waiting for either a bicycle or a dock. It is these types of stations that have to be monitored by the Dublin City Council, in terms of adding bicycles or freeing spaces, to ensure that the distribution of bicycles is reasonably even in the network. However, stations like this one can also be indicative of a station with very low activity, which is not ideal.

4.2 Public Transport Rating

A 200m perimeter was set up for each station, and any public transport within that 200m was associated with that station. Each mode of transport was given a rating as explained before in section 3.3. An example of the process is shown below for station 38, Grantham Street can be seen in Figure 5. Within the 200m perimeter there is one light rail stop and 5 Dublin Bus stops.

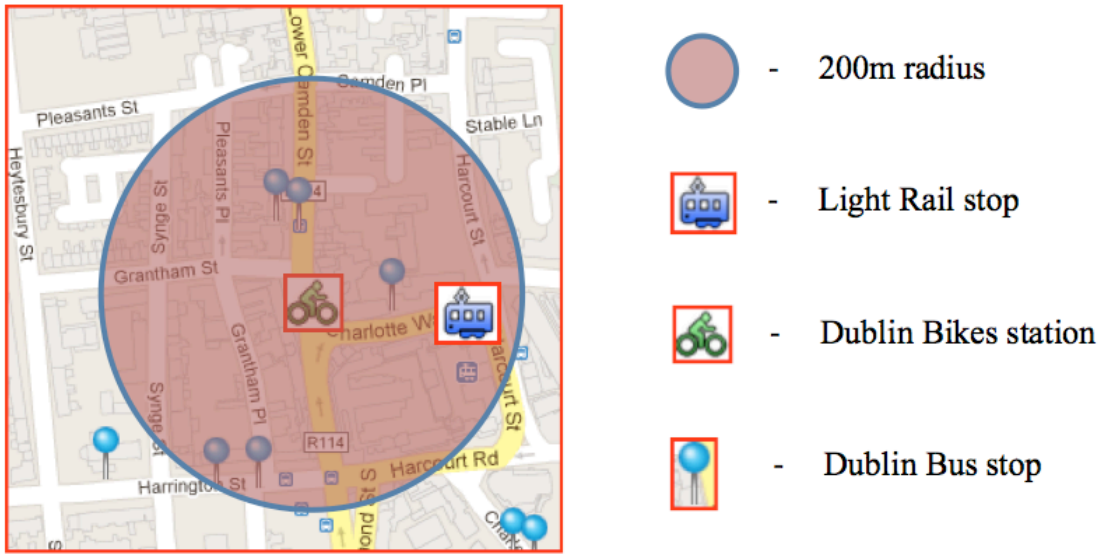

Figure 5: Example of Public Transport Rating System (Grantham Street)

Table 1 presents the both the busiest rating and the PT Rating. The average PT Rating of the original top 20 busiest stations is 2.7725 and the average PT Rating of the original bottom 20 stations is 0.9725. In taking a more general view of the data and the averages, one could say that the public transport in an area has a bearing on how much activity there is at a station. In theory this should be true. Transport services increase footfall in an area which increases the likeliness that someone will use the facility.

Table 1 PT Rating

Station No.	Name	PT Rating	Nash's Busyness Scale
8	Custom House Quay	6.2	1
23	Custom House	4.75	33
32	Pearse Street	4.05	2
18	Grantham Street	3.95	5
38	Talbot Street	3.9	12
33	O'Connell Street	3.4	7
4	Greek Street	3.25	36
22	Townsend Street	2.6	16
41	Harcourt Terrace	2.5	NEW
5	Charlemont Street	2.25	9
21	Leinster Street South	2.05	27
1	Chatham Street	2	4
35	Smithfield	2	6
40	Jervis Street	2	21
9	Exchequer Street	1.9	8
27	Molesworth Street	1.85	19
2	Blessington Street	1.8	37
39	Wilton Terrace	1.7	11
36	St. Stephen's Green East	1.65	29
20	James Street East	1.65	20
15	Hardwicke Street	1.6	40
14	Fownes Street Upper	1.5	13
24	Cathal Brugha Street	1.5	24
17	Golden Lane	1.35	28
13	Fitzwilliam Square	1.3	35
25	Merrion Square East	1.3	15
30	Parnell Square North	1.25	39
44	Upper Sherrand Street	1.25	NEW
29	Ormond Quay Upper	1.05	32
26	Merrion Square West	0.95	26
19	Herbert Place	0.9	3
34	Portobello Harbour	0.9	10
11	Earlsfort Terrace	0.85	18
10	Dame Street	0.85	25
28	Mountjoy Square West	0.7	22
6	Christchurch Place	0.7	30
12	Eccles Street	0.5	31
16	George's Quay	0.4	38
7	High Street	0.3	17
43	Portobello Road	0.3	NEW
37	St. Stephen's Green South	0	14
31	Parnell Street	0	23
3	Bolton Street	0	34
42	Smithfield North	0	NEW

4.3 Survey Results

The following analysis was based on results taken from surveys carried out on different stations over 17 days between October 2011 and March 2012. From the 7 stations that were critically analyzed, there were 237 respondents. The results of the surveys are shown in Table 2.

Table 2 Results of the survey

	N	%		N	%
Gender			**Trip purpose**		
Male	180	76%	Work	223	94%
Female	57	24%	Education	8	3%
			Other	6	3%
Role of DB trip					
Substitute	128	54%	**Trip before DB**		
Compliment	109	46%	Walk	128	54%
			Transit	73	31%
Use of DB per week			Car	8	3%
Rarely	9	4%	Own bicycle	28	12%
2-5 times	68	27%			
5-10 times	160	66%	**Living distance to DB station**		
11+	8	3%			
			0-2 km	76	32%
Reason for picking station			2.1 – 5 km	47	20%
Prox. to transit stop	75	32%	5.1 – 10 km	24	10%
Prox. to work/college	64	27%	10+ km	90	38%
Prox. to home	98	41%			

Those surveyed were asked how they would have got to their destination before the Dublin Bikes scheme: Before Dublin Bikes was in existence:

- 54% of those users previously walked to their final destination.
- 31% of users previously used public transport and instead, they now use Dublin Bikes as their primary mode of transport or one of two primary modes.
- 3% used to drive to their destination, either in a car or motorbicycle.
- 12% of users used to cycle their own bicycles and have now changed over to Dublin Bikes.

The results are quite similar to that of previous studies mentioned in the Literature Review. The majority of the respondents use the scheme as a substitute for walking. 97% of respondents use the scheme as a substitute for sustainable travel. This has gone up considerably since a previous study which concluded that 78% of respondents use the scheme as a substitute for sustainable travel.

That 54% of former walkers is made up of users from all three zones. The cycling leg of the journey could therefore be in combination with other public or private transport or on its own. If one lived close enough, the cycling leg of the journey could be the only leg and therefore

the ‘last mile’ theory still applies to some extent. Of the 54% of users that walked as part of their final journey leg:

- 32% lived within 2km of their final destination
- 20% within 2.1 and 5km
- 10% within 5.1 and 10km
- 38% lived further than 10km from their respective destinations.

Clearly those that use the facility encompass a wide area. Of the 32% of people that previously walked as part of their commute to their destination and lived within 2km, it is most likely that walking was the only transport medium. It may not have been of any benefit to use any other public transport. There is some scope in the 20% that lived within 2.1 and 5km of their final destination that walking could also have been the primary transport mode. One would have to live closer to the 2.1km mark than 5km, but there is some scope, even if only small.

For at least 48-68% of the people that walked as a significant portion of their journey, Dublin Bikes serves as a complimentary service to forms of public transport

- 48% is minimum number that use Dublin Bikes in conjunction with another form of public transport, those that live 5.1km + from their destination
- 68% is the max percentage if all those living outside 2.1km used a combination of public transport and walking to get to their destinations.

5. Discussion and Conclusions

The objective of this project was to determine whether there was a relationship between Dublin Bikes and public transport. This relationship could be established by examining the activity at a station and the public transport surrounding that station. The relationship was to be examined to determine if the public transport in the surrounding area had a positive or negative impact on the activity at the stations. Quantifying that relationship was also part of this work.

These results are as one might expect; the greater the PT Rating of a station, the greater the footfall, which increases the likeliness that someone would use the station. However, there is the counter argument that with a high PT Rating may work against the activity of a station. A high PT Rating indicates that there are other transport options in the area. This has been shown to be the case at a number of stations, such as Smithfield where the transport modes compete with one another. The results suggest that public transport works against stations located on the outer Zone and benefits those in the CBD. Considering the results as discussed, public transport positively influences the activity at a stations and distance is not a factor. Certain areas would be successful in terms of activity when the expansion of the scheme is complete based in the work from this project.

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