Evaluation of the current bus system in Dublin- Identifying weaknesses and comparing to latest bus network proposal, Bus Connects

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Declaration: I, Barbara I. Palleros Baez, declare that this research is my original work and that it has never been presented to any institution or university for the award of Degree or Diploma. In addition, I have referenced correctly all literature and sources used in this work and this this work is fully compliant with the Dublin Business School's academic honesty policy.

Signed: *Barbara I. Palleros Baez*

Date: *07/01/2019*

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Abstract

Public transportation design and characteristics need to be adapted to suit the needs of those it is intended for, residents and visitors. As a city's population grows the system requires revision and updates so that the increased volumes of travellers are catered for and any new developed areas, created through dispersed city growth, can have adequate access to the public transport system. Dublin's experienced urban sprawl has generated the need for stretching the bus services that currently travel in a radial manner intersecting at the city centre where the highest level of commercial and employment activities occurs. The National Transport Authority has issued a proposal for a bus network redesign under the name of Bus Connects that aims at improving journey times, frequency and reliability of the service provided, among others. This study identifies the current bus service weaknesses from the users' perspective through a quantitative primary research. It then assesses the characteristics proposed in Bus Connects in accordance with those identified current system issues, to understand if the main presently unsatisfied needs would be considered into the new system. The findings show that one of the main issues raised by bus travellers in Dublin is the normal operating hours with 37.9% and 42% of responses suggesting extended services hours should be adopted on weekdays and weekends respectively, however this measure is not included into the Bus Connects proposal. Other raised issues, including connectivity of outer neighbourhoods, frequency of services and integrated fare structure to include various modes of transportation in one fare, are considered and improved in the Bus Connects proposal. The satisfaction level towards the mobile applications available for bus services is also evaluated and its relevance towards the satisfaction with the overall system is analysed, finding a positive correlation between them and an identified need for Real Time Information improvement. Additionally, the relevance of convenient bus accessibility when looking for housing location options is assessed, to interpret the effect that the current bus system weaknesses may have in a city that is going through a housing shortage crisis.

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1. Introduction

1.1 Context for the Research:

"…high quality and more efficient public transport provisions that responds economic needs and connects residents with jobs is considered as a key factor for city growth" (Ustaoglu *et al.*, 2017)

As the population in a city grows, there is a need for increase in housing developments to accommodate the enlarged number of residents. Ireland's population has been in continuous growth since 1990 in accordance with data from the Central Statistics Office (CSO) (2018) as can be observed in Appendix C. As a consequence, Dublin, being the capital city, has experienced the largest population growth in the country.

Dublin's building heights have historically been limited through guidelines that varied depending on the area of development being considered but did not exceed six to eight storeys generally (Department of Housing, Planning and Local Government, 2018, p. 1), with very limited exceptions made (particularly in recent years) for locations such as the Docklands. This has led to the city physically growing horizontally through dispersed development since the 1990s (Ustaoglu *et al.*, 2017). Such a type of development requires public transportation systems to accompany the growth by expanding their reach further so as to allow residents in the new areas to commute from their homes to any activities they may be involved in without having to rely on ownership of a private vehicle.

The main cities in Ireland, including and particularly Dublin, are going through a housing shortage crisis, an issue that is extensively discussed by media in a frequent basis. Despite the general awareness of this issue, it is not expected to be resolved in the near future due to the population growth forecasts for the coming years and to the current inability to develop new homes at the rate that has been studied to be optimum to meet the growing demands (Morgenroth, 2018).

Simultaneously, the public transportation system in Dublin has many proposals for future development or upgrade. The latest one related to the bus system specifically has been identified to be called Bus Connects, which aims at improving the existing service by providing faster and more frequent bus route services, as well as a new network design (National Transport Authority, 2018c).

Effective public transportation in Dublin could aid the above-mentioned current housing crisis, even if in a small manner, by allowing ease of access to already developed or soon to be developed areas, such that no housing opportunities are wasted or available to only a reduced fraction of the population who own private cars.

1.2 Aims of this Research:

This research aims to investigate the effectiveness of the existing bus system in Dublin and identify its main weaknesses from the users' perspective. Through this, this study aims to analyse the proposed changes in the bus system for the near future (the Bus Connects proposal) according to these main issues identified. It will also aim to find any impact or influence that accessibility to the bus system may have when considering alternatives for housing locations so as to identify any possible linkage between the currently undergoing housing shortage in Dublin city and the bus transportation system available, with the ultimate aim of finding out: **Is the proposal for the new bus network system dealing with the main issues currently experienced by its users?** And **Does the current bus system in Dublin have an impact in the housing shortage issue?**

Moreover, the study will include research on characteristics of and initiatives adopted to bus public transportation systems from other cities to analyse possible additional/alternative solutions that could be applicable to Dublin's bus system.

From the above, the following sub-questions are identified for this study:

- What are the current issues in Dublin's bus system as experienced by bus commuters?
- Do the existing bus service characteristics influence residents when looking for accommodation?
- What are the development or improvement plans for the bus services in Dublin in the coming years that can improve mobility in the city?
- What measures have been adopted in bus systems in other cities that could be beneficial for consideration in Dublin city?

The main contribution of this study will be the identification of the currently unsatisfied bus commuters' needs with the existing bus transportation system through the development of adequate primary research, and the evaluation of how the newest proposal considers these needs.

1.3 Rationale for the Research:

Housing shortage is a well-known, frequently discussed issue for Dublin and other cities in Ireland. There is constant research being carried out to understand the future projection in size of the city and the implications of not being able to accommodate the expected growth. Literature found, however, has not provided an insight into the effects that the existing bus system has on Dublin city residents commuting needs that can affect them at the time of assessing accommodation alternatives in or around the city. This is considered relevant since a lack of adequate or convenient accessibility to public transport can equate to some housing opportunities being only accessible to residents who own private

cars, who, in turn, would also be subject to the increasing traffic congestion affecting their commuting times (National Transport Authority, 2016a) and to restricted parking opportunities in the city centre (McGee, 2018).

It was reported that the current infrastructure in Ireland is lagging behind with the increasing demand from the growing population, the transportation system being one of them, and in order to be able to continue growing economically by attracting more business, this issue will need to be addressed. Some believe that the housing shortage issue (along with school capacities, healthcare and public transport) is already starting to discourage investment (MacDonald, 2016). Others expect that the upcoming United Kingdom Brexit measures will continue to attract UK firms into Dublin, despite the housing crisis, though the shortage of accommodation along with its elevated prices are still highlighted as the main factors currently discouraging new or further investment (O'Carroll, 2017).

McGee (2018) reported that future developments in the city centre of Dublin will not include provision for car park spaces in an effort to reduce private car usage and encourage use of public transport instead. For this sustainable measure to be successful and feasible for residents, public transportation options need to be available, accessible and efficient, as well as cost-effective for its users, so that all residents may be able to adopt public transportation as an alternative to private cars, particularly those who commute longer distances and/or do not have the opportunity to walk or cycle as an alternative to their activities.

As stated by Vickerman (2007) there's a "need for further work on micro studies to unravel how the decision-making of firms and households is influenced by transport infrastructure" (Vickerman, 2007, as cited by Wangsness, Rødseth and Hansen, 2017) thus suggesting that the availability and quality of public transport services is one of the considerations that both firms and residents assess prior to choosing a home or an office location. Locations with better access to public transportation tend to be better valued and thus also more popular for investment.

New projects to improve Dublin's public transportation system have been looked at for many years, with some proposals going ahead, such as the expansion of one of the tram lines, the "LUAS Cross city" project which was the extension of the green LUAS line northbound, others ending at the proposal phase without success, such as the Bus Rapid Transit (BRT) proposal, "Swiftway" which was issued for consultation back in 2014, and others still being analysed and debated such as "Metro North" (Ginty, 2017). The Bus Connects proposal is the latest proposal related to the bus system and for which works could begin as early as the end of 2019.

This study will contribute to the existing literature through an assessment of the weaknesses in the current bus system from the users' perspective and evaluating the extent to which these are being incorporated into the latest Bus Connects proposal. It also aims at finding any linkage that the current

bus system and the existing housing shortage issue may have in Dublin city, if at all. The purpose of this will be to identify any developments in the bus transportation system that could potentially assist to improve the bus commuters' experience and accessibility to buses and to understand which limitations in to the bus public transport can currently be discouraging its use in some cases and causing that already-existing housing opportunities may be wasted. In order to achieve this, the study will also investigate current adopted bus system characteristics in a similar city from another country that may be considered applicable for future consideration into the bus system here in Dublin.

1.4 Dissertation Structure

The background for this study with its various sub-topics is detailed in Chapter 2 through the literature review that assisted with the development of the research topic and the identification of different themes. This chapter is thus divided into these identified themes and the latest and most relevant information on them has been summarised. This is where the highlights of the proposed new bus network design (Bus Connects) can be found, along with other relevant topics such as the current situation for Dublin commuters in terms of transportation, further information on the previously mentioned housing crisis as well as the city's projected continuing growth that is influencing the way in which Dublin develops and plans for the future. Transport characteristics from other cities that differ from Dublin's existing system are also included in this section and another section on the concepts that agile cities bring forward related to public transportation.

Chapter 3 in this study shows the process undertaken to find the most appropriate research methodology to suit this particular research topic, through an analysis of the research onion model explained in Saunders, Lewis and Thornhill (2012). The methods for carrying out the primary research are thus identified and explained, possible biases and ethical issues are also acknowledged.

The following chapter, number 4, presents a summary of the findings that were collected through the primary research, this is done mainly through figures that aid to visualise the results, with brief explanations to assist in their understanding.

A discussion of the findings follows in Chapter 5, with a more in-depth analysis of what they portray and how they are interpreted by the researcher, also considering the previously found literature, particularly providing an analysis of the bus network proposal for the near future.

A conclusion of the main findings can be found in chapter 6, which summarises the analysis carried out previously and focuses on those that are more relevant to this study. This chapter also includes recommendations for further study.

1.5 Limitations to the Research

Dublin bus transportation system is part of a network of public transportation systems which also includes tram lines (LUAS) and trains (DART). Isolating the bus system from the other modes of public transportation is assessing an incomplete system, and it is possible that some of the weaknesses presented in the bus system are compensated even if partially, by one or both other existing modes of public transportation. Similarly, it is possible that the users completing the survey adopt more than one mode of public transportation. Survey questions should be clear and explicit in their focus towards buses only.

While the best efforts will be made to collect a varied sample of bus commuters (in terms of ages, and destinations) this will be subject to availability and willingness of users to participate in the survey, and due to the anonymous nature of the online collection of responses, the researcher will not be able to ensure that the sample is indeed varied or not.

It is expected that residents living closer to the city centre will have different needs regarding public transportation than those living in outer neighbourhoods, this study will not differentiate between those, but rather get a general outlook on bus users' views and needs.

The main dissertation topic is related to the current issues and a proposal of improvements based on the primary quantitative research and secondary research of bus systems in similar cities from other countries and comparing them with the existing Bus Connects proposal and the steps being taken towards improvement in the near future. However, it should be noted that the researcher is not an expert in the area of public transportation planning and design, this, and the limited time allocated for this study may mean that some issues are missed or would be beneficial to be looked into with further detail.

Time constraints for completing the dissertation could prove to be a challenge, due to the number of participants required to complete the primary research and the time needed to analyse the information and data collected as well as for the secondary research. This time limitation also influences the depth of the research and analysis that can realistically be performed in such a complex and wide topic such as bus public transportation characteristics, that usually requires years of planning and design. Hence it is expected that further research may be relevant into some if not all the individual factors analysed.

It is important to note that the study carried out was based on adult individuals' experiences, and does take into consideration children, elderly or family travelling situations and needs. Similarly, it does not differentiate any experiences that bus users with disabilities may have.

It is worth noting also that since the Bus Connects proposals issued by NTA are under a first round of public consultation process, and no final project has been decided on at this stage, in fact, a second

draft followed by another round of public consultation is expected for 2019. Therefore, the proposal is likely to be amended, not only through the duration of this study, but also in the next coming years, and thus, some of the findings from this study may be altered.

2 Literature Review

2.1 Literature Introduction

This chapter will provide background information on studies or reports previously published by others that are related to the research topic being proposed and which have been deemed relevant and thus consulted both during the process of topic development and for analysis carried out at later stages. These previous studies range from a variety of sources and themes and are thus separated into different sections according to their themes, providing diverse aspects that have been considered and researched for the development of this dissertation.

2.2 Dublin's expected growth in the near future

A note published in the Irish Times by McGee (2018) reported an expected population growth in Ireland by 2040 that would require additional estimated 550,000 homes, with about half that amount in Dublin city alone. Looking at a nearer future however, the Dublin city chamber is currently basing all planning towards accommodating 280,000 more residents by 2031, according to Dublin Chamber CEO Burke (Lyne, 2018).

A study carried out by the European Environment Agency (EEA) found Dublin to be one of the "worst cases of sprawl type developments" when studied within a European context back in 2006 (Ustaoglu *et al.*, 2017, p. 2). Urban sprawl has many implications and generates demands on urban development, such as infrastructure which includes, among others, transportation for accessibility and connectivity. This type of growth in Dublin city has be attributed in part to the unwillingness of the City Council to allow for high rise buildings historically. Low-rise buildings are more suitable for independent housing type, while high-rise buildings generally are adopted for office use and for apartment type accommodation. This height limitation on buildings has thus generated an insufficiency in apartment type accommodation, which according to projections from Eurostat are the most looked-after type of housing since the 90s and are expected to continue to be so (Burke-Kennedy, 2017).

As per the above mentioned, Dublin has historically developed outwards, expanding and growing by covering new land and requiring extension of all services and infrastructure. In order to limit these additional works, the National Development framework thus now proposes redevelopment of existing formerly developed areas to be encouraged and prioritised, with higher-density projects and high-rise buildings where suitable (McGee, 2018).

The above is agreed by a Department of Housing and Planning spokesman who mentioned the need to limit urban sprawl where possible by pushing for more "compact development" (O'Donoghue, 2017),

referring also to the impact on public transportation that the continued expansion of the city would have, a thought which was also shared by FitzGerald (2018). A report found from the World Resources Institute explains the advantages of compact growth, stressing on the positive environmental impact compared to urban sprawl, explaining that compact cities produce fewer carbon emissions due to the fact that public transport and other sustainable modes of transport are more easily accessible (Haddaoui, 2018), in such cases in which public transportation is proved to be efficient, private modes of transportation loose some of their appeal.

The National Transport Authority (NTA), on the other hand, observed that there was a notable increase in the number of people that choose to live in the city centre compared to 10 years before (National Transport Authority, 2016b). It is possible that a deficiency in the accessibility towards housing alternatives that are located further away from the city centre could be a reason for this population growth in the heart of the city, and should this be the case, this trend could continue, unless accessibility is improved for outer neighbourhoods.

2.3 Housing Shortage

A report published by MacDonald (2016) highlights the current issues in terms of capacity that is being experienced throughout Ireland due to the rapid population growth that has occurred and which is expected to continue. One of the issues mentioned is the lack of housing options for the new residents. MacDonald mentions PayPal as an example of a company that has struggled to house new employees, having to request their Ireland-based employees to rent out any spare rooms for newcomers where possible. MacDonald also notes that this shortage of capacity is starting to discourage opportunities in Ireland, noting, for instance, the Web Summit event, which used to take place in Dublin but has relocated to Portugal due to the abovementioned accommodation capacity issue. Bodkin (2018) supports this by commenting that a survey carried out in Dublin identified that employers were finding it more difficult to find and retain employees due to the increasing costs of housing, which are in turn encouraged to continue on the rise due to the high demand.

A study performed on “Scenarios and Implications” of the different regions in Ireland points out that indeed, accommodation prices have risen as a result of the increased demand and notes the “slow supply response in the Irish and particularly Dublin housing market” still today, also remarking that as prices for accommodation continue to increase, there is risk that the expected immigration could start to reduce (Morgenroth, 2018). In this way, the author warns that a lack of housing for the expected continuous population growth in Dublin could lead to a reduction in such predicted growth.

IReach carried out a survey and found that the majority of respondents in Ireland believed government is responsible for solving the housing shortage issue by investing in more construction, but almost as many respondents’ believed that in order to solve the housing crisis, rent control should be stricter

(McHugh, 2018). This last finding reflects another issue resulting from the high demand on accommodation experienced in Dublin, and that is that while the cost of rent has increased significantly, the soft approach towards rent control has resulted in some cases in landlords or tenants taking advantage of the situation by renting or subletting bedrooms without contracts and only through the payment of cash (Power, 2018), such conditions of living and lack of legal agreements can also influence businesses abilities to attract employees from overseas or in some cases even retain employees that have already made the transition.

While there are efforts being done to increase the number of housing options, Financial company Investec has predicted that new completed homes in 2018 and 2019 would be around 21,500 and 24,000, respectively, with both figures falling short of the originally expected 30,000 and 50,000, indicating that the required new demands will not be met for a number of years (Bodkin, 2018). This report again remarks on the increasing prices of property which are affecting the overall living cost in Dublin, noting that a survey has found cost of living in Dublin to be pricier than London's, once again pointing out that business opportunities could be lost in the future should this trend continue. Others even warn about the possibility of a housing market collapse, should the cost of rent continue to increase (Reid, 2018).

Professor McQuinn from the Economic and Social Research Institute (ESRI) believes that the upcoming UK Brexit could result in a reduction in housing demand for Ireland (Gleeson, 2018) in which case, Ireland's economy would not be as favoured but the housing shortage crisis could see a positive turn of events, due to a decreased demand than is currently forecasted. However, most agree that the opposite is more likely to occur with large number of people moving from the UK to Ireland during and after Brexit process, particularly from the financial sector (O'Carroll, 2017).

2.4 Commuting into and out of Dublin City centre

"Travel is a derived behaviour: most people travel not just for the sake of it but in order to participate in spatially disjointed activities. When people's need for housing is taken into account, transport policies may confront more challenges" (Zhao and Li, 2016, p. 948)

A study performed by Murray (2017) referred to figures from the National Transport Authority (NTA) from 2011 showing that the vast majority of the commuting in Ireland is done by car (73%) and only 4% carried out via the use of buses. In Dublin specifically, on that same year, it was noted that 100,000 people used public transport, including buses, Luas and trains (Murray, 2017).

In 2015, the NTA reported that there were approximately 200,000 journeys to the city centre during the peak times every weekday. The report also expressed their expectation that by 2023, this number will increase by around 40,000, while at the same time noting an increase in the traffic volume already

experienced in the M50 and radial accesses to Dublin (National Transport Authority, 2016a). O'Donoghue (2017) further noted that congestion is already a problem in the main cities in Ireland, mainly due to the vast use of private cars, which in turn affect the bus services by causing delays, and thus impacting on the efficiency of the bus transportation system.

Ustaoglu *et al.* (2017, p. 22) reported that the urban sprawl observed in and around Dublin since the early 1990s has resulted in an increase of private car use, also agreeing that this mode of transportation is overwhelmingly higher than all others. This suggests that residents in outer areas of the city have a preference towards travelling via private car over using public transportation services. A study carried out on a "car-shedding" concept provided a clearer report on this by noting that Dublin's suburb residents expressed "poor access to lack of alternatives to the private car as a means of transport" (Carroll, Caulfield and Ahern, 2017) highlighting the lack of efficiency on of all modes of public transport, including busses, perceived by residents in these areas. It is understood that this would, on the one hand, limit opportunities of accommodation in those areas for people without access to private car or who prefer not to use a car for daily commute, and on the other, this would contribute to the increasing traffic congestion, affecting the quality of existing public transport system, as mentioned.

As previously noted in section 2.2, plans towards the future growth in Dublin are expected to restrict further urban sprawl, however in stating this, O'Donoghue (2017) also remarks that the existing public transportation services are insufficient even within the existing city footprints, suggesting that even in the case that future developments are limited within the existing city boundaries, planning should focus on solving this deficiencies in the public transportation system that would in turn also aid in reducing congestion. As stated by Simpson in 1987 there is a "need to make our urban work, shopping and recreation places more accessible while generating less travel" (Simpson, 1987, as cited by Rafter, 1996) a quote that is applicable to Dublin's connectivity situation, in which existing bus routes operate in a radial-type manner, all intersecting at the city centre, with no connection of outer neighbourhoods (Jarret Walker & Associates, 2018c, p. 3) this system forces bus users to travel to the city centre and change buses to head outwards again even if travelling to a neighbouring suburb.

Public transport in the main cities of Ireland is a frequently discussed topic, and as expressed by Ustaoglu *et al.* (2017) it is a key factor which if organised properly can aid in the process of continued population growth. An NTA member in charge of reviewing and reassessing the current bus system has reportedly defined it as "inflexible and 'immensely complicated" (Clarke, 2018). As such, there have been proposals developed for modification and improvement of the current system that attempt not only to improve its quality for current users, but also to decrease private car use by attracting more users. To this end, measures such as a change to the fare structure that would allow the combination of different means of public transportation without additional cost are being investigated (Kelly, 2017), among others. Dublin has already been identified as the being second in a raking of the most expensive cities for commuting, with only London having higher public transportation costs (Morrell, 2017).

As noted above, when considering the option of combining a bus with another mode of public transport such as tram (LUAS) or train (DART), the current payment system for public transportation does not allow for one ticket to be purchased for use in more than one mode of transport (Jarret Walker & Associates, 2018c). Having said this, monthly and annual tax saver tickets that allow different combination of transport types to be used are available, however companies need to register with TaxSaver for employees to have access to these and purchase them on their behalf (taxsaver.ie, 2018). Alternatively, annual tickets for use in bus and rail or in bus, rail and tram options also exist in the rail webpage (Irish Rail, 2017). Outside from these "bundle" tickets purchased monthly or annually, there are no options for purchasing tickets daily or sporadically that is valid in more than one mode of transport per trip.

Reports from Dublin City Council and NTA earlier this year noted that the number of commuters into Dublin City reached a new peak figure and stated that for the first time the use of public transport has risen above 50% of the commuter journeys, also reporting that when including the use of bicycles, taxi or walking, 70% of the trips were done through a sustainable mode of transport (Kilraine, 2018). Adding on to this, FitzGerald (2018) has reported that up to a quarter of increase in population is expected by 2040, and that by then most commuters will rely on the use of buses mainly, even with the plans of development of a new metro system going forward and with the existing tram (LUAS) and train (DART) systems (FitzGerald, 2018).

The existing bus system in Dublin has been under constant debate regarding its effectiveness, efficiency, convenience and accessibility and cost, the proposal drafted for the Bus Connects network identifies some of the most popular weaknesses in the current system, namely: the lack of interconnectivity with other means of public transport in the fares paid, the lack of connectivity between outer neighbourhoods having to transfer in the city centre (both mentioned previously), the overlapping of many routes for long distances, the complexity of the network, the low frequency on some routes (Jarret Walker & Associates, 2018c).

As stated by Zhan (2016, p. 39) "Commuters often make travel choices based on their perceptions of the convenience, cost, comfort and cool quotient of various mobility modes" and as such, city governments have a degree of influence people's decisions and their elected mean of travel through "media and education" that can help promote the "cool quotient" for the use of public transportation. While car ownership is still linked to status for many, this concept has started to weaken in some locations where traffic congestion has reached very high levels and where investment into public transportation options has resulted in cars being the slower transportation option, and public transportation a more reliable and convenient solution (Boutot, 2015), which can be considered a positive attitude change towards sustainability measures, and provides developing and growing cities such as Dublin with better opportunities for success if promoting an efficient public transportation

system. One very modern aspect of Dublin buses worth advertising about is that they provide access to WiFi for their users. (DoDublin, 2018)

2.5 Agile Cities

New and constantly developing technologies have provided opportunities for improvement in various aspects of city life, including mobility. The use of data allows for integration of different modes of public transport, such that commuters can find the fastest or most economic or in general most convenient mode of travel. Most importantly, the development of mobile applications that makes best use of data available provides commutes with options and accurate information. A report from the World Economic Forum describes Agile Cities as those that have the ability to adapt to changing needs in a quick manner, and further defines Agile Mobility as: “Agile mobility involves flexible infrastructure supported by a collaborative digital platform that makes available real-time information about supply and demand of services, and ensures transportation optimization, unhindered access, and systems interoperability” (World Economic Forum, 2018).

There is a tendency by developed cities to work towards this concept of agility, even if the same term is not utilised, by taking advantage of latest technology and information available to innovate and improve the quality of the services provided. In its report, the World Economic Forum notes that there are three areas in which innovation has been sought and experimented with in some cities: Physical, Digital and Environmental (World Economic Forum, 2018). When looking at bus public transportation, all these three measures are involved for new designs, utilising digital tools for ticketing and data collection systems as well for Real Time Information (RTPI), focusing on limiting pollution by promoting residents to travel in sustainable ways and even providing more environmentally-friendly vehicles, and physically building the infrastructure needed to provide these services.

In Dublin, research carried out by Wise (2012, p. 37) on Dublin Business School (DBS) international students and their experiences as new arrivals into the city found that among the difficulties experienced during their period of adaptation included among other things “negotiating the local transport system”. This finding suggests that the information available for public transportation is difficult to understand by those that are not used to the system. Seeing that the sample included third level students from 2012, the finding could also indicate that there may have been deficiencies in the mobile applications available at the time, a lack of awareness of their existence or perhaps they were not found to be user friendly or intuitive enough.

As pointed out by Badger (2016) the complexity of public transport use deriving from large number of bus routes as well as possible combination with other means of public transport, particularly in large cities, has led to a higher dependence in the development and constant improvement and updates of

mobile applications. As Dublin's population continues to grow, and public transportation continues to develop, so will the need for constant updated information available to its residents and visitors increase, and the accompanied update on relevant mobile applications will be needed to allow those travelling within the city to have access to the most suitable or convenient method/s of travel. "Without apps, it's nearly impossible for us to take advantage of all the transit options — and all the places transit might take us — that exist" (Badger, 2016)

Data can be used in many ways to assess and analyse existing situations, as per a study carried out with data from the Netherlands, for example, it is possible to identify bottlenecks in the buses routes by studying historical operations data. This provides authorities with the opportunity to assess the reasons for those bottlenecks and design a solution to improve these identified areas, improving the flow of transport and also bringing higher reliability into the public transport timetables (van Oort *et al.*, 2015).

The concept of "Agile cities" posed in the World Economic Forum report (2018) mentioned previously notes there are ways to measuring the level physical, digital and environmental metrics for agile mobility. These metric include (among others) measures of the following: person-based accessibility described as the "time it takes to earn the cost of mean travel time to work", multimodal transport explained as "links between different modes of transport", presence of integrated mobility payment systems and the use of mobile applications to facilitate transport activity (World Economic Forum, 2018). Agility in transportation is a growing concept for the main cities around the world, that aim at allowing people to commute as efficiently as possible. Also, by providing urban residents with efficient modes of public transportation, sustainable travel is encouraged and negative environmental impacts are reduced (Wood, 2018).

Agile cities also make use of technology available in many other ways, one of which is to avoid commuting all together for some residents by allowing for remote work alternatives. As noted by Gino *et al.* (2017) "one way to reduce your commute without switching jobs or moving is to occasionally work from home or at a place closer to home such as the shared offices provided by companies like WeWork. Telecommuting is becoming increasingly common"

When looking at Dublin's case, an alternative, modern, mobility option introduced in 2008 is GoCar, which offers a car-sharing service. As was reported by Hamilton (2018) its success in recent years has generated the announcement of further investment into this company and states that a national survey showed that two thirds of respondents believe the number of cars on the streets should be reduced, but at the same time found that more than half of respondents are not satisfied with public transport options available.

Through the effective use of data, models can be run with ideas for system improvement, prior to adopting them and in this way, it is possible to analyse potential effects and outcomes without the

consequences and cost involved in implementation, so that weaknesses in the proposals can be identified and improved. An example of this is a study carried out in South- East Queensland, Australia, in which the data collected via the smartcards used for public transport (equivalent of the local LEAP card) was used to model two scenarios proposed with the intention of improving network effectiveness, one scenario provided fare discounts to trips that needed transfers and the second scenario was to increase the number of stops on buses that feed train stations, both of which proved to be effective in improving the public transport network (Yen *et al.*, 2016, p. 4035). In this way, the effects, positive, negative or neutral of proposed changes in the existing systems can be assessed without suffering the financial and social impacts and it is possible to make a better decision regarding their functionality and efficiency based on a "virtual" trial run.

Regarding the promotion of sustainable travel, Zhan (2016, p. 34) proposes that additionally from investment into modern, efficient public transportation, a system that combines public transport options with other sustainable modes of transport such as bike-sharing providers or car-sharing providers could make the whole system more attractive, by providing opportunities for closing the gap in cases where the closest public transportation stop is considered inconvenient either at departure or arrival location, and thus allowing a door-to-door service that competes with the private car alternative. Zhan further suggests that "the smart phone could be the future platform bringing together real-time trip planning with an integrated ticket booking and payment system to make multimodal trips hassle-free and attractive".

2.6 Other cities

Metro Manila, the capital region in the Philippines, has been identified as having a similar situation as Dublin with urban sprawl type of growth and increased housing and prices in those areas that are closer to where the main employment areas have settled. This has led to the commuting distances increasing for numerous residents. However, differently to Dublin's case, many of those dispersed Manila commuters make use of the public transportation system as opposed to private vehicles. "The majority of daily commuters in Metro Manila using public transport travel longer distances than they did 20 years ago… Moreover, authors' survey shows and increased demand for transportation" (Andong and Sajor, 2017). In this particular case, however, the increase of demand of public transportation is not related to sustainability measures by the government or even due to a greater effectiveness in the found in this type of transportation service (in terms of security, efficiency or accessibility), but rather due to cost-convenience.

Manila, however, is just one of the various cities that have experienced drastic urban sprawl levels and property price increases that foster longer commutes for low-income earners, Zhang & Gao (2008) identified Beijing as one of such cities also, while Zhao and Li (2016, p. 948) further point out that this is the situation in many of the large cities in China. In such cases, low income earners are faced with

the higher costs for commuting also, due to the increased travel distance. At the same time, Boutot (2015), reported that after major investment in public transportation and the inclusion of alternative mobility solutions, the traditionally association of car-ownership with status is losing strength in China, and public transportation is gaining more popularity.

Differently from the above, Estonia's capital city, Tallim has adopted a policy of free public transportation during the past 5 years for residents, which encourages local residents to spend their money in other local businesses such as cafes or restaurants instead of public transportation and aid those with lower income, while at the same time encouraging a reduction in traffic and air pollution (Gray, 2018). A study carried out in 2016 regarding this measure however, found that it was residents who previously used to walk that generated the main increase in use of buses once the measure was adopted, so that in its majority the initiative has replaced one sustainable way of mobility for another, as opposed to reducing car-usage (Gray, 2018). Despite this, due to the increased popularity of public transportation, Estonia is planning on rolling out the same initiative to the rest of the country and has inspired other countries to consider similar measures. In Paris, the mayor announced that a study would be carried out on the feasibility of such a measure to be implemented in the city (De Clercq, 2018). Similarly, Germany will be trialing free-public-transportation in five cities that they have identified suffering from air quality issues. This free-public-transportation initiative is an attempt to reduce the use of private cars which will lower air pollution, and also assist them in meeting EU regulations on air pollution (Reuters, 2018).

In South East Queensland, Australia, buses are organized in a radial way and many of them run in dedicated bus lanes, which is identified as a Bus Rapid Transit (BRT) system, they adopted an integrated fare system to include all modes of public transport, except for taxis. Through the use of a "Go-card" (similar to the Irish LEAP card), the fare is paid in accordance with the overall number of zones travelled, disregarding the number of transfers done along the way (Yen *et al.*, 2016, p. 4023).

Opposing the described transport system characteristics of South East Queensland, Thompson, (1977, cited in Yen *et al.*, 2016, p. 4032) posed that a radial system is not as effective in providing connectivity as a networked transport system with interchanges. This networked style of public transportation has been adopted successfully in Zurich, Switzerland (Yen *et al.*, 2016, p. 4032). According to Yen *et al.* (2016, p. 4023) another characteristic of the public transportation system in Zurich is that they have adopted four types of transport cards, namely: adult, child, senior and concession, where only the adult-type pays for a full fee and "the latter three types have a 50% fare reduction of the full adult fare"

Winnipeg, in Canada, has been identified by The International Institute for Sustainable Development (IISD) as a fast-growing city that has faced an average yearly population growth of 1.7% since 2013 mainly due to immigration. As such, this city's growth can be considered similar to Dublin's, and so are the views expressed regarding its public transport services, which according to IISD are considered unreliable (Gunn, Stanley and Temmer, 2018). The article also suggests that Winnipeg is lagging

behind with the Real Time Information (RTPI) systems that are used to inform transport users of expected arrival times.

In 2015, a study considering the transferability of urban mobile solutions which are being used in leading cities around the world was commenced. This study identified 58 different urban mobility solutions and categorized them into clusters based on their purpose and effects. From these, it is worth mentioning the following identified solutions related to public transport: BRT systems, Trolley Bus Systems, Public Transport ITS, Integrated fare system, Integrated public-transport network planning, dedicated bus lanes, Intermodal Interchanges, Multimodal Journey Planners, Car-Sharing Schemes, Participation of stakeholders and citizens in planning stages (Lah *et al.*, 2015). Dublin has been working on some of these solutions also, such as Car-Sharing Schemes with the introduction and future expansion of Go-Car (Hamilton, 2018), Multimodal Journey Planners, such as the TFI mobile application, partially dedicated bus lanes throughout the city (shared with cyclists, taxis and in some locations with the LUAS system also), and the participation of stakeholders and citizens for future planning, such as the currently undergoing consultation process for the Bus Connect proposal. Others, however, can still provide options for public transport improvement, such as the integrated fare system, BRT systems or intermodal interchanges.

In Perth, Australia, the public transportation system has been reported to have limited accessibility, resulting in residents without private cars with “fewer accessible urban opportunities” (Ricciardi, Xia and Currie, 2015 cited in Zhao and Li, 2016, p. 948). A report prepared by RMIT University in Australia found that Perth’s policies on creating access to activity centres are not being implemented well and when compared to other Australian capital cities, their policy for public transport is not ambitious enough aiming at: “60% of residences should be within 400 m of a bus stop or 800 m of a train stop” (Hooper *et al.*, 2018), and the measured result was 64%. The same report indicated that dwellings closer to the city centre were found to have a higher level of accessibility to frequent public transport and the level decreased as the distance from the city centre increased. Perth’s public transportation system was described as consisting of radial type rail services meeting at the city centre, fed by and supported by bus services, with a fully integrated system combining buses, trains and ferries and a SmartRider electronic ticketing system that can be used in any of those systems and works through tag-on, tag-off with the ticketing system automatically charging the fare corresponding to the stages travelled (Department of Transport, 2011, p. 14). There is a defined boundary within the city centre in which all public transportation can be used for free, with some bus services (called CAT) particularly designed and allocated to travel within this area for free, additionally to other buses and trains arriving from or traveling to outer zones, that can also be used for free when travelling within this free-transit-area (Transperth, 2018). In 2011 a draft proposal was issued for consultation for the development of additional of Mass Transit Systems (either BRT or light rail) to complement Perth’s public transport network (Department of Transport, 2011, p. 20).

In Bologna, Italy, an initiative to encourage sustainable modes of transportation was introduced in which residents can record journeys completed via public transport, cycling or walking through the use of a mobile application and earn points with each trip (with a limitation of four per day). Services and goods, such as beer or cinema tickets, can then be purchased with the collected points in some participating local businesses. This initiative was named Bella Mossa and was showed to be successful in its initial four-month trial period (Wood, 2018).

An article published by the World Economic Forum compared the popularity between Beijing, London and New York's public transportation systems and fount that Beijing, having higher population density than the other two cities registered the least public transport mode share. In this comparison Fang (2015) further identifies that the number of jobs located within a 20-minute walk boundary of the main metro station in Beijing, Guomao, is significantly less than those found in a similar boundaries around Oxford Circus and Grand Central Station (main metro stations in London and New York respectively), deducing that this lower number of jobs within convenient walking distance leads to the lower public transport mode share, stating that 20 minutes is considered the maximum time a person walks without taking a break.

2.7 Plans for changes in Bus system

In October 2018, the NTA published a report which details fare changes that were later adopted on December 2018. Such amended fares, which stipulated the increase of some fares and decrease on others, are explained as an initial step towards a different fare structure which is proposed to be adopted in the coming years along with the "Bus Connects" initiative. This future initiative brought along with the Bus Connect project would allow only two fare options: "a short distance fare and a 90-minute fare". In this way, the 90 minute fare will allow for use and combination of various public transport options during the 90 mins after payment of the fare, namely: "Dublin bus, Luas, Go Ahead Ireland services, Ianrod Eireann DART services and zones 1-4 on short Hop Zone commuter services" (National Transport Authority, 2018b, p. 4), introducing in this way an integrated fare system for Dublin's public transport systems.

According to Burns (2018), another characteristic of the "Bus Connects" initiative is that it would involve the removal of long-existing routes towards the city centre in Dublin and the new design to be implemented will require some passengers to change their one-bus journey to a multiple-bus journey by adopting seven core routes and thirteen supporting orbital routes. Existing routes in Dublin are radial-like, with buses going through the city centre. In the new system, the orbital routes would connect outer neighbourhoods in a ring-type manner and intersect with the radial-type routes that coincide in the city centre.

Additionally, it is expected that the new system would include a fleet increase that will see a growth in the number of services running post-peak hours and on the weekend. According to a report published by NTA by Jarret Walker & Associates (2018) the increased frequency in the new services will mean that even when a bus change is required, the trip overall should be faster than it currently is with a single bus.

Bus Connects would also see the introduction of 230km of lanes dedicated only to the use of buses and another 200kms of cycle lanes (National Transport Authority, 2018a) and the re-categorization of bus services such that frequent and infrequent services, peak or all-day services are differentiated for users (Jarret Walker & Associates, 2018c, p. 6), this would translate into a different numbering system which will also involve use letters, a different one to identify each of the core corridors (the seven main routes) (Burns, 2018a). Higher frequency of peak-hour services is also proposed.

Part of this proposal also aims to generate better and more frequent access to suburban centres such as Dun Laoghaire or Blanchardstown, which are also developing and growing commercially, with some companies already setting up their offices in these areas instead of the city centre (Jarret Walker & Associates, 2018c, p. 9).

With regards to movements within the city centre itself, an internal orbital route is proposed to be introduced that would facilitate travelling within the edges of the city centre (Jarret Walker & Associates, 2018c, p. 9) and aims at reducing the need of private cars in this already-congested part of the city.

While some of the diagrams with proposed “spine” routes (main radial routes) differentiate a few as BRT (Bus Rapid Transit) lines, there is no explicit proposal of BRT lines to be introduced as part of the Bus Connects project in the reports that were published by the NTA. Previous proposals for the introduction of BRT routes back in 2014-2016 were faced with obstacles from residents at time of consultation and did not progress. Some sources state, however, that the BRT concept has not been fully discarded and will be dependent on Metro proposals that would connect Swords and the airport to the city centre and beyond, however this project is still not fully developed (Ginty, 2017).

As mentioned, the Bus Connects proposal is still in the early development phase, currently undergoing a first round of consultation. The proposal has received various criticisms and observations already, almost 30,000 submissions were issued by September 2018 (Burns, 2018c). The Transport Infrastructure Ireland (TII) has also issued a submission pointing out some of the limitations on existing roads that would not allow for the proposal to be accommodated (Burns, 2018b), and the Dún Laoghaire-Rathdown County Council has expressed concerns regarding the need for interchange of bus routes claiming it increases “inconvenience, insecurity and uncertainty” to many users (Burns, 2018a). A new draft proposal is due to be issued by mid-2019 and another consultation round will be held prior to issuing a final project proposal. Hence, it is expected that there will be changes

implemented onto the current proposal details when the following versions or the proposal are developed.

2.8 Literature Conclusion

The findings collected above indicate real challenges for Dublin's city planning towards a near future due to the continued population growth that is forecasted. The ongoing housing crisis in Ireland and particularly in Dublin are beginning to hinder business opportunities by causing continued increase in the already-high cost of renting as well as by lack of options.

The public transportation system in any city impacts on accessibility for residents and visitors, particularly for those who do not own private vehicles. This system can also contribute towards a city's measure of sustainability, by helping to reduce the use of private cars and subsequently aiding in the limitation of congestion which is commonly experienced in highly populated cities.

The latest developments in technologies allow for collection of data that provides opportunities for many studies to be carried out, such as a virtual trial of proposed network changes, or the identification of the busiest bus routes. Through data, designs for public transport development can be improved and tested prior to implementation. RTPI systems allow for bus users to have access to updated information on bus routes and expected arrival times, so that travelling can become more efficient and convenient.

Bus Connects proposal includes a redesign of Dublin's existing bus system, with increased service frequency and outer neighbourhood connectivity as well as integrated fare systems. This proposal was issued in draft form for public consultation, after which amendments to the proposal are expected to be presented by mid-2019.

3 Research Methodology

The philosophy of primary research and consequent research methodology to be adopted for this study is determined through the assessment of the philosophies and “the research onion” concept identified and detailed by Saunders, Lewis and Thornhill (2009, 2012).

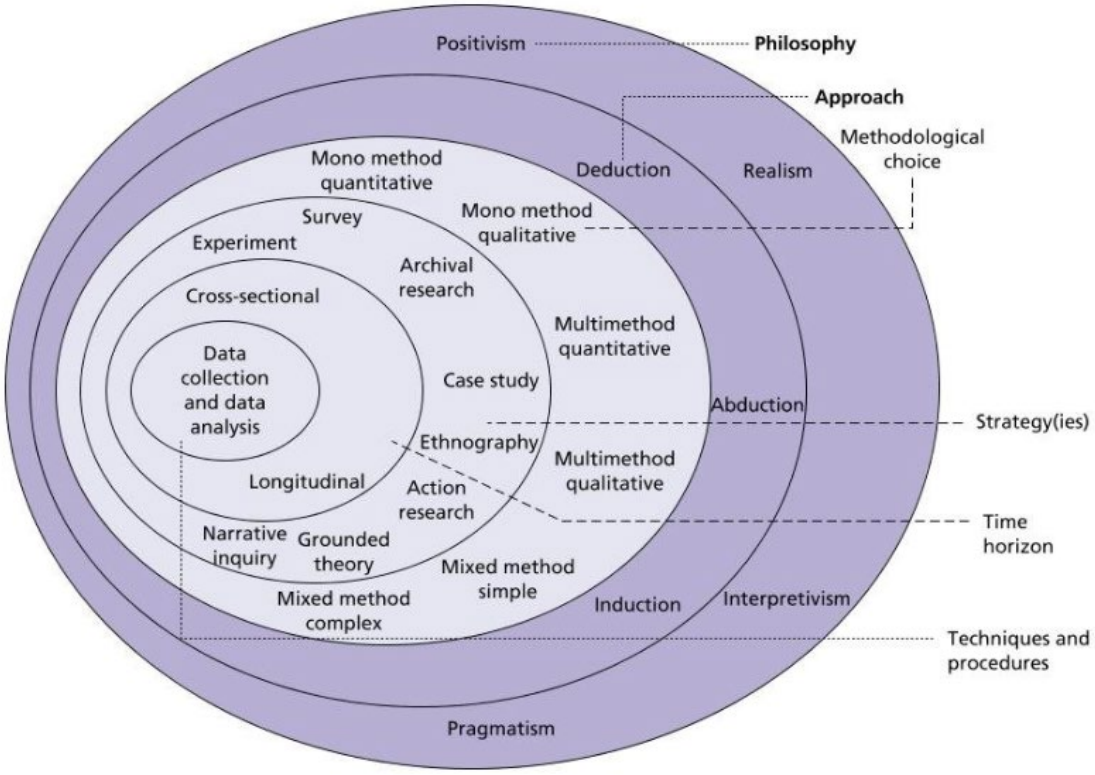


Figure 1: The Research Onion (Saunders, Lewis and Thornhill, 2012, p. 128)

A pragmatic philosophy focuses on looking at contributing in a practical manner to society and aims the research having a purpose and the ability to generate an outcome. In this case, the current issue is identified as the public transportation system in Dublin particularly concentrating on buses, and the way that this research will aim to contribute to society is by identifying issues experienced by current bus users with the existing services and analysing them against the proposals issued for upcoming changes on the bus system. From this, it is considered that pragmatic is the most suitable type of philosophy for this study, with an epistemology that is focused on practical research that integrates different perspectives: the perspective from bus users and their identified needs, and that from planning experts through the study of the latest issued proposal Bus Connects.

By looking at bus system characteristics in other cities, the study will also aim at contributing with ideas for improvement of the bus system. At the same time, the study aims to assist with another identified issue in Dublin, the housing shortage crisis, through the abovementioned assessment of the bus public transportation system and an evaluation of the relevance of adequate access to the bus system when

assessing alternatives for housing. As is an identified characteristic of a pragmatic research philosophy, the researcher understands there is no one-way of undertaking this research and there are multiple realities to be considered, particularly due to the awareness that transportation needs, in frequencies, characteristics or cost, are different for each individual (Saunders, Lewis and Thornhill, 2012, p. 130). For this reason, it is aimed at obtaining participation from a large enough sample so that any findings made from the data are based on the situations that are representative of the majority.

Regarding the assessment of bus public service accessibility and its level of relevance when considering options of locations to live, it is acknowledged that an individual's choice of accommodation is influenced by various factors, public transport being just one of them. It is recognised that those factors have different priorities for each person -thus factors that influence decisions on housing are subjective and cannot be standardised to be true for the whole population.

This study's approach is proposed to be performed in an inductive manner, without any initial hypotheses formulated that would need to be tested through the primary research. Instead the primary research carried out will provide an understanding of the experiences of bus users with the existing public bus system and through that, an identification of the main and most popular issues encountered by bus-users can be carried out. These results will be the basis for the development of theories through the analysis of "patterns, consistencies and meanings" (Gray, 2013, p. 18) that will be later be brought up for comparison against the latest proposal for future changes in the bus system.

The inductive approach allows for a more flexible methodology for the development of theories, restricted mainly in this case, by the research design structure. Opposite to the manner in which data is typically collected for an inductive-type research, a more structured quantitative primary research methodology is proposed, to provide higher reliability in the results by allowing for multiple cases to be considered.

The operating characteristics of bus public transportation are viewed in this study through an objectivism position, that is built and designed in such a way as to address the residents needs as far as practicable and possible but once in operation it follows its defined timetables, routes and rules independently to each individual's needs in a structured manner, and its function remains unchanged, despite any changes that might be adopted along the way for improvement or other reasons.

From the above identified ontology, and the differentiation on the paradigms provided by Saunders, Lewis and Thornhill (2012, p. 141), it is identified that the corresponding paradigm applicable to this study is functionalist. This was determined by an assessment of the "Four paradigms for the analysis of social theory" matrix shown in the figure below which was developed by Burren and Morgan (1982) referred to by Saunders, Lewis and Thornhill, and the acknowledgement that from the second dimension, regulation is better suited to this study, that aims at finding issues experienced by bus

travellers and thus understanding the weaknesses of the existing bus system. In this way, the main problems on the bus public system can be exposed and understood and recommendations of the new structure proposed through Bus Connects can be developed.

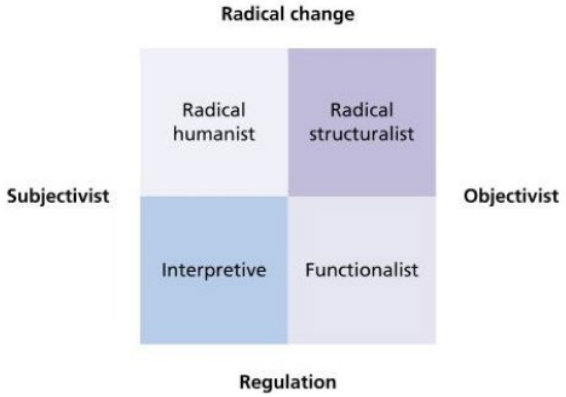


Figure 2: Four paradigms for the analysis of social theory (Saunders, Lewis and Thornhill, 2012, p. 141)

The quantitative methodology with the use of large samples is a characteristic that is generally attached to a positivist paradigm (Gray, 2013, p. 25), however in this case, the prior formulation of hypotheses, (usually associated with such a paradigm) will not be adopted, as mentioned previously, instead formulating analysis, theories an observations after the data is collected, which is typically a characteristic of a phenomenological research that uses inductive methodology instead, according to Gray (2013), however being a pragmatic philosophy, this mixed methodology is still considered to be suited.

3.1 Research Strategy

The research strategy identified most suitable for this study was the development of a survey with a questionnaire that provides results for descriptive statistical analysis. This method of primary research will aim at collecting information from an adequately sized sample that would be considered representative of those Dublin's residents who make use of bus public transportation. From such a survey, findings can be generated with a reasonable degree of control due to the adoption of a questionnaire that provides respondents with mostly limited response options as opposed to open ended questions. The data collected however, is not aimed at proving hypotheses, as mentioned earlier, but rather at producing a more qualitative-like analysis, to identify the main and most relevant issues faced by those that consider bus transportation an influencer at the time of looking for accommodation.

Following the above, the primary research methodology for this study is proposed as quantitative. The collection of data from commuters to find out the main current issues experienced when using the existing bus system in Dublin as well as the relevance of bus accessibility for housing location selection will require the collection of information from various participants to increase the validity of the data for analysis, as previously mentioned. This part of the research will thus be performed through the use of

a questionnaire survey distributed online through social media (Facebook) in order to obtain sufficient responses to consider the information reliable and representative of the usual commuters into and out of Dublin city centre.

The future expected developments for the bus system (whether already underway, approved but not yet commenced, or with strong support for a near future development) keeping the focus on bus-related proposals only, have been researched as part of the secondary research of this study, and included into the literature review section. In this case, the main and latest relevant proposal found is named Bus Connects and has been identified as having recently completed a first round of public consultation phase. This information is mainly obtained from the National Transport Authority websites, with some details found or reiterated within published news in local online newspapers.

3.2 Population and Sampling

For the quantitative research, the sampling frame is identified as follows: Adults in the city of Dublin who are working in/studying in/traveling frequently to their main activity. Only adults above 18 years of age are to be included as the research participants, residents below this age are not considered relevant for this study since they generally do not have a choice of where to live, might not yet be independent. Population above the age of 65 will also be excluded from this study, the reason being that after retirement, residents' lifestyles may not generally require transportation use as frequently or in the same manner, it is also acknowledged that elderly people can often have different accessibility needs which are not included as part of this study. According to the 2016 census, the population in Dublin city between the ages of 18 to 65 (inclusive) was of 387,832 (Central Statistics Office, 2016), which is identified as the sample frame for this study.

For determination of the sample size, a 95% confidence level of certainty will be aimed at, with a 5% of margin error. Following this, with the aid of a table from Saunders, Lewis and Thornhill (2009) which can be found in Appendix B, a sample size of 383 has been identified as suitable for this study.

A simple random sampling technique will be used as a method for selecting those participating in the survey, with the intention of eliminating any bias. This has been determined through an analysis carried out for the selection of the most appropriate sampling technique as per Saunders, Lewis and Thornhill (2009) which can be found in Appendix A. An online distribution of the survey will remove any human bias that can occur with targeting specific participants face to face, by phone, or via email, for example.

3.3 Data Collection and Data Analysis

The quantitative research, to be carried out through an online survey, will be distributed through the use of Facebook social media to anonymous Dublin residents. Although it is recognised that the city centre

of Dublin is where a large percentage of activities occur daily, it is the area with the largest congregation of offices, restaurants, theatres, bars and pubs, retails and schools, the research will not request respondents to provide information on the origin and destination of their journeys. A filter question will be set up to ensure that only bus-users respond to the questionnaire. An online method of distribution was selected for the survey with the intention of obtaining a greater response rate, considering that people can access it at a time that is convenient for them to do so, in a non-intrusive manner. Facebook was chosen as the distribution platform because it was reported as the most popular social media used in Ireland (Twomey, 2018) and its users have a wider age range than most other social media (Weckler, 2018).

It is acknowledged, however, that the chosen method of distribution for the survey generates a certain bias towards the type of respondent that will be provided with the opportunity to answer the questionnaire. Only Dublin residents with access to internet and a Facebook account that additionally is part of one of the several targeted Facebook groups will be reached.

In order for this type of primary research to be achieved, the researcher will need to make use of a software for survey design. There are many options available online from different firms that allow this type of work to be achieved. After due exploration of the alternatives available, Google Forms was selected suitable for this study's purpose. On the one hand because it allows for unlimited answers to be provided, which is a desirable characteristic due to the large sample that is aimed at, on the other because the results can be downloaded onto a spreadsheet which can later be edited to be able to carry out the appropriate analysis, also it is free of charge and user friendly. The online nature of the survey will also assist respondents to be frank and honest with their responses due to the anonymity that is attached to this method. Also, the online distribution allows for men and women of varied ages to have access to it without any biases.

After the collection of data is complete, a descriptive analysis will be carried out with the assistance of SPSS software. SPSS is a statistical analysis tool widely used, and was selected due to its popularity in the literature regarding data analysis for quantitative data, and the availability of information concerning its use, including tutorials or instructions such as in Hair *et al.* (2016). Additionally, data from a spreadsheet can be easily imported into this software (after proper editing) and finally, it is a software available for use to DBS students.

3.4 Ethical Issues

The use of public transportation, and busses in particular in this case, is a frequent activity for the researcher, and as such, there are personal experiences and opinions formed regarding the characteristics of these services. Keeping this in consideration, and for the purpose of this research, the adoption of a questionnaire type of survey distributed in an online manner is considered better suited

for the primary research, where the bus system limitations or obstacles are to be identified through participants' responses. This type of structured survey, developed appropriately, will allow respondents to be independent and unaffected by the researcher's views and opinions.

Additionally, assistance from an third party (a member of the DBS library staff is suggested) will be requested after the questionnaire is prepared, to review the questions and responses available and provide a fresh, impartial view of the questionnaire and advice on the clarity of the questions and responses as well as of any biased that may be present, so that adjustments can be done prior to issuing the questionnaire.

The online nature of the survey will allow for anonymity of respondents to be maintained. The only personal question expected is the identification of an age gap, which is mainly used to filter out respondents outside from the stipulated age range for this research of 18-65 years old, but that may later be adopted for other analysis also. Gender, ethnicity, salary or other personal questions are not relevant to this research and thus will not be requested.

The purpose of the survey will be clearly stated, as well as the intended use of the data collected for participants to know prior to completing the questionnaire. Their consent to use the data for the study will also be requested, should the participant not agree, the questionnaire would not be released. In this manner, data without consent of use for the study will be avoided.

4 Data Analysis and Findings

The survey carried out on the use of buses in Dublin generated a total of 314 responses, with anonymous respondents who accessed the survey through a link published in various Dublin Facebook groups, ranging from groups for accommodation search, to neighbourhood notice boards, buy and sell groups and even an expats group. The variety of the groups selected was aimed at reaching as wide a variety of Dublin residents as possible.

The sample size aimed at was 383 respondents, as previously mentioned, however due to time constraints on the dissertation period, the survey was closed after 4 weeks of being published with 314 responses (82% of sample size), to allow time for analysis, discussion and any further editing required.

The questions in the survey aimed at understanding the experience of bus users with the current bus system, as well as to find out the perceived changes required that would improve the users' experience from their own point of view. A sample of the questionnaire published can be found in Appendix D.

In Question 3, that asked how often the respondent makes use of bus services, one of the participants chose the option "Never", which had the instruction to stop filling in the questionnaire, however since this participant chose to continue and answered all other questions in a manner that made sense for a bus user, it will be assumed that this was an error in selection at that particular question and the next (and nearest option in the questionnaire) will be assumed to be the correct one, which is "Rarely: up to 10 one-way trips per month".

Question 12 asking about the mobile applications used for information regarding routes and times of buses had the following corrections made to the data previous to its analysis: one respondent selected "Irish Rail" in the "Other" option, this was removed from the data because it is not used for buses, only for rail information, thus it is unrelated to the study. Another participant wrote "Next stop" in the "other" option which was interpreted as referring to "Next Bus" since the one stated in the response was not found to be in existence. While "hittheroad.ie" and "Dublin bus website" are webpages and not applications, they were kept in the responses provided.

The questionnaire prepared for this survey consisted mostly of multiple choices with nominal scale type answers. For this nature of responses, in a statistical test, it is considered that the appropriate measure of tendency is Mode and there is no Measure of dispersion (Hair *et al.*, 2016, p. 348). A large sample size, however, can allow a Likert scale type answer to be considered as an Interval scale type in certain cases, for which a standard deviation and a mean can be calculated. This assumption will be adopted for Questions 13 and 15 later on. This study does not attempt to test any hypotheses, as previously discussed, and the data analysis will be carried out through the use of descriptive statistics.

From those who participated in the survey, 49.7% of have reported to use the bus frequently in question 3, another 22.6% use the bus sometimes and 27.4% claimed to use buses only rarely.

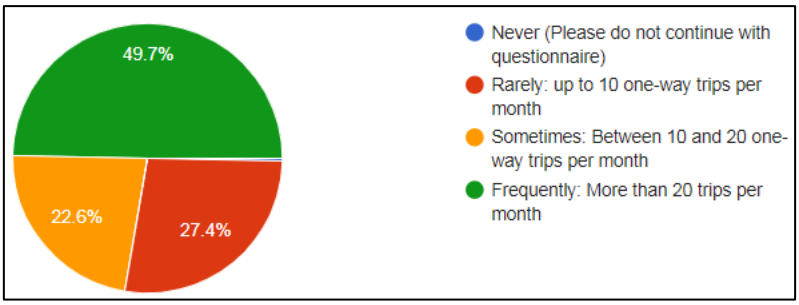


Figure 3: Frequency of bus use by respondents

Regarding the distance from their home to the nearest bus stop, the vast majority, 65.9% claimed to have a very short walk of mess than 5 minutes' walk in question 4, another 26.1% said their closest stop is between 5 to 10 mins walk, 5.1% have to walk up to 15mins to the nearest stop and only 2.9% walk for longer than 15mins to be able to access a bus.

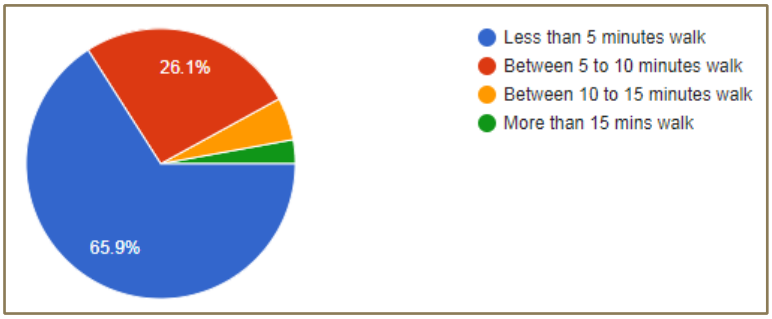


Figure 4: Distance from home to closest bus stop

As can be observed in the bar chart below (Figure 5), when asked about fare saver options in Question 14, while one of the survey participants chose not to respond this question, it is significant to note that from the rest, the majority of the participants (80.2%) use a leap card, and many of the respondents who identified "study" as one of the main motives for using the bus make use of the student discounts available, however a very small percentage of the sampled participants (7%) use other discounted offers available for bus use, namely: rambler, monthly and annual tickets. Seeing that almost half of the participants (49.7%) claimed to use buses frequently, the relevance of this finding is that either users are not fully aware of the benefits of these saving alternatives or, the savings offered are not significant enough with the "ticketing packages" offered for bus users.

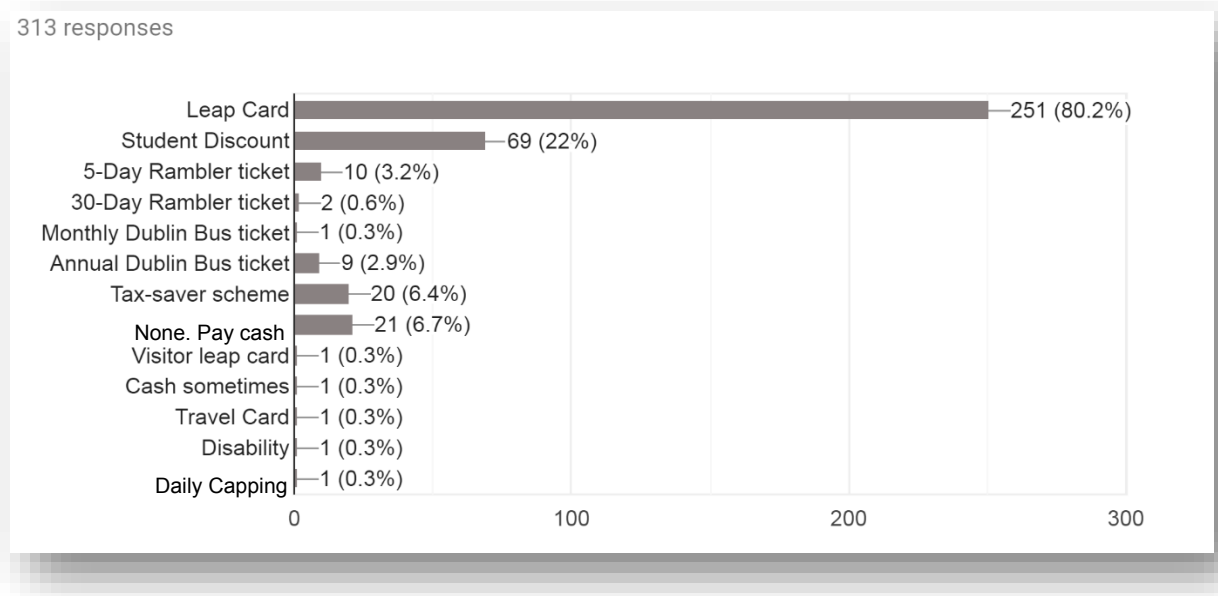
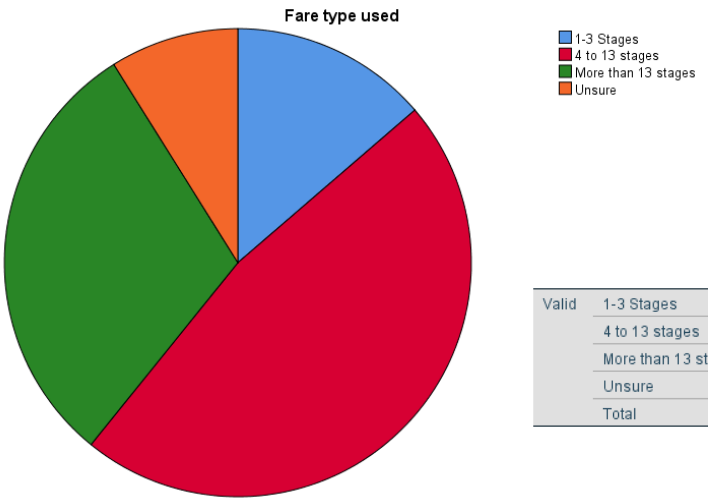


Figure 5: Question 14 Responses- Fare Saver Options

Another observation made related to fares is that when answering Question 9, which enquired about the type of fare paid when commuting, the majority of the participants (148 participants, equivalent to 47.1% of the sample size) stated to purchase fares for use between 4 and 13 stages, while another 30.3% travels distances greater than 3 stages, as can be observed in the Pie Chart and table below. It is likely that the "unsure" group is paying the full fare by just presenting their leap card to the reader, thus paying for more than 13 stages, however, this cannot be confirmed. This "unsure" group comprises the smallest group with only 8.9% of the sample population, however, it is still sizable considering they are unaware of the delineation of the stages in the city and could thus be paying for more than they need to.



Fare type used

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-3 Stages	43	13.7	13.7	13.7
	4 to 13 stages	148	47.1	47.1	60.8
	More than 13 stages	95	30.3	30.3	91.1
	Unsure	28	8.9	8.9	100.0
	Total	314	100.0	100.0	

Figure 6: Type of fare used most by respondents

The majority of respondents (32.1%) said to spend up to €30 monthly on bus services, 28.8% stated they spend between €65 and €100, 18.9% spend between €30 and €65 and 13.8% claimed to spend between €100 and €140, only 1.9% claimed to be spending above €140, while 4.5% of the participants chose not to disclose their monthly expenditures, with 2 participants not answering the question.

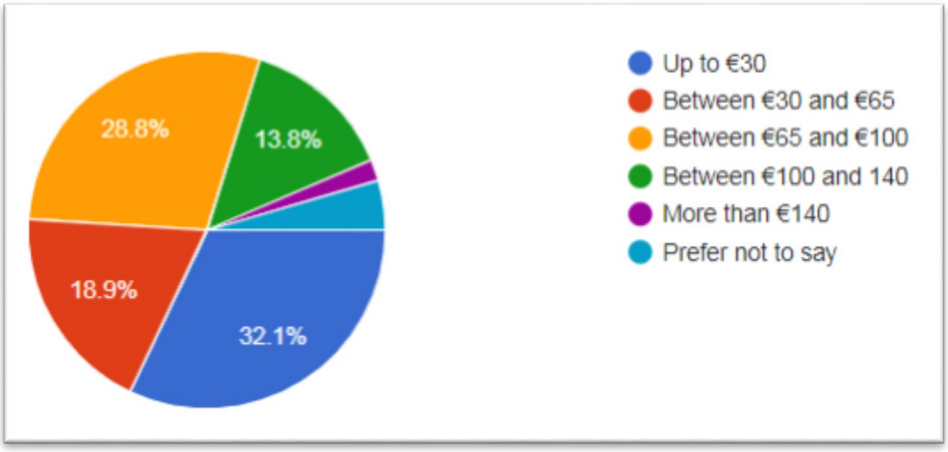


Figure 7: Rough amount spent on bus monthly

The percentage of respondents who said that they combine bus services with other means of public transport, tram or rail (LUAS or DART) was 22.9%, and another 31.2% claimed to do so sometimes, while the 45.9% remaining answered that they don't currently combine the bus with LUAS or DART.

When asked about the use of buses during the weekend in question 6, 63.4% of the respondents claimed to do so. And with regards to the use of buses during the night time, asked in question 7, only 22.3% replied positively, while the remaining 77.7% stated they do not travel during with buses during the night time (outside the bus normal working hours).

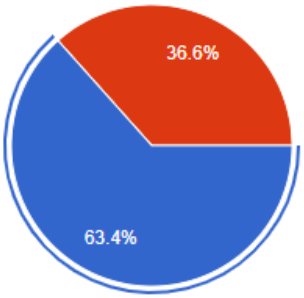


Figure 9: Use of buses on weekends

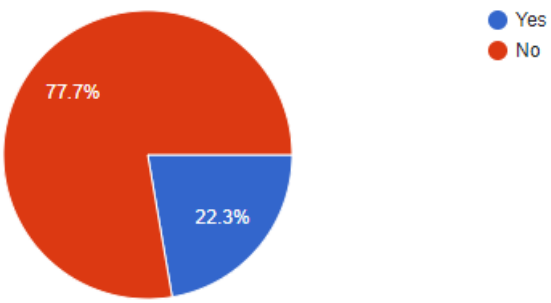
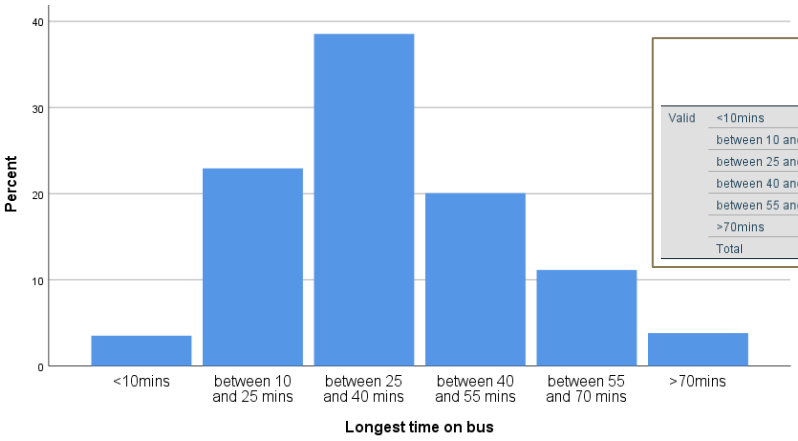


Figure 8: Use of buses during night time

The answers to question 10, asking about the length of one-way bus trip from home to main activity (or vice-versa), provided varied responses, as can be observed in the graph below, with the largest percentage of respondents travelling between 25 to 40 mins. Commuters investing a time between 10

and 25 mins where the second most popular with a response of 22.9%, closely followed by those commuting between 40 and 55mins, that were a total of 20.1%.

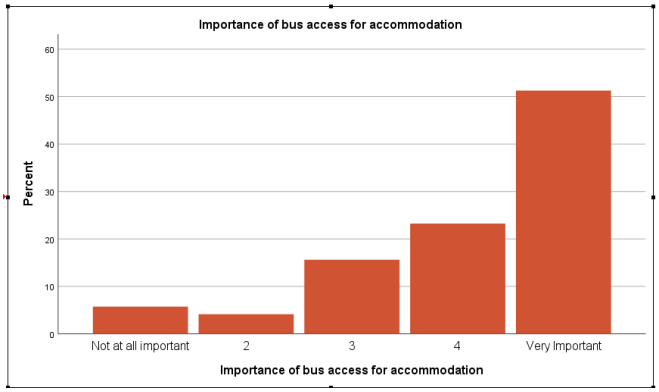


Longest time on bus

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<10mins	11	3.5	3.5	3.5
	between 10 and 25 mins	72	22.9	22.9	26.4
	between 25 and 40 mins	121	38.5	38.5	65.0
	between 40 and 55 mins	63	20.1	20.1	85.0
	between 55 and 70 mins	35	11.1	11.1	96.2
	>70mins	12	3.8	3.8	100.0
	Total	314	100.0	100.0	

Figure 10: Longest commuting time on bus

One of the most relevant questions asked in the survey for this study, was Question number 11, which requested the participants to rate from 1 to 5 the importance of bus accessibility when looking for a place to live. In this question, a response of 1 indicated “not important at all” and a score of 5 indicated “Very important”. As can be observed in the bar chart and table below, 51.3% of respondents gave a score of 5, and another 23.2% a score of 4, which would indicate that for this number of people, bus accessibility is still important. Thus, between those two groups, an average of 74.5% of respondents consider bus accessibility necessary for their commuting needs.



Importance of bus access for accommodation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all important	18	5.7	5.7	5.7
	2	13	4.1	4.1	9.9
	3	49	15.6	15.6	25.5
	4	73	23.2	23.2	48.7
	Very Important	161	51.3	51.3	100.0
	Total	314	100.0	100.0	

Figure 11: Level of importance of bus access when considering accommodation location

When asked about the level of satisfaction with the bus service in question 15, participants were requested to rate their level of satisfaction between 1 and 5, with 1 being equivalent to “Poor” and 5 of “Excellent”. The results obtained can be seen in the table and histogram below, which also interposes its equivalent mean distribution. Even though the questionnaire posed this question in a nominal manner, due to the large sample, it is assumed that a normal distribution analysis can be considered adequate. Looking at the response that was selected the most by participants, it can be seen this would be a level of 4 with a number of 101 responses (32.2 % in a sample of 313, due to one missing answer),

this is equivalent to a Good level of satisfaction. However, when looking at the mean value obtained, 3.08 indicates a nearly neutral average response, in which respondents are neither happy with nor unhappy with the bus service in Dublin.

Level of satisfaction with buses

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Poor	31	9.9	9.9	9.9
	2	63	20.1	20.1	30.0
	3	94	29.9	30.0	60.1
	4	101	32.2	32.3	92.3
	Excellent	24	7.6	7.7	100.0
	Total	313	99.7	100.0	
Missing	System	1	.3		
Total		314	100.0		

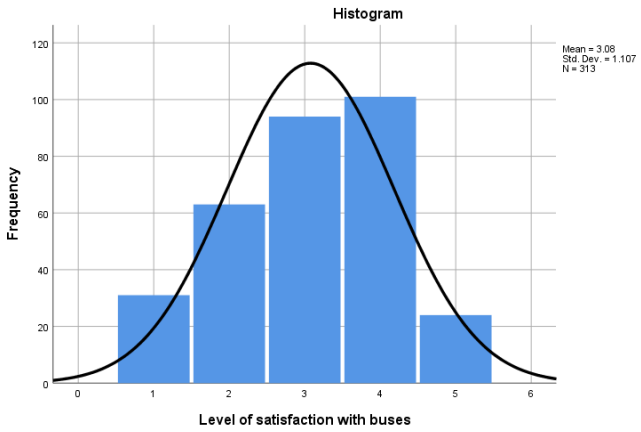


Figure 12: Histogram with level of satisfaction with existing bus services

Question 17 asked participants what changes would improve their experience with the existing bus system, if anything at all. As can be found in the bar chart below, it can be clearly observed that the most popular choices by the respondents included the extended service times (both on weekends and weekdays), as well as more frequent bus services on weekdays (this was the most popular response with 44.6% of respondents' votes), though weekends was also a common choice as well as integrated payment system for tickets to be valid on LUAS, DART and buses on the same trip. Slightly less popular but still prevalent were the options of ring-type routes avoiding the city centre and connecting outer neighbourhoods and finally, just above 26% of respondents also expressed that more express routes would be beneficial for them.

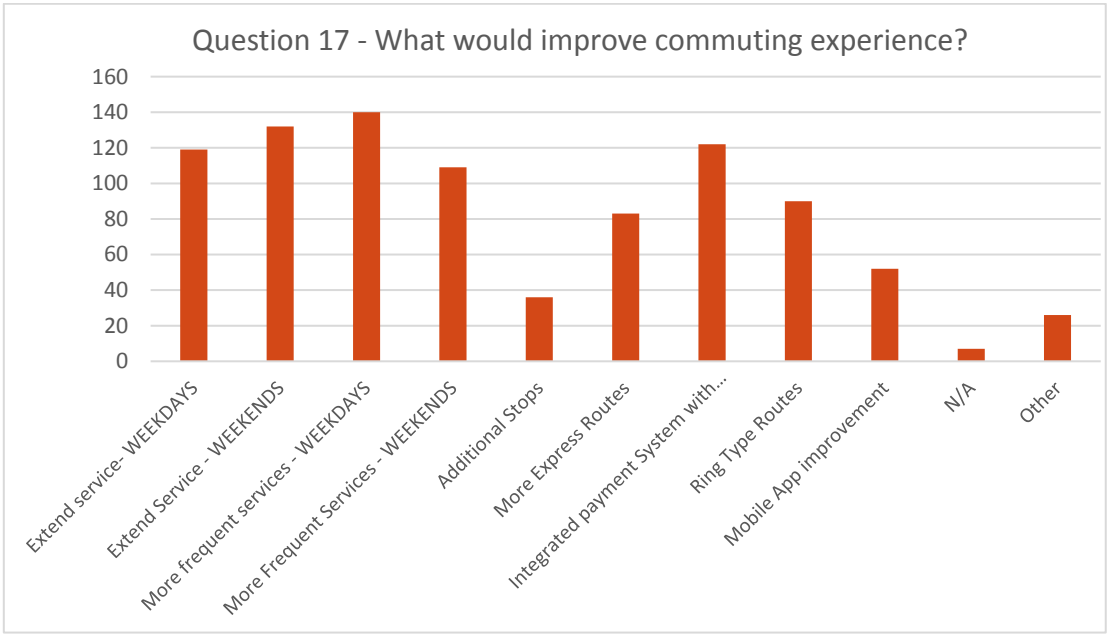
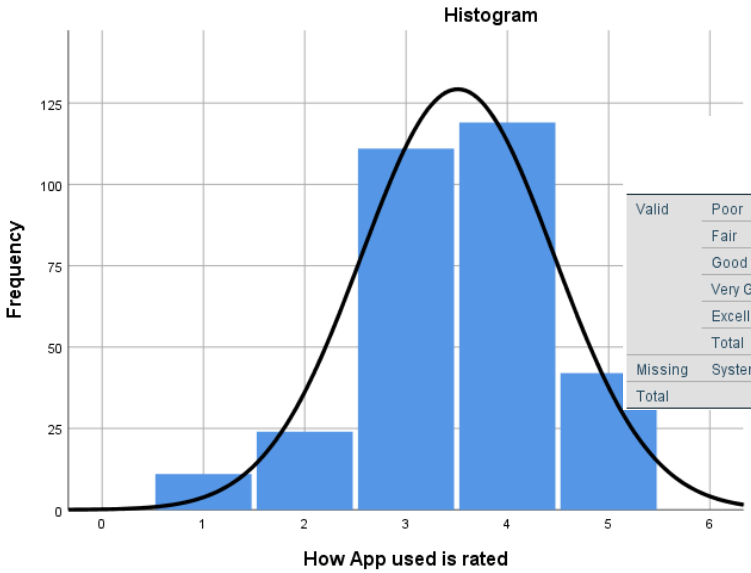


Figure 13: Bus Service Improvement Options

Participants were also asked to identify any mobile application used for obtaining bus times and route information in question 12, in which the most popular response was the Dublin Bus Application with a result of 77.4% of participants, the second most popular application used by respondents was Google Maps with 56.7% of users within the sample. TFI Journey Planner was third with 12.1% of respondents' votes. Other applications where mentioned in the "other" response option, from which the most popular was Moovit with 8 responses. The next question, number 13, asked participants to rate the applications used from a scale of 1 to 5, where 1 was equivalent to "poor" and 5 was "excellent". 119 respondents gave a score of 4, and 111 rated the applications used as "good" (equivalent to a score of 3). The Mean score for question 13 was calculated with the software SPSS as 3.51, as can be observed below.



How App used is rated

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Poor	11	3.5	3.6	3.6
	Fair	24	7.6	7.8	11.4
	Good	111	35.4	36.2	47.6
	Very Good	119	37.9	38.8	86.3
	Excellent	42	13.4	13.7	100.0
	Total	307	97.8	100.0	
Missing	System	7	2.2		
Total		314	100.0		

Figure 14: Rating of Bus Mobile Applications

5 Discussion

The levels of satisfaction with the bus public service as seen in the previous section, obtained a mean almost neutral score, from which the conclusion is that bus users are neither happy nor unhappy with the bus service. This can be seen as positive in the sense that many aspects of the existing bus service are considered adequate for their users, however clearly, as is usually the case with public transportation, particularly in growing cities, there is room for improvement, and a significant number of participating bus users have concerns, suggestions or even complaints regarding the existing service. It is understood that perceptions regarding public transportation are very varied among users, since personal needs and experiences are all different, thus it is expected that when asked about suggestions for improvement, it is highly unlikely that all responses will state “None”, not in Dublin, or in any other city. However, when a significant percentage of the participants coincide on the suggested improvements, then this indicates issues that are affecting a noteworthy portion of the population and is impacting on the quality of service provided, which can in turn be discouraging many potential users from switching to public transport use.

As stated by van Oort *et al.* (2015) “The key factors to enhanced and more cost-efficient public transport are travel time and service reliability”. When considering these two factors, it seems the Bus Connects proposal is aiming at improving both according to the information provided by Dublin Bus, particularly focusing on greater frequency of service. Furthermore, it was stated that “passengers consider service reliability twice as important as frequency” (Balcombe et al. (2004) cited in van Oort *et al.*, 2015), and this has been observed to be true by those participating in this study’s survey, particularly in the last two questions, number 17 and 18 in which respondents were asked to state how the bus service and their mobile applications could be improved to meet their needs better. Those who added their own comments onto the suggested improvements either on question 17 or in question 18 (which was provided to expand on suggestion related to mobile applications) mostly agreed that reliability and accuracy on the information provided was needed.

5.1 Bus Accessibility and Housing Decisions

When asked about the relevance of having bus service accessibility at the time of looking for a new home, as was observed in the previous section, 25.5% of participants did not consider this relevant or were neutral about its level of relevance, this number of people could be understood to have alternative means of travel available from their home, whether it is that they own a vehicle, cycle, walk or have aimed at having access to the train or LUAS lines instead of bus routes. However, for the vast majority (74.5%), this is potentially a deciding factor when faced with the alternatives available for their home location. Since this survey was intended towards bus users alone as opposed to the general public, this is not a surprising finding, it is rather logical instead. What is slightly surprising is that while 74.5% mentioned bus access was important, only 49.7% of the sample claims to use the bus frequently, this

means that some respondents who use the bus service “sometimes” or perhaps even “rarely” (and are thus most likely commuting by other means more frequently), still consider bus access relevant when looking for accommodation, even if it is for sporadic or infrequent use.

The above is a relevant finding for this study, indicating that not only residents who are dependent on public transportation for their daily commuting will find themselves restricted or limited by the availability of public transport when looking for a place to live. Therefore, homes that have inadequate, limited or lack access to public transport would be discarded not only by those relying on bus use to commute on a regular basis, but also by residents who have other alternative (and preferred) mode of transport. This leads to the supposition that there could potentially be some wasted accommodation opportunities in a city where housing is going through a shortage crisis and where the population is forecasted to continue growing in size in the coming years.

A positive finding regarding accessibility was provided in the responses related to the walking time required to reach a bus stop from their home location. The results showed that only 2.9% of the respondents need to walk for longer than 15mins. According to (Fang, 2015), adequate accessibility includes walks of no more than 20 minutes, and following this parameter, the vast majority of residents in Dublin would currently have an acceptable level of accessibility to bus stops from their homes.

5.2 Bus Users’ needs and Bus Connects Proposal

Another interesting finding is that a significant number of respondents selected “Extend bus service time” (both weekends and weekdays) in Question 17 that asked what would improve their bus experience (119 and 132 respondents for Weekdays and Weekends respectively as can be seen in the previous section). Yet the majority claimed not to be using bus services during the night time. This could be interpreted that many of these participants would use public transport at night, if it was available in a similar manner as during the daytime with similar fares and higher frequency than the currently existing Night buses. A few of the respondents even added this as a comment in the “Other” option of this question. The existing “Nitelink” buses cost €4.50 with a leap card (€6.60 if paying cash) per trip regardless of the distance travelled, they run Fridays and Saturdays only and with a frequency of 1hr or 2hrs depending on the route. Such services are most likely considered infrequent and costly and thus inadequate for these respondents who claim not to commute by bus outside the normal working hours of existing bus services but yet state they would want extended bus service hours.

The findings of Question 17 in general provide a perspective of what bus users perceive would be beneficial changes in the existing bus services and allow for an evaluation of the Bus Connects proposal from a bus user perspective.

As stated previously, the extension of the normal operating hours both on the weekend and during the week, where two of the most popular responses. It is not surprising that the option for the weekends is even more popular, since this is usually the time used for leisure and social activities for individuals, and the city centre provides many options for dining and particularly for drinking, which leads to the need for use of public transportation or taxis afterwards. For individuals working in such places, their shifts would end past the midnight curfew for the existing bus services, and thus these individuals would be left with few options for returning back home. Regarding this point, Bus Connects proposal makes no mention regarding extending operating hours for the daily bus services on weekdays or weekends, nor does it mention any expected changes on the existing Nitelink services. All of the details on the new proposed bus system characteristics are related to day services, on or off-peak traffic hours.

The most voted change requested by the survey participants, as shown before, was “more frequent bus services” on weekdays. On this point, Bus Connects proposal states that more frequent services are expected both on the core corridors and in the orbital routes, particularly during peak-hour times (Jarret Walker & Associates, 2018c). Similarly, they propose there would be more frequent services on weekends too, which was another popular response in to the questionnaire.

Regarding an integrated payment system that combines train, tram and bus services, which was the third most voted initiative by respondents in question 17, Bus Connects plans to add this style of combined ticketing system as was previously noted, though the introduction of the 90min ticket, which allows public transport users to commute via bus, LUAS or DART and combine any of the systems for the duration of 90 mins after purchase.

As per previous research, the Bus Connects initiative will be modifying the existing bus routes by removing some of the existing radial routes and adding 13 supporting orbital routes, these latter ones would join outer neighbourhoods in a ring-type manner without going to or through the city centre. This proposal responds to the participants needs of introducing Ring-type routes identified in question 17 as the sixth most voted proposal, after frequency of services, extended service times and integrated fare system, as was previously observed.

Finally, among the popular proposed solutions in question 17, with more than 80 participants’ votes, was the request for more express routes. The current bus system offers 15 “Xpresso” routes operating from Monday to Friday (excluding public holidays) on peak-hour morning and afternoon times as can be found in the Dublin Bus webpage (Dublin Bus, no date). The Bus Connects proposal also includes 15 express routes to complement the normal bus system during peak hour times in a similar manner (Jarret Walker & Associates, 2018a, pp. 142–145). From this, it can be understood that bus users will not see an increase on the express route options with the Bus Connects project as is currently proposed. Having said this, the core radial lines, or “spines” are proposed to have very frequent services, with 3 very high frequency of service, that is proposed to be less than 5min or better. Furthermore, some of

the drawings included into the proposal, identify some of these spines as BRT network (as can be observed in the diagram below) and the NTA website that summarises the details of Bus Connects mentions the use of BRT system in three of the core radial routes (National Transport Authority, 2018c). BRT is a system that is characterised as having fewer stops and priority within the traffic network that allows the overall trips to be quicker. The reports issued by NTA regarding the Bus Connects proposal, though, do not mention these BRT lines explicitly as such in the rest of the documentation, and some sources state that the BRT network is still being analysed and it will be dependent on the proposed metro line development.

Figure 30: Medium-Term - Core Radial Bus Corridors

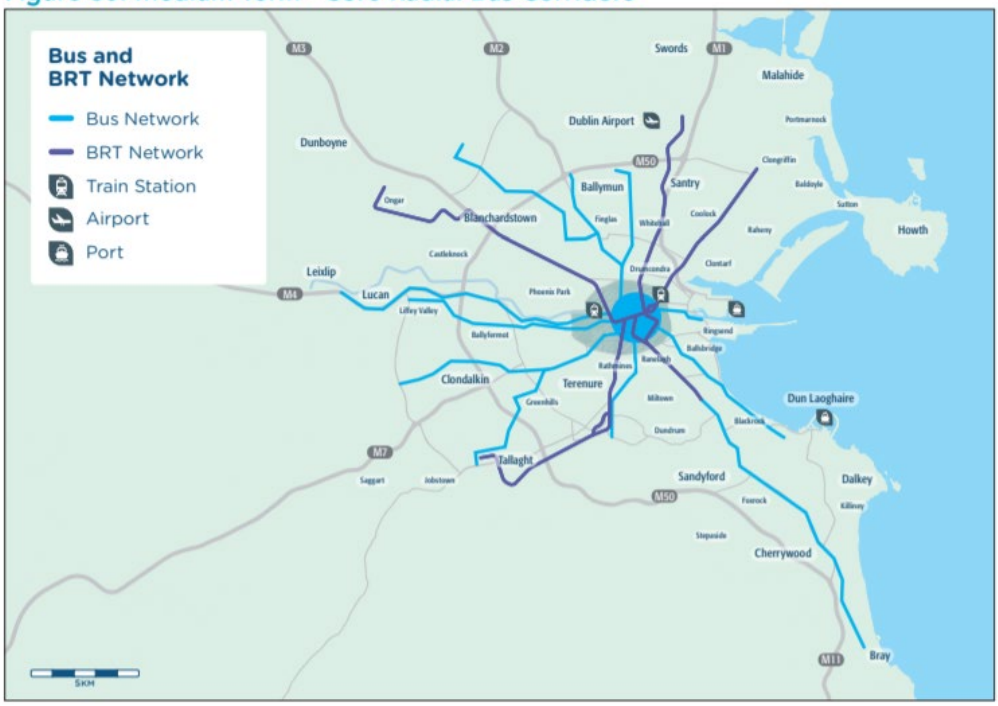


Figure 15: Bus Connects proposed Core Radial routes. (Jarret Walker & Associates, 2018b, p. 25)

5.3 Mobile Applications for Buses in Dublin

As per the results reported previously, Dublin Bus app was shown to be the most popular from the various applications available, followed by Google Maps which is an internationally used tool, and has not been developed specifically for Dublin public transportation.

TFI Journey Planner only received a 12.1% of popularity, despite containing more information than Dublin Bus, by providing alternatives with other means of transportation such as train and tram as well as combination options and even taxi estimated travelling times, additionally, it provides estimated fares for public transport. However, when asked about suggested improvements for the applications used in

question 18, TFI was reported to have issues regarding location accuracy and bus arrival times, as well as missing some existing routes options.

Still, Dublin Bus Application was voted the most popular mobile application from the options available, and the mean score obtained regarding the quality of the mobile applications used was 3.5 which lies between “Good” and “Very Good”, which would suggest that even though there is room for improvement, its bus travellers still find it useful. The main criticism received through question 18 from the survey regarding the applications used was the lack of accuracy or reliability in the information provided (23 respondents commented on this), or sometimes lack of information altogether with real time information (RTPI) not working. “Ghost” buses were also mentioned by a few, expressing their frustration when a bus scheduled does not show and simply disappears from the applications and the stop’s sign RTPI without any previous warning of delay or issues.

As stated earlier in this chapter, service reliability is one of the main factors that users are affected by and that defines their preference towards the mode of transport used (when options are available), as well as affects their perception on the quality of the service provided. With the number of tools and technology that are available, expectations regarding the accuracy of information presented are much higher, and the existence of mobile applications for public transport use become less meaningful if they cannot cope with the accuracy expected from them. Badger (2016) was previously referred to as noting that as public transportation in a city becomes more complex, mobile applications become more important to allow users to navigate through the systems available as well as provide them with options that combine different means of transport. These applications need to be constantly updated and improved to provide the best results to their users.

The existing bus system has been in place for a very long time with only minor changes being implemented over the years, thus long-term residents know the defects on the system and despite any faults, are used to allowing for the relevant contingency plans to go around the mobile applications and RTPI issues. Should the proposed Bus Connects program go ahead, there will be major changes put in place that will undoubtedly require plenty of communication from the NTA to Dublin residents prior to, during and after the implementation of changes, and will require the mobile applications available to be updated accordingly to assist bus users in finding the new routes, the connections available and the times of travel expected with the new options, as well as the fares (though the proposed simplified 2-fare structure will provide only two options in the fare to be paid). It is believed that the inaccuracies and conflicting information that is now experienced with the bus applications would make the transition onto any new system much more difficult and confusing for bus commuters in Dublin, considering that some of the existing route will be removed, all routes will be renamed and frequencies (and thus timetables) will be changed.

From the data collected in the survey, a correlation study between the mobile application score rating and the bus service score rating was performed to analyse the relationship between these two variables. While both of these variables have been portrayed as being similar to a scale variable (used in SPSS for interval or ratio data) by determining their mean and standard variation in the previous section portraying the findings of the survey, it is acknowledged that they have ordinal-type characteristics. Likert scales are classified as ordinal scales due to their answer leaning towards one end of a scale or the other which implies a certain "order" is relevant in the answers provided, as is pointed out by (Easterby-Smith *et al.*, 2018, p. 295). For the above, the correlation analysis is carried out through the calculation of Spearman's rho (instead of Pearson's correlation coefficient used for continuous scale type of data) as is suggested in such a case by Easterby-Smith *et al.* (2018, p. 331), which is also considered as providing more conservative results than Pearson's r (Hair *et al.*, 2016). The results obtained through the analysis performed using SPSS can be observed in the table below.

Nonparametric Correlations

Correlations

			How App used is rated	Level of satisfaction with buses
Spearman's rho	How App used is rated	Correlation Coefficient	1.000	.504**
		Sig. (2-tailed)	.	.000
		N	307	306
	Level of satisfaction with buses	Correlation Coefficient	.504**	1.000
		Sig. (2-tailed)	.000	.
		N	306	313

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 16: Correlation Analysis between Mobile App Rating and Bus Satisfaction Scores

From the above, the following is observed: The level of statistical significance, being 0.00 is considered high (a commonly used rule of thumb is that values below 0.05 imply a high level of significance, as stated by Hair *et al.*, (2016)). This result indicates confidence on the reliability of the statistical analysis. Following the indicators provided by Hair et al. (2016), a correlation coefficient of 0.504 indicates a strength of association of moderate level, and by the value being positive it indicates that the direction of the correlation is indicated as positive, meaning when one variable increases, so does the other. In this case, as the level of satisfaction with the mobile applications increases, so does the level of satisfaction with the bus services in general.

This correlation analysis thus, agrees with the previous discussion that the level of satisfaction that bus users feel towards with the relevant mobile applications can influence their level of satisfaction with the quality of service of the overall bus transport system. Reliability on the information available regarding services timetables and routes can impact on an individual's experience with the service as a whole. At the same time, accurate, reliable RTPI and route planner mobile applications form part of the "Agile

city" concept, which is a concept Dublin can aim at achieving through all the upcoming changes and near-future growth expected.

5.4 Bus Fares

As was noted in the previous section, the "package" or "bundle" options offered for bus tickets, namely: rambler, monthly and annual bus tickets, are not popular within the participants of this survey. Whether this is because the savings offered are not sufficiently significant, or the offers available are not advertised adequately and are thus unknown to the bus users, any of these scenarios would make the existence of the rambler, monthly and annual tickets inefficient.

It is worth noting that the survey did not provide any question specifically related to the perception of adequacy in the fare values and the saver options available. Some individuals chose to comment on this in question 17 where they had room to provide "other" ways in which the service could be improved.

The only information provided in the Bus Connects proposal regarding fares was the intention of introducing an integrated payment system to remove penalties when changing buses or modes of public transport, integrating the various public transport alternatives (bus, train and tram) within the same travelling ticketing system. Also the removal of the option for cash purchase of tickets on board of the buses is proposed, and the potential introduction of debit/credit card payment options (Graham, 2017).

As was previously mentioned, the Bus Connects proposal will see a change in the number of fare options available, the currently existing "1 to 3 stages" option will remain a type of fare option with the Bus Connects proposal, however the other two existing fares ("4 to 13 stages" and "more than 13 stages") will be merged into a "90min travel ticket" valid for 90 minutes on any of the types of public transport available. It is not yet known what the price of this 90-min all-public-transport-inclusive ticket will be, however it is expected that it will be somewhere between the "4 to 13 stages" fare and the "more than 13 stages" fare (National Transport Authority, 2018b, p. 4), hence those residents currently commuting via bus between stages 4 and 13 will see a price increase in their travels. From the results of Question 8 in the survey carried out, previously exposed, this will see an effect onto the largest group within the sample population (47.1%), which, when considered as representative of the Dublin's population, would indicate that the vast majority of the residents would suffer a fare increase for the same length of travel.

The above would indicate that a large portion of Dublin's residents could potentially be faced with an increase public transport cost, coupled with the existing unattractive bundle tickets discount options. Should these "discount" options remain unchanged, the Bus Connect changes might not reach the expected 50% increase in bus commuters, as expressed by Graham (2017), or even if it does, would put a strain into the bus users allocated travel budget.

The results regarding the number of stages travelled when taking the bus to the main activity also showed that 8.9% of the sample was unsure of the distance travelled in terms of the defined stages within the city for public transport. While it is the minority within the population, an almost 9% indicates to the researcher a significant number of people that may be spending more than they need on bus fares, but most importantly, it indicates that the system of boundaries for change of fares is not understood by all its users. A tag-on, tag-off approach like the one adopted in Perth, Australia, would simplify this issue by allowing an electronic system and its technology to automatically allocate the corresponding fare in accordance with the stages travelled at tag-off.

As was previously reported by the World Economic Forum (2018), when aiming for an agile city concept one of the metrics that relates to transportation services is the measure of the "time it takes to earn the cost of mean travel time to work". Previous literature found that "in some large cities… low-income earners have longer commuting times" (Zhao and Li, 2016, p. 948) suggesting also that low-income earners would pay for the higher fare prices, due to the greater distance required to be travelled. While Dublin is not yet considered a large city, the above is still considered a relevant statement, as the city continues to grow and the housing prices continue to rise particularly in the city centre, this could be a developing characteristic to be mindful of, particularly as the new Bus Connects proposal would indicate an increase in public transport fares for many of the bus users, as was previously discussed.

Keeping all the above in mind, improving the frequency, punctuality and comfort level offered in buses, trains and trams in Dublin through Bus Connects and other proposals, can fail to achieve the targeted number of future users if the fare prices are not convenient or accessible to the residents (including low-income earners). As previously noted, Ireland has been identified as the city with the second highest public transportation prices currently (Morrell, 2017) and the upcoming fare restructure could lead to further increases, as mentioned.

Apart from developing a flowing transit system that can reduce congestion levels (ideally removing it all together) and provide residents with convenient and effective ways to move around the city, sustainable modes of transport – which includes public transportation systems- are encouraged due to an increasing need to restrict and lower pollution and CO2 emissions. Various cities around the world have acknowledged the need to promote public transport use even if fare collections need to be even partially sacrificed. As noted by Wood (2018) "city planners and policy-makers are turning to "nudge" initiatives to encourage people to behave in more eco-friendly ways". Previous findings noted in section 2 of this study provided examples of these types of initiatives, such as Tallim in Estonia, (and some cities in Germany soon) adopting free transportation systems, or the city of Perth, Australia, that provides a free transit area in the busiest part of the city. A different approach was observed in Bologna, Italy, with an implemented point system to reward sustainable mobility in a different manner. Since the future fare price changes have not yet been disclosed for Dublin, it could be worth keeping these examples of

initiatives promoting public transportation in mind. A free public transportation system could be considered too ambitious, as is currently debated in Paris (De Clercq, 2018), however other initiatives such as the one adopted in Bologna may be more realistic in Dublin's case.

6 Conclusions and Recommendations

The study presented current bus users in Dublin with the opportunity of identifying the main issues that they consider important according to their commuting needs by means of a survey. The survey was presented via various Dublin Facebook groups to reach as many and as varied respondents as possible. The data collected showed that indeed a varied representation was achieved due to the representation of frequent and sporadic bus travellers, students and workers, of different age groups and travelling different distances to reach their activities.

The most popular improvement suggestions identified from the primary research were then compared to the proposals for the latest bus network redesign, Bus Connects, that is currently in public consultation phase as a first draft. This analysis showed that while various of the bus users concerns are being improved through the NTA's proposal, such as the addition of orbital routes, the increased frequencies on bus services and the integration of fare system with other modes of transport, the second main issue brought up by bus users has not been dealt with in the initial draft: the extension of bus service hours into the night both during the week and on weekends. The data collected indicates that the existing night bus services are considered insufficient or inadequate by city residents.

Another unresolved issue in the Bus Connects proposal is the inclusion of more express routes, though this measure was not considered as relevant as the extension of normal service hours, it was still relevant to a significant number of respondents. The proposal includes the same number of express routes that currently exist. However, the future works on "Bus Corridors" for the core routes is expected to improve the timing on these core routes. Should this be the case, the request for express routes would be partly satisfied, while the number of stops would not be reduced, buses are expected to travel faster and meet their expected arrival times which are also proposed at higher frequencies.

The relevance of suitable mobile applications was also analysed, proving from the data collected that there is a positive and significant correlation between the satisfaction on mobile applications used and the satisfaction on the overall bus system service. This finding was in line with literature that highlighted the growing importance of mobile applications as public systems grow bigger and/or more complex and suggested that reliability of the transportation system was the most valued aspect, more so than frequency of service or travel time, suggesting bus users prefer to have accurate and updated information on routes and bus arrival times above all. There is no mention on updates or modifications for the mobile applications in the Bus Connects proposal as it stands. The new network distribution of buses and the new bus numbering structure, as well as the modified timetables, however, imply that mobile applications will be updated to suit. It would be beneficial if the reliability on the RTPI system they use was be improved during this updating process as this was identified as the main concern relating to the use of mobile applications.

A study like the one performed provides a general outlook on the perceived issues of the existing transportation system characteristics. It is expected, however, that the experiences and quality of the bus service varies in different areas of the city, residents living closer to the city centre would have different transport opportunities (number of routes available and frequency) than those living in outer neighbourhoods. A more specific analysis of the existing and proposed bus network for each independent neighbourhood would be suggested to provide a more detailed study of the effects that the new proposal.

As previously noted, this study did not differentiate the needs of different groups of the community, such as travellers with disabilities, travelling with children, pregnant women, and the study also excluded the participation of young and elderly people. It would be worth studying the impact of the proposal on these various groups, particularly the effects of a network that would require interchanges for some of the routes that are now direct.

Reflections

Undertaking and MBA course after having graduated from my bachelor's degree more than 10 years ago has proven to be a bigger challenge than I had anticipated. Spending so many years as part of the working force had not only made my academic studying skills a bit rusty, but also, I have to admit, has faced me with a slightly changed methodology of academic learning, more independent and with many more sources of information available for research.

Personally, I found the autonomous part of this degree -the dissertation period- the most challenging of all, having to rely on my own organizational and research skills to advance through this stage of the degree. The topic chosen is current and constantly changing, not only in Dublin, public transportation systems get revisited and updated continuously in most active cities, particularly those experiencing growth. For this reason, the literature on this is very vast and it can lead to many varied sub-topics. This is something that I could have envisioned better at the proposal stage, with the information and experience I have now attained after this process is completed.

The different modules included in the MBA have provided me with an overall perspective of the various aspects included in a business, which was what I was aiming for when enrolling for the course. However, the research methodology, methods and techniques learned through the development of the dissertation and the literature found, as well as the data analysis techniques for the various type of data available were broader topics than anticipated and more complex, the knowledge obtained in both of areas these was not expected at the time of deciding to embark on this MBA. I was also particularly pleased with learning how to use a new software for statistical analysis, SPSS, even if the use of it in this dissertation was limited.

The primary quantitative research carried out led to the learning process on questionnaire development and required some creativity for finding respondents, even when it was just distributed through one social media, it was necessary to find appropriate groups that would provide with relevant data. The results obtained were to my satisfaction, however some of the notes included by respondents proved that there were other areas available for study in this topic, such as the safety on buses. This was interesting to observe as a researcher and proves that there generally are more branches in the same topic to be considered than initially thought of. The original topic presented as a proposal in second semester mutated slightly as the secondary research was developed further, while the main topic focusing on Dublin's bus system was maintained, the focus on the type of research changed somewhat as more information was found on the subject.

This experience has provided opportunities for improving academically with concepts, theories, researching and obtaining information that I did not have before. At the same time, it has provided a platform to improve (mainly through practice) on other areas such as debating, working in groups,

critical thinking, giving presentations or preparing written reports. As a civil engineer, the development of reports has been a constant and common task during the years, even during my bachelor's studies, however the information portrayed was usually based in graphs and figures, which being issued within peers or managers of similar background do not require detailed explanation. Developing essays and reports with plenty of written words has been a welcomed challenge, that I believed has led to the improvement of writing skills.

Bibliography

Andong, R. F. and Sajor, E. (2017) 'Urban sprawl, public transport, and increasing CO2 emissions: the case of Metro Manila, Philippines', *Environment, Development and Sustainability; Dordrecht*, 19(1), pp. 99–123. doi: http://dx.doi.org/10.1007/s10668-015-9729-8.

Badger, E. (2016) *Have public transport networks become too complex for our brains?*, *World Economic Forum*. Available at: https://www.weforum.org/agenda/2016/03/have-public-transport-networks-become-too-complex-for-our-brains/ (Accessed: 16 November 2018).

Bodkin, P. (2018) *Ireland's chronic housing shortage is the economy's 'most pressing issue'*, *TheJournal.ie*. Available at: http://www.thejournal.ie/ireland-housing-shortage-2-3929194-Mar2018/ (Accessed: 10 August 2018).

Boutot, P.-H. (2015) *How transport is changing in China*, *World Economic Forum*. Available at: https://www.weforum.org/agenda/2015/06/how-transport-is-changing-in-china/ (Accessed: 22 November 2018).

Burke-Kennedy, E. (2017) *Housing crisis stems from apartment shortage, economist claims*, *The Irish Times*. Available at: https://www.irishtimes.com/business/economy/housing-crisis-stems-from-apartment-shortage-economist-claims-1.3231943 (Accessed: 11 August 2018).

Burns, S. (2018a) *BusConnects plan: South Dublin council has 'major concern'*, *The Irish Times*. Available at: https://www.irishtimes.com/news/ireland/irish-news/busconnects-plan-south-dublin-council-has-major-concern-1.3675882 (Accessed: 25 December 2018).

Burns, S. (2018b) *National road system may not be able to cope with BusConnects plans*, *The Irish Times*. Available at: https://www.irishtimes.com/news/ireland/irish-news/national-road-system-may-not-be-able-to-cope-with-busconnects-plans-1.3677108 (Accessed: 30 December 2018).

Burns, S. (2018c) *Nearly 350 homes will lose part of their gardens in BusConnects plan*, *The Irish Times*. Available at: https://www.irishtimes.com/news/ireland/irish-news/nearly-350-homes-will-lose-part-of-their-gardens-in-busconnects-plan-1.3697852 (Accessed: 30 December 2018).

Burns, S. (2018d) *The bus battle: 'Moving routes won't solve Dublin's problem'*, *The Irish Times*. Available at: https://www.irishtimes.com/news/environment/the-bus-battle-moving-routes-won-t-solve-dublin-s-problem-1.3644515 (Accessed: 12 November 2018).

Carroll, P., Caulfield, B. and Ahern, A. (2017) 'Exploring a Case of Car Usage and Ownership Reduction in Dublin Through Car-Shedding Interventions', *Universities' Transport Study Group*, pp. 1–12.

Central Statistics Office (2016) *Age Groups - CSO - Central Statistics Office*. Available at: https://www.cso.ie/en/releasesandpublications/ep/p-cp3oy/cp3/agr/ (Accessed: 9 August 2018).

Central Statistics Office (2018) *Population and Migration Estimates April 2018*. Available at: https://www.cso.ie/en/releasesandpublications/er/pme/populationandmigrationestimatesapril2018/ (Accessed: 15 November 2018).

Clarke, V. (2018) *Dublin Bus routes redesign is for the 'city of the future'*, *The Irish Times*. Available at: https://www.irishtimes.com/news/environment/dublin-bus-routes-redesign-is-for-the-city-of-the-future-1.3552330 (Accessed: 12 August 2018).

De Clercq, G. (2018) 'Paris mulls free public transport to reduce pollution', *Reuters*, 20 March. Available at: https://www.reuters.com/article/us-france-paris-transportation-idUSKBN1GW1KU (Accessed: 6 January 2019).

Department of Housing, Planning and Local Government (2018) *Urban Development and Building Heights - Guidelines for Planning Authorities*. Consultation Draft. Ireland: Department of Housing, Planning and Local Government, pp. 1–14. Available at: https://www.housing.gov.ie/sites/default/files/publications/files/draft_urban_development_and_building_heights_guidelines.pdf (Accessed: 4 January 2019).

Department of Transport (2011) *Public Transport for Perth in 2031: Mapping out the future for Perth's Public Transport Network*. Draft for Consultation. Australia, pp. 1–43. Available at: http://www.ppt.asn.au/pubdocs/ABOUT_P_PT_Plan2031.pdf (Accessed: 6 January 2019).

DoDublin (2018) *Dublin Bus*. Available at: https://dodublin.ie/dodublin-card/dublin-bus (Accessed: 7 January 2019).

Dublin Bus (no date) *Xpresso - Dublin Bus*. Available at: http://www.dublinbus.ie/Your-Journey1/Timetables/Xpresso/ (Accessed: 26 December 2018).

Easterby-Smith, M. *et al.* (2018) *Management & Business Research*. 6th edn. U.K.: SAGE Publications, Inc.

Fang, K. (2015) *What makes people use public transport?*, *World Economic Forum*. Available at: https://www.weforum.org/agenda/2015/03/what-makes-people-use-public-transport/ (Accessed: 7 January 2019).

FitzGerald, J. (2018) *John FitzGerald: Dublin's bus network needs major overhaul*, *The Irish Times*. Available at: https://www.irishtimes.com/business/economy/john-fitzgerald-dublin-s-bus-network-needs-major-overhaul-1.3668211 (Accessed: 15 November 2018).

Gino, F. *et al.* (2017) 'Reclaim Your Commute', *Harvard Business Review*, 1 May. Available at: https://hbr.org/2017/05/reclaim-your-commute (Accessed: 31 October 2018).

Ginty, C. (2017) 'Millions spent on Dublin's Bus Rapid Transport projects', *IrishCycle.com*, 24 January. Available at: http://irishcycle.com/2017/01/24/millions-spent-on-dublins-bus-rapid-transport-projects/ (Accessed: 26 December 2018).

Gleeson, C. (2018) *Hard Brexit would damage ability to build houses in State, TDs told*, *The Irish Times*. Available at: https://www.irishtimes.com/news/social-affairs/hard-brexit-would-damage-ability-to-build-houses-in-state-tds-told-1.3696537 (Accessed: 20 November 2018).

Graham, A. (2017) 'Fare deal – BusConnects project aims to increase passenger numbers by 50%', *Engineers Journal*, 4 July. Available at: http://www.engineersjournal.ie/2017/07/04/busconnects-transport-plan-dublin/ (Accessed: 27 December 2018).

Gray, A. (2018) *Estonia is making public transport free*, *World Economic Forum*. Available at: https://www.weforum.org/agenda/2018/06/estonia-is-making-public-transport-free/ (Accessed: 31 October 2018).

Gray, D. E. (2013) 'Theoretical Perspectives and Research Methodologies', in *Doing Research in the Real World*. 3rd edn. SAGE Publications, Inc., pp. 15–38.

Gunn, G., Stanley, M. and Temmer, J. (2018) *Making Winnipeg a Smart City With New Technologies*, *International Institute for Sustainable Development (IISD)*. Available at: https://www.iisd.org/blog/making-winnipeg-smart-city-new-technologies (Accessed: 30 November 2018).

Haddaoui, C. (2018) *Cities Can Save $17 Trillion by Preventing Urban Sprawl | World Resources Institute*. Available at: https://www.wri.org/blog/2018/11/cities-can-save-17-trillion-preventing-urban-sprawl (Accessed: 20 November 2018).

Hair, J. F., Jr *et al.* (2016) *Essentials of Business Research Methods*. Third. New York: Routledge.

Hamilton, P. (2018) *GoCar to invest €10m in service expansion*, *The Irish Times*. Available at: https://www.irishtimes.com/business/transport-and-tourism/gocar-to-invest-10m-in-service-expansion-1.3689810 (Accessed: 20 November 2018).

Hooper, P. *et al.* (2018) *Creating liveable cities in Australia: A scorecard and priority recommendations for Perth*. Australia: RMIT University. Available at: http://cur.org.au/cms/wp-content/uploads/2018/08/perth-scorecard-1.pdf (Accessed: 6 January 2019).

Irish Rail (2017) *DART and Short Hop Zone Fares*, *Irish Rail*. Available at: http://www.irishrail.ie/rail-fares-and-tickets/dart-and-short-hop-zone (Accessed: 3 January 2019).

Jarret Walker & Associates (2018a) *Chapter 7: Recommended Network Plan*. Public Consultation Report, pp. 75–153. Available at: https://busconnects.ie/media/1239/chapter7recommendednetworkplan.pdf (Accessed: 26 December 2018).

Jarret Walker & Associates (2018b) *Chapter1: What is the bus network redesign?* Public Consultation Report, pp. 19–25. Available at: https://busconnects.ie/media/1233/chapter1whatisthebusnetworkredesign.pdf (Accessed: 27 December 2018).

Jarret Walker & Associates (2018c) *Dublin Area Bus Network Redesign Public Consultation Report - Summary*. Available at: https://busconnects.ie/media/1311/busconnects-dublin-network-redesign-summary_tagged_resized.pdf (Accessed: 3 December 2018).

Kelly, O. (2017) *Dublin Bus loses control of 24 bus routes serving suburbs*, *The Irish Times*. Available at: https://www.irishtimes.com/news/social-affairs/dublin-bus-loses-control-of-24-bus-routes-serving-suburbs-1.3182303 (Accessed: 23 April 2018).

Kilraine, J. (2018) 'More than 50% of commuter journeys use public transport'. Available at: https://www.rte.ie/news/dublin/2018/0522/965236-commute/ (Accessed: 5 November 2018).

Lah, O. *et al.* (2015) 'TRANSFERABLITY OF SUSTAINABLE URBAN TRANSPORT SOLUTIONS', *Energy, Climate and Air Quality Challenges: The Role of Urban Transport Policies in Developing Countries*, p. 19.

Lyne, L. (2018) *Dublin developments could be transformed with lifting of height restrictions*, *dublinlive*. Available at: https://www.dublinlive.ie/news/dublin-news/move-lift-height-restrictions-dublin-14612910 (Accessed: 4 January 2019).

MacDonald, C. (2016) 'The capacity conundrum', *OECD Observer*, (305), pp. 1–3.

McGee, H. (2018) *Housing: Urban developments to be focused within existing footprints*, *The Irish Times*. Available at: https://www.irishtimes.com/news/politics/housing-urban-developments-to-be-focused-within-existing-footprints-1.3394929 (Accessed: 18 April 2018).

McHugh, R. (2018) *25% would support greater rent controls to solve housing crisis Ireland,Property, news for Ireland, Commercial Property,Property,*. Available at: https://www.businessworld.ie/news-from-ireland/25-would-support-greater-rent-controls-to-solve-housing-crisis-571083.html (Accessed: 11 August 2018).

Morgenroth, E. L. W. (2018) *Prospects for Irish regions and counties: scenarios and implications*. ESRI. doi: 10.26504/RS70.

Morrell, A. (2017) *These are the cities where commuting costs the most*, *World Economic Forum*. Available at: https://www.weforum.org/agenda/2017/05/these-are-the-cities-where-commuting-costs-the-most/ (Accessed: 6 January 2019).

Murray, R. (2017) 'Commuting in Dublin: An Analysis of Factors as Predictors of Occupational Burnout', p. 45.

National Transport Authority (2016a) *Dublin City Centre Transport Study*, pp. 1–123. Available at: http://www.dublincity.ie/sites/default/files/content/RoadsandTraffic/Traffic/Documents/Dublin%20City%20Centre%20Transport%20Study%20May%202016%20corrected%20cycle%20network.pdf.

National Transport Authority (2016b) *Dublin City Centre Transport Study - Executive Summary*. Available at: http://www.dublincity.ie/sites/default/files/content/RoadsandTraffic/Traffic/Documents/NTA%20Dublin

%20City%20Centre%20Transport%20Study%202016%20exec%20summary.pdf (Accessed: 23 April 2018).

National Transport Authority (2018a) *Core Bus Corridor Project - BusConnects*. Available at: https://busconnects.ie/initiatives/core-bus-corridor-project/ (Accessed: 5 December 2018).

National Transport Authority (2018b) *Determination of cash, Leap and pre-paid fares including monthlies and annual fares for all operators providing contracted public transport services with effect from 1 December 2018*. Determination No. 1-2018. Available at: https://www.nationaltransport.ie/wp-content/uploads/2018/10/Fares_Determination_2018_Final-1.pdf (Accessed: 12 November 2018).

National Transport Authority (2018c) *What is Bus Connects?* Available at: https://busconnects.ie/about/ (Accessed: 27 December 2018).

O'Carroll, L. (2017) 'How London's loss is Dublin's gain after Brexit', *The Guardian*, 1 December. Available at: https://www.theguardian.com/politics/2017/dec/01/how-londons-loss-is-dublins-gain-after-brexit (Accessed: 15 November 2018).

O'Donoghue, P. (2017) *'We need high-quality public transport. Cork and Galway should get light rail'*, *TheJournal.ie*. Available at: http://www.thejournal.ie/national-planning-framework-draft-ireland-2-3713191-Nov2017/ (Accessed: 18 April 2018).

van Oort, N. *et al.* (2015) 'Data driven improvements in public transport: the Dutch example', *Public Transport*, 7(3), pp. 369–389. doi: 10.1007/s12469-015-0114-7.

Power, J. (2018) *Dublin's rental black market: Bunk beds, no contracts, overcrowding*, *The Irish Times*. Available at: https://www.irishtimes.com/news/social-affairs/dublin-s-rental-black-market-bunk-beds-no-contracts-overcrowding-1.3374207 (Accessed: 12 August 2018).

Rafter, D. O. (1996) 'Sustainable transport planning and the Dublin transportation initiative', *European Planning Studies*, 4(2), p. 225.

Reid, O. (2018) *Housing crisis must be solved to avoid another crash*, *The Irish Times*. Available at: https://www.irishtimes.com/opinion/housing-crisis-must-be-solved-to-avoid-another-crash-1.3343163 (Accessed: 10 August 2018).

Reuters (2018) *Germany is trialing a plan for free public transport in polluted cities*, *World Economic Forum*. Available at: https://www.weforum.org/agenda/2018/02/germany-is-trialing-a-plan-for-free-public-transport-in-polluted-cities/ (Accessed: 30 November 2018).

Saunders, M., Lewis, P. and Thornhill, A. (2009) *Research Methods for Business Students*. Fifth. England: Pearson Education Limited.

Saunders, M., Lewis, P. and Thornhill, A. (2012) *Research Methods for Business Students*. 6th edn. Pearson Education Limited.

taxsaver.ie (2018) *EMPLOYEE - www.taxsaver.ie*. Available at: https://www.taxsaver.ie/Commuters/ (Accessed: 3 January 2019).

Transperth (2018) *Transperth Free Transit Zones*. Available at: https://www.transperth.wa.gov.au/tickets-fares/free-travel/transit-zones (Accessed: 6 January 2019).

Twomey, K. (2018) 'Latest Social Media Stats for Ireland', *COMMUNICATIONS HUB*, 24 February. Available at: http://communicationshub.ie/blog/2018/02/24/latest-social-media-stats-ireland/ (Accessed: 7 January 2019).

Ustaoglu, E. *et al.* (2017) 'Developing and Assessing Alternative Land-Use Scenarios from the MOLAND Model: A Scenario-Based Impact Analysis Approach for the Evaluation of Rapid Rail Provisions and Urban Development in the Greater Dublin Region', *Sustainability*, 10(1), p. 61. doi: 10.3390/su10010061.

Wangsness, P. B., Rødseth, K. L. (VerfasserIn) and Hansen, W. (VerfasserIn) (2017) 'A review of guidelines for including wider economic impacts in transport appraisal', *Transport reviews : TR*, 37(1), pp. 94–115.

Weckler, A. (2018) *Elderly are now Facebook's biggest users as teens flock to Instagram*, *Independent.ie*. Available at: https://www.independent.ie/business/technology/elderly-are-now-facebooks-biggest-users-as-teens-flock-to-instagram-37596537.html (Accessed: 7 January 2019).

Wise, J. (2012) 'Short-term International Students Perceptions of their Learning and Sociocultural Experiences in Dublin Business School, Ireland', p. 64.

Wood, J. (2018) *In this Italian city you get rewarded with beer and ice cream for not driving your car*, *World Economic Forum*. Available at: https://www.weforum.org/agenda/2018/10/bologna-rewards-cycling-walking/ (Accessed: 30 November 2018).

World Economic Forum (2018) *Agile Cities: Preparing for the Fourth Industrial Revolution*. Available at: http://www3.weforum.org/docs/WP_Global_Future_Council_Cities_Urbanization_report_2018.pdf (Accessed: 20 November 2018).

Yen, B. T. H. *et al.* (2016) 'Assessing Interchange Effects in Public Transport: A Case Study of South East Queensland, Australia', *ScienceDirect*. (World Conference on Transport Research), pp. 4019–4037. doi: 10.1016/j.trpro.2017.05.268.

Zhan, M. (2016) 'Car-lite Urban Mobility as Urban Sustainable Innovation', *Innovation Magazine*, 15(1), pp. 32–39.

Zhao, P. and Li, S. (2016) 'Restraining transport inequality in growing cities: Can spatial planning play a role?', *International Journal of Sustainable Transportation*, 10(10), pp. 947–959. doi: 10.1080/15568318.2016.1191693.

Appendices

Appendix A

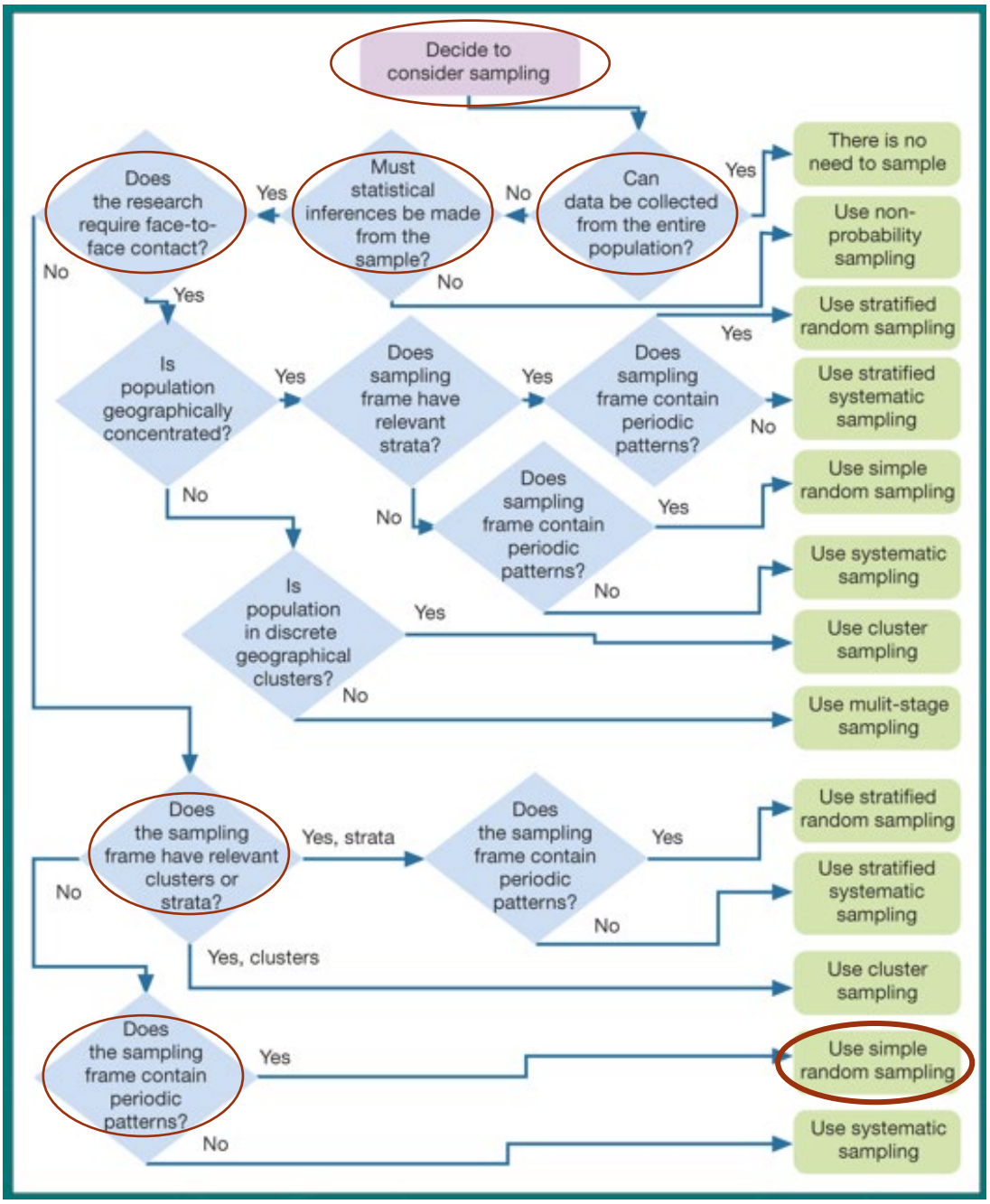


Figure 17: Sampling Technique (Saunders, Lewis and Thornhill, 2009, p. 223)

Appendix B

Sample Sizes with 95% Confidence level

Table 7.1 Sample sizes for different sizes of population at a 95 confidence level (assuming data are collected from all cases in the sample)

	Margin of error			
Population	**5%**	**3%**	**2%**	**1%**
50	44	48	49	50
100	79	91	96	99
150	108	132	141	148
200	132	168	185	196
250	151	203	226	244
300	168	234	267	291
400	196	291	343	384
500	217	340	414	475
750	254	440	571	696
1 000	278	516	706	906
2 000	322	696	1091	1655
5 000	357	879	1622	3288
10 000	370	964	1936	4899
100 000	383	1056	2345	8762
1 000 000	384	1066	2395	9513
10 000 000	384	1067	2400	9595

Figure 18: 95% confidence level sample sizes (Saunders, Lewis and Thornhill, 2009, p. 219)

Appendix C

Table 1 Components of the annual population change, 1987 - 2018

Year ending April	Components of Population change							
	Births	Deaths	Natural increase	Immigrants	Emigrants	Net migration	Population change	Population
	'000							
1987	61.2	32.2	29.0	17.2	40.2	-23.0	5.9	3,546.5
1988	57.8	31.6	26.2	19.2	61.1	-41.9	-15.8	3,530.7
1989	53.6	31.0	22.6	26.7	70.6	-43.9	-21.2	3,509.5
1990	51.9	32.8	19.1	33.3	56.3	-22.9	-3.7	3,505.8
1991	53.1	31.1	22.0	33.3	35.3	-2.0	19.9	3,525.7
1992	52.8	31.4	21.4	40.7	33.4	7.4	28.8	3,554.5
1993	50.4	30.4	20.0	34.7	35.1	-0.4	19.6	3,574.1
1994	49.1	32.6	16.6	30.1	34.8	-4.7	11.8	3,585.9
1995	48.4	31.2	17.2	31.2	33.1	-1.9	15.4	3,601.3
1996	48.8	32.0	16.7	39.2	31.2	8.0	24.8	3,626.1
1997	50.7	31.7	19.0	44.5	25.3	19.2	38.2	3,664.3
1998	52.7	31.2	21.5	46.0	28.6	17.4	38.8	3,703.1
1999	53.7	32.4	21.2	48.9	31.5	17.3	38.5	3,741.6
2000	54.0	32.1	21.8	52.6	26.6	26.0	47.9	3,789.5
2001	55.1	30.2	24.8	59.0	26.2	32.8	57.7	3,847.2
2002	58.1	29.3	28.8	66.9	25.6	41.3	70.0	3,917.2
2003	60.8	28.9	31.9	60.0	29.3	30.7	62.6	3,979.9
2004	62.0	28.6	33.3	58.5	26.5	32.0	65.3	4,045.2
2005	61.4	27.9	33.5	84.6	29.4	55.1	88.6	4,133.8
2006 [1]	61.2	27.0	34.2	107.8	36.0	71.8	106.0	4,232.9
2007	66.6	28.4	38.2	151.1	46.3	104.8	142.9	4,375.8
2008	73.0	28.0	44.9	113.5	49.2	64.3	109.2	4,485.1
2009	75.3	28.6	46.7	73.7	72.0	1.6	48.3	4,533.4
2010	77.2	28.4	48.8	41.8	69.2	-27.5	21.4	4,554.8
2011	75.1	27.7	47.5	53.3	80.6	-27.4	20.1	4,574.9
2012	73.2	28.7	44.5	57.3	83.0	-25.7	18.8	4,593.7
2013	69.4	29.8	39.6	62.7	81.3	-18.7	21.0	4,614.7
2014	68.4	29.2	39.2	66.5	75.0	-8.5	30.8	4,645.4
2015	66.4	29.9	36.5	75.9	70.0	5.9	42.3	4,687.8
2016 [2]	65.4	29.8	35.6	82.3	66.2	16.2	51.8	4,739.6
2017 [3]	63.9	30.8	33.1	84.6	64.8	19.8	52.9	4,792.5
2018 [3]	61.2	30.7	30.5	90.3	56.3	34.0	64.5	4,857.0

[1] Up to and including 2005, the annual population estimates are on a de facto basis. From 2006 onwards the concept of usual residence is used.

[2] Census of Population 2016.

[3] Preliminary.

Figure 19: Ireland's Population Table 1987-2018 (Central Statistics Office, 2018)

Appendix D

Primary Research Questionnaire

Dublin Bus users' experience and impact on accommodation decisions

Master's Dissertation Research - Dublin Business School (DBS)

* Required

Introduction

You are being asked to take part in a research study which aims to investigate Dublin bus users' experience with the existing bus services and the consideration regarding bus public transport access at the time of evaluating location options for accommodation.

In this study, you will be asked to respond to a series of statements or questions relating to different aspects in your experience using the bus services in Dublin and select the response option or options that best suits you, or provide additional comment where applicable.

The study typically takes less than 5 minutes to complete.

Participants' Rights

You may decide to stop being a part of the research study at any time without explanation required from you. You have the right to ask that any data you have supplied to that point be withdrawn / destroyed.

You have the right to omit or refuse to answer or respond to any question that is asked of you.

You have the right to have your questions about the procedures answered (unless answering these questions would interfere with the study's outcome). If you have any questions as a result of reading this information sheet, you should ask the researcher before the study begins.

Confidentiality/ Anonymity

The data I collect does not contain any personal information about you except age range and rough estimate on amount spent on bus services monthly, you will not be identifiable as a participant of this study. All responses are strictly confidential and will be used for the purpose of this master's dissertation research and analysis.

I thank you for your contribution to this research and will be glad to answer your questions about this study at any time, you may contact me at: 10351115@mydbs.ie, or my supervisor at: heikki.laiho@dbs.ie

1. **Please click "I accept" to continue** *
   Mark only one oval.
   - ◯ I accept
   - ◯ I do not accept *Stop filling out this form.*

Please complete the questions below

Master's Dissertation Research

2. **What age group do you belong to?** *
   Mark only one oval.
   - ◯ Below 18 years old (Please do not proceed with questionnaire) *After the last question in this section, stop filling out this form.*
   - ◯ Between 18 and 25 years old
   - ◯ Between 26 and 45 years old
   - ◯ Between 46 and 65 years old
   - ◯ Above 65 years old (Please do not proceed with questionnaire) *After the last question in this section, stop filling out this form.*

3. **How often do you use busses in Dublin?** *
Mark only one oval.

- ◯ Never (Please do not continue with questionnaire) *After the last question in this section, stop filling out this form.*
- ◯ Rarely: up to 10 one-way trips per month
- ◯ Sometimes: Between 10 and 20 one-way trips per month
- ◯ Frequently: More than 20 trips per month

4. **How far is the nearest bus stop to your home?** *
Mark only one oval.

- ◯ Less than 5 minutes walk
- ◯ Between 5 to 10 minutes walk
- ◯ Between 10 to 15 minutes walk
- ◯ More than 15 mins walk

5. **Do you usually combine a bus with other means of public transport (LUAS or DART) for commuting?** *
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Only sometimes

6. **Do you commute via bus during the weekend?** *
Mark only one oval.

- ◯ Yes
- ◯ No

7. **Do you commute via bus during nights (between 11:30pm and 5:00am)?** *
Mark only one oval.

- ◯ Yes
- ◯ No

8. **What is your main reason for commuting?**
Mark only one oval.

- ◯ Work
- ◯ Study
- ◯ Work and Study
- ◯ Other

9. **From the bus fare options available, which one do you use when commuting from your home to your most frequent activity?** *
Mark only one oval.

- ◯ 1 to 3 stages
- ◯ 4 to 13 stages
- ◯ More than 13 stages
- ◯ Unsure

10. **How long is the overall one-way bus trip to your main activity? (please indicate total time on one-way trip spent on buses only) Please indicate longest trip time if length of trip varies per day/ time of day.** *
Mark only one oval.

- ◯ 10 minutes or less
- ◯ Between 10 and 25 minutes
- ◯ Between 25 and 40 minutes
- ◯ Between 40 and 55 minutes
- ◯ Between 55 and 70 minutes
- ◯ More than 70 minutes

11. **On a scale of 1 to 5, how important was accessibility to bus routes at the time of choosing location for accommodation?** *
Mark only one oval.

	1	2	3	4	5	
Not at all important	◯	◯	◯	◯	◯	Very important

12. **Please tick any mobile Application you use for bus times/routes (you may choose more than one)** *
Check all that apply.

- [ ] Dublin Bus App
- [ ] TFI Journey Planner
- [ ] Google Maps
- [ ] Do not use any
- [ ] Other: _____

13. **In general, how do you rate the phone Application/s used for bus times/routes information?**
Mark only one oval.

	1	2	3	4	5	
Poor	◯	◯	◯	◯	◯	Excellent

14. **Please indicate any fare saver payment options you use from the options below (You can select more than one option, if applicable)**
Check all that apply.

- [ ] Leap Card
- [ ] Student Discount
- [ ] 5-Day Rambler ticket
- [ ] 30-Day Rambler ticket
- [ ] Monthly Dublin Bus ticket
- [ ] Annual Dublin Bus ticket
- [ ] Tax-saver scheme
- [ ] None of the above. Pay cash each time
- [ ] Other: _____

15. **On a scale of 1 to 5, how satisfactory is the bus service in Dublin for your commuting needs?**
Mark only one oval.

	1	2	3	4	5	
Poor	◯	◯	◯	◯	◯	Excellent

16. **Please indicate (roughly) how much you spend monthly on bus services**
Mark only one oval.

- ◯ Up to €30
- ◯ Between €30 and €65
- ◯ Between €65 and €100
- ◯ Between €100 and 140
- ◯ More than €140
- ◯ Prefer not to say

17. **From the options below, tick ONLY those applicable that would improve your commuting experience** *

Check all that apply.

- [ ] Extended bus service hours on WEEKDAYS
- [ ] Extended bus service hours on WEEKENDS
- [ ] More frequent services on WEEKDAYS
- [ ] More frequent services on WEEKENDS
- [ ] Additional stops
- [ ] More express routes
- [ ] Integrated payment system to combine bus fares with LUAS and DART (payment of fare per overall distance instead of per each mode of transport)
- [ ] Ring-type routes connecting outer neighbourhoods (avoiding city centre)
- [ ] Mobile App improvement, please state in next question
- [ ] Not Applicable
- [ ] Other: _____

18. **If selected in previous question, please specify which mobile App you are referring to and what improvement you recommend**

_____